Dear Editor, Solid Earth

Please find posted our revised version of our article **Analogue experiments on releasing and restraining bends and their application to the study of the Barents Shear Margin.**
We would like to thank the anonymous reviewers for their thorough and insightful reviews, which helped to significantly improve the quality of the manuscript.

We have particularly condensed, simplified and removed some repetitions between introduction and discussion, particularly concerning regional aspects.

Below we detail our response to the reviewers' comments and suggestions.

One annotated and one clean version in word-format of the manuscript that display revisions done by us are posted as separate files.

**Please note that the symbols λ and μm (as seen in word-file lines 246 and 442) comes out as square in the pdf-file that was generated in the editorial procedure.**

**Comments of Reviewer 1:**

Both reviewers find the regional information to be too extensive and repetitive. Several changes have been done to avoid this (see detailed comments related to comments from Reviewer 2) below. Reviewer 1 found the sequence of presentations of structural elements to be non-intuitive. We have restructured this section so that regional structural elements are presented in sequence from north to south.

Details about the **experimental set-up** and dimensions are given in the introduction to the Experiments and in Figure 3B (perhaps overlooked by reviewer?). An addendum D to Figure 3 (photograph) has been produced to highlight the varying width of the silicone putty as described in the text. Expanding the modelling setup description as requested by the reviewer is at variance with the opinion of reviewer 2, who wants us to shorten the modelling setup section.

We agree that using **PIV methods** would allow for a quantitative analysis of the modelling results. Such analysis has previously been performed by us (Leever et al., 2011) in context of strain partitioning in a shear margin environment. Besides that, the reasons why we refrained adding this method are as follows: 1. As PIV software relies on pattern recognition algorithms applied to successive top-view photographs, adding syn-tectonic sedimentation during the model runs, significantly alters the pattern and adds a big deal of uncertainty to the areas where sedimentation has been applied. As such we feel that a qualitative analysis of the models based on top-view and cross-section images allows for a more detailed and accurate description of the models. 2. focusing on the regional aspects of the Barents Shear Margin in this paper, we found that a full PIV-analysis would take much space and attention,

and that this would fit better into an article that would be dedicated to the experimental methods and analysis. For the reasons above we prefer to stick to the model analysis as presented, which in our view is sufficiently well aligned with the available kinematic and geometric data from the natural laboratory.

We have tried to focus the **discussion** on the application of the modelling results on the Barents Sea problems. The discussion and conclusions have been clarified and sharpened on the points requested by reviewer.

**Figures/figure captions** 1, 2, 3, 5, 6, 7, 9 and 10 have been revised according to comments by the reviewer (specified below).

**Grammar and spelling.** The manuscript has been run through word spell- and grammar checks. Misprints and unclear phrasings identified by the reviewer have been corrected. The reviewer has identified some sections with long/complex phrasings. These have been rewritten/simplified.

**General comments from Reviewer 2:**

Abstract has been shortened, omitting general regional information that can be read from the general introduction. Main conclusions have been high-lighted.

Regional descriptions have been modified and simplified to ease discussions of regional structures. Some parts that refer to previous descriptions (like fold families) have been omitted to avoid confusion between present (PSE) and previous nomenclature.

Reference to both seismic interpretations and experimental results have been strengthened and Figure 2 has been expanded to strengthen the relation between observations in reflection seismic data and experiments.

Figures and related text in manuscript have been revised/harmonized to enhance clarity.

Discussion of regional aspects have been simplified on several points.

Reviewer 2 expresses concern about how the geometry of the shear margin (e.g. area of crustal thinning) was constrained. This is fully based on seismic mapping and an additional figure (**Figure 3D**) has been prepared to display the configuration (see comments to figures below).

We have found that taking out lines 449-458 as suggested by Reviewer 2 is at variance with the opinion of Reviewer 1 who wants us to expand on the model setup and scaling section. As these lines contain among others critical information on the length-scale ratio, we did not find it logic to remove this information from the text.

**Specific comments Reviewers 1 and 2**

The following specific changes emphasize points of revisions in line with general revisions as suggested in General comments above. Comments are marked R1 and R2 to link the comment to the review documents in each case.

Lines 148-151 (R1): This section has been expanded and specified when it comes to specification of general problems related to the analyzed area.

Line 165 (R1): The relation between the Barents shear margin and the de Geer zone has been specified.

Lines 167ff (R1): “Structuring” has been changed to “structural development” throughout the manuscript.

Line 170 (R2): Further description of these segments follows in lines 175ff.

Line 175 (R1): Moved to Senja shear margin as suggested.

Line180 (R1): Basin name has been included.

Line 188 (R2): Sedimentary thickness specified.

Line 208ff: (R1) Presentation/description of the Vestbakken Volcanic Province to be moved? We have restructured this section so that regional structural elements are presented in sequence from north to south.

Line 212 (R2): The relative positions of the Sørvestsnaget Basin and the Senja Ridge have been emphasized.

Line 225 (R2): Rephrased

Line 232 (R1): The reference given concerns the two last sentences in the section.

Line 246 (R2): The square in the pdf-file is λ in the word document. The l was transformed by the building of the pdf-document.

Line 250 (R1): Changed to “linked”

Line 271 (R2): Misprint. Figure-reference taken out.

Line 273 (R2): Sentence has been removed.

Lines 294ff (R1): Reformulation as suggested.

Lines 330ff (R1): Introduction to this section rewritten.

Line 331 (R1): Reference to Fold family 3 taken out. (Not used in the following).

Line 389 (R1): Process for determining taper angle included.

Lines 405-413 (R1): Not sure we understand this remark. This describes the experimental set-up and are not results.

Lines 425ff (R1): As described above/below, the angles were chosen according to the analysis of the opening and plate movements by Gaina et al. (2009), see above, the introductory remarks to Descriptions and Discussion. We have added a sentence to underline that here.

Line 429 (R1): Sieve was applied to obtain a smooth surface. Explanation added.

NB: Line 442 (R2): The unit is **μm** (as seen in word-file). Comes out as square in the pdf-file that was generated in the editorial procedure.

Lines 443-447 (R1): The shape of the silicone putty lid followed the geometry determined from seismic mapping, as described in the following sentence: "Additionally, an 8 mm thick and of variable width corresponding to the mapped transition zone". A parantheses has been added to state this even more clearly.

Lines 449-458 (R2): Information on scaling: See comment under "General comments from Reviewer 2" above.

Lines 467-447 (R1): We have used PIV-methods in previous studies (e.g. Leever et al. 2011a,b). Although favourable for a dedicated experimental work, we feel that the present work mainly addresses regional issues and that the use of PIV-method would seriously expand the text. We still acknowledge this remark and consider writing a pure geometrical version of these results (with some added examples/complexities) to be published separately.

Lines 499-501 (R1: The Reviewer is correct that this may seem obvious. We still feel the need to stress that the positive structures include elements of different types that are not easily distinguished when first detected and monitored thereafter (Figure 7), and that a classification must await the cutting of the experiments. We have therefore chosen to keep this sentence as it is.

Line 504 (R1): A section has been added here to introduce the reader to the different structure types. We have not used the term "SPSE" as referred to by the Reviewer, but the Reviewer is correct that "EPS" occurs a couple of places in the text. These are misprints for PSE (Positive Structural Element) and have been corrected.

Line 534 (R1): The continuation of the sentence says what kind of structures which was requested by the Reviewer, namely: «a system of *en échelon* separate N-S to NNE-SSE- striking

normal and shear fault segments». We feel that the requested information is given and have therefore kept the sentence as it is.

Lines 536-538 (R1): The full terms and short explanations have been added in parentheses.

Lines 592-594 (R1): The description has been rewritten and expanded.

Lines 650ff (R1): Y-shears have been identified in Figure 8.

Lines 652-654 (R1): This is concluded from the present experiments and documented in Figures 5,6 and 10 as referred in the text.

Lines 657-659 (R1): See explanations to line 443-447 above.

Line 694 (R1): This is just an observation done during the present experiments. We are not aware of other experiments that describes the temporal aspects of fault linkage. We have however determined the process to have taken place between .25 an .50 cm of displacement, and since the velocity of the experiment is known, the timing can be calculated. We did not have any ambition of representing this part of the development in a scaled timeframe, and doubt that this would be scientifically meaningful. We have therefore not changed the text on this point.

Line 713 (R1): The opening velocity is known for the NE-Atlantic (e.g., Gaina et al. 2009). Furthermore, we know that the bulk extension vector was greater than the extension factor by adding up extension and shortening (Vågnes et al. 1997). These references that are referred to elsewhere in the text, have been added here.

Line 744 (R1): Changed to “stress configuration”.

Lines 745-763 (R1): The regional summary has been taken out to avoid repetition.

Lines 762-763 (R1): “Structural development” has been substituted for “complexities”.

Lines 777-782 (R1): Section expanded and re-written.

Lines 785-786 (R1): Redundant statement obliterated.

Lines 790-792 (R1): The basin linking situation has been specified.

Lines 798-800 (R1): The segments are identified and labelled in Figure 4, so a reference to that figure has been included.

Line 827 (R1): Statement has been reformulated to focus on the influence of mechanically stratified sequences on fold configurations.

Line 844 (R1): This is a misprint. Should read “PSE-structure”. Misprint corrected.

Lines 884-887 (R1): Sentence has been simplified.

Lines 972-973 (R1): The section has been re-written and the conclusions have been substantiated.

Line 990 (R1): Statement clarified.

**Figures (additions requested by reviewers)**

**Figure 1.** Missing names (abbreviations) in Figure 1B in map and figure caption have been added/harmonized. We have changed the sequence of abbreviations in the figure captions so that structural elements are presented in sequence from north to south to enhance readability.

**Figure 2:** Seismic examples has been added and abbreviations of structural types (PSE's) have been added. Figure caption has been expanded accordingly.

**Figure 3:** Picture has been added (Figure 3D) and cartoon (Fig. 3A) to display the true geometry of the silicone putty layer.

**Figure 5:** Magnified scale bar has been added.

**Figure 6:** Information has been added for each frame to emphasize key structural elements and configuration/deformation stage. Magnified scale bar has been added.

**Figure 7:** Y-shears and scale (previously given I caption) have been emphasized.

**Table 1:** Table has been added more clearly to identify and explain positive structural element types (PSEs). References to figures that illustrate the different PSE-types have been added.

Figure captions have been revised in harmony with revisions of figures.

**Technical comments from Technical Editor**

References in text have been corrected from format: **"**Author year; Author et al. year" to format: "Author, year; Author et al., year". This has been done throughout the manuscript.

**Additional technical comments (Reviewer 1):**

All technical errors (misprints) pointed to have been corrected

Line 480: Sentence reformulated

Lines 773-774: Section re-written

Line 777: Rephrased

Lines 814-819: Section rewritten

Lines 927-927: Section rephrased.

We hope that the Editorial Board finds our revisions adequate and satisfactory. If additional revisions are found to be necessary we are of course willing to consider such.

Oslo March 27th 2023

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emeritus professor