Responses to Review Comments

In the following, review comments are in ***blue italic*** font, while responses are in **black normal** font.

Reviewer #3 (Laura Henrika Bührig)

Dear Authors,

I have read your manuscript "Evolution of submarine canyon-fan systems in fault-controlled margins: Insights from physical experiments" with great interest, given the limited number of experimental studies that have been published on the evolution of deep-water systems, the detailed documentation of your experiments, and the focus on the interplay of gravity flow processes and fault activity. From this, your research contributes valuable new insights which complementthose of other experimental, numerical, field, and metastudies of deep-water systems. The manuscript is overall well written, and the scientific content is clearly delivered in both text and figures. However, there are several major issues I find with the manuscript, in particular: (i) a shortcoming regarding the critical discussion of the experimental setup, the results and their interpretation, and (ii) the very limited consideration of recent modelling and metastudies of deep-water sedimentary systems both in providing a framework for your research and for the discussion of your findings. Please find in the following a summary of my main points of critique.

Reply: We are grateful and thank the reviewer for thorough assessment of our manuscript and for providing us constructive comments and suggestions that specially enhanced the contextualization of our study from a field research perspective. In the revised version, all the comments and suggestions have been considered and changes have been made to improve the manuscript. We added a point-by-point reply in the following.

Major points:

(1) My first major concern with the manuscript in its present form is that it is missing both in the introduction and in the discussion sections the acknowledgement and integration of findings from previous studies that have contributed new insights into the evolution of deep-water sedimentary systems in a source-to-sink context and are relevant to your research.

For example, there are several recent studies which have quantitatively investigated aspects of submarine-canyon geomorphology as a function of environmental and physiographic variables on a global scale based on large datasets (e.g. Nyberg et al., 2018; Bernhardt & Schwanghart, 2021; Soutter et al., 2021; Bührig et al., 2022a&b) in addition to the study by Sømme et al. (2009) of which some of the findings have been utilised by Lai et al. All of the above studies have investigated the tectonic setting as a controlling factor on canyon evolution; hence, the statement in line 29 that "most of our knowledge about the evolution of submarine canyons come from case studies along passive margins" is not true.

Reply: We have extensively revised the Introduction and Discussion sections.

(2) In addition to the very limited view on quantitative metastudies, the introduction solely focuses on insights gained from experimental studies and omits findings from numerical/stratigraphic forward modelling studies that have explored the evolution of deep-water systems (e.g. Wan et al., 2021; 2022).
Reply: We have added modeling studies in the Introduction to enhance the completeness of literature reviews.

(3) The underrepresentation of findings from recently published studies relevant to the conducted research in the manuscript in the introduction is carried into the discussion section. A discussion of the findings from your study in context of those by prior studies is desirable to assess the applicability of the findings to real-world systems, and vice versa.
Reply: We have extensively revised the Discussion section.

(4) Generally, I have missed in the discussion section a critical discussion of the results and their interpretations. It is stated in line 340 that the experimental approach is [likely] "universal for all margin types", but this ignores the complex and variable influence of different tectonic settings on the morphometric characteristics of subenvironments in deep-water systems (e.g. submarine canyons; Nyberg et al., 2018; Bernhardt & Schwanghart, 2021; Soutter et al., 2021; Bührig et al., 2022a&b), as well as the importance of the physiographic setting of a submarine canyon for the dispersal of sediment to deep-water environments (e.g. Soutter et al., 2020; 2021; Bernhardt & Schwanghart, 2021; Bührig et al., 2022a&b). Moreover, it should be highlighted that other environmental controls (e.g. contour currents, Rodrigues et al., 2022) and processes (e.g. canyon flushing, Mountjoy et al., 2018) –just two examples amongst many – which have been inferred to exert control on the morphologies of deep-water systems might overprint such scaling relationships. As a consequence, some continental margins might be more suitable for the attempt at reconstructing deep-water system morphologies from scaling relationships compared to others. These are caveats to the approach which need to be mentioned. That being said, it is equally important to highlight the strength of the study setup, which is that it allows to investigate the influence of isolated controls and processes on the geomorphologic evolution of deep-water systems, which is difficult, if not impossible, in natural systems.
Reply: In the Discussion section, we have revised our statement, reminding readers to consider more local complex environmental conditions when using the findings of this study. In addition, we have included the modern data from Bührig et al. (2022) in Fig. 12 and Fig. 13, aiming to assist readers in connecting experiments and field cases, especially in deep-water sedimentary systems.

(5) My second major concern with the manuscript is that the authors state in the last paragraph of the conclusions section "we claim and demonstrate that at least we are able to predict the first-order general morphological and sedimentological patterns at basin scale".
In my opinion it is not possible to make these deductions based on the results presented in the study and that this is also not shown by the results. Due to the inherent limitations given under experimental conditions the experiment setup cannot reproduce natural conditions. This needs to be stated more clearly and also needs to be addressed in the discussion and conclusion sections. Moreover, the Haida

Gwaii margin does not represent a classical transform margin but also has a convergent component (see Harris et al., 2014), which has to be considered regarding the applicability of the findings to other active margin settings.

Reply: We have rephrased our statement in the revised Conclusions and removed references to Haida Gwaii. We have instead used the modern data from Bührig et al. (2022a) and Bührig et al. (2022b) to help readers establish links between experiments and the field.

(6) It is stated in lines 30 & 31 that the occurrence of downslope gravity currents is more frequent along active margins compared to passive ones, but this is only supported by two references which focus on Taiwan as a study site and hence do not support this claim. Moreover, as emphasized in the Milliman & Kao (2005) paper the triggering of these flows along the margins of Taiwan do not necessarily have to be related to seismic activity but to climate phenomena (e.g. typhoons).

Reply: We have removed these sentences since they were supplementary to the manuscript and lacked the necessary precision.

(7) It is stated in line 33 that "Haida Gwaii [...] provides good field examples that illustrate the evolution of canyon-fan systems in an active margin". It is not clear from the text why this margin was specifically chosen and why it constitutes a "good" example. It is also unclear to which extent the examples of submarine canyons hosted along active margins cited in lines 37-38 are "similar" to the Haida Gwaii canyons. I suggest expanding on the topic of different active-margin settings in the introduction section a little bit more to provide the framework for the later discussion.

Reply: We have removed all references and comparisons to Haida Gwaii, and extensively rewritten the Introduction and Discussion.

Minor points:

(1) I found it confusing that in section 2.2 and Figure 2a "Morphometric definitions" canyon width (Wc) and fan width (Wf) are introduced as study parameters but are later not referred to.

Reply: In the analysis of morphometric analysis, we did obtain data on canyon width and fan width. However, we have not yet discovered any interesting trends that can be compared to published data or help us predict hard-to-obtain volume information. Future research can continue to analyze these width data and perhaps establish more valuable relationships. This clarification has been included in the revised Conclusion.

(2) Section 3.2 contains text that is interpretative (lines 204-206 & 220-224) and should be moved to the discussion section.

Reply: We have deleted the text.

(3) The first key finding of the study listed under Conclusion No. 1 is that the results support the existence of Hack's scaling relationships "in both laboratory-scale and field scale submarine canyon-fan systems". I suggest rephrasing since the results of the study only support the former.

Reply: We added Fig. 12 in the revised manuscript. This figure illustrates that Hack's scaling

relationship is applicable to laboratory-scale and field-scale, even with the new data from Bührig et al. (2022a) and Bührig et al. (2022b).

(4) The way conclusion No. 7 is presently phrased inadvertently reads as if the prediction of fan volumes based on canyon length is a finding that has newly emerged from the outcome of this study. I suggest rephrasing the sentence more clearly to highlight the new formula developed based on the results of the study and to explicitly credit Sømme et al. (2009) who identified this scaling relationship prior to the present study.

Reply: We have modified the figure legend of Fig. 13 and added experimental data on washovers (Lazarus, 2016) as well as modern data from active margin and passive margin (Bührig et al., 2022). For deep-water sedimentary systems, we propose an empirical formula for estimating fan volume based on canyon length. This formula is in good agreement with the comparison results of 26 representative source-to-sink (S2S) systems worldwide, including passive margins, active margins, and mixed margins. The estimated fan volumes using the modern data from Bührig et al. (2022) fall within a reasonable range compared to the globally representative S2S fan volumes.

(5) Correction of the spelling of "Somme et al." in Figure 12b to "Sømme et al." and adding of the reference to the reference list.

Reply: We have corrected the spelling.

(6) Grammar-checking of the manuscript.

Reply: We have checked the grammar of the article.

References cited in our reply:

Bührig, L. H., Colombera, L., Patacci, M., Mountney, N. P., and McCaffrey, W. D.: Tectonic influence on the geomorphology of submarine canyons: implications for deep-water sedimentary systems, Source or Sink? Erosional and Depositional Signatures of Tectonic Activity in Deep-Sea Sedimentary Systems, https://doi.org/10.3389/feart.2022.836823, 2022a.

Bührig, L. H., Colombera, L., Patacci, M., Mountney, N. P., and McCaffrey, W. D.: A global analysis of controls on submarine-canyon geomorphology, Earth-Sci. Rev., 104150, https://doi.org/10.1016/j.earscirev.2022.104150, 2022b.

Lazarus, E. D.: Scaling laws for coastal overwash morphology, Geophys. Res. Lett., 43, 12,113-112,119, https://doi.org/10.1002/2016GL071213, 2016.