Responses to Review Comments

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

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Reviewer #2 (Morelia Urlaub)

This manuscript seeks to understand how submarine canyon systems and fans develop in a fault-controlled setting. The authors use laboratory analogue models of a continental slope, the bottom of which is modified by a simulated normal fault. The parameters tested here are fault slip rate and sediment inflow discharge. The authors find that the fault slip rate controls the number and spacing of canyon-fan systems (higher slip rate = more systems at closer spacing). Changes in sediment input do not result in different morphology. Length, area and volume of canyon and fans are proportional to sediment input. While this is an interesting study and the manuscript is well-written, I have several comments that need clarification. I must say, though, that I am not an expert in geomorphological modelling.

Reply: We thank the reviewer's positive feedback and constructive comments. Our responses to each question are listed below.

1. For the field analogue the Queen Charlotte Fault is mentioned. This is a strike slip fault, which is also correctly stated in the manuscript. Yet, the model set-up includes a normal fault at the bottom of the slope. I do not see the connection. In general, I would like to see more field examples for fault-controlled submarine canyon systems, ideally with distinct morphologies and, if known, different fault slip rates. This would strengthen the relevance of this study, and could serve as validation for the laboratory work.

Reply: We acknowledge that Queen Charlotte Fault, as a strike fault, may not be the most suitable choice to illustrate the manuscript content. We have removed all references to the Queen Charlotte Fault and added several other field examples for fault-controlled submarine canyon systems in the revised Introduction. We also discuss the influence of fault slip rate and inflow discharge on canyon morphology in Discussion section 4.2 to strengthen the connection between experiments and field observations.

2. How is the scaling problem addressed? I assume that grain size, overall size of model, slope angle all need to be balanced to reproduce realistic settings. I was surprised by the slope angle of 38°. Where in nature do you find such slope angles in submarine settings? Also in line with this: How are boundary effects accounted for?

Reply: We address the scaling issue in revised Discussion section 4.1. Below, we provide a brief explanation.

In the study, we decouple complex phenomena into two main mechanisms: (1) breaching processes driven by gravity, and (2) submarine canyons and hangingwall fans formed by saline underflow. The comparison between experiments and models shows that the long profiles themselves exhibit a high degree of self-similarity (Fig. 10), indicating that laboratory-scale canyon-hangingwall fan long profiles are scale versions of each other. In the morphometric analysis, we discovered Hack's scaling relationship spanning 22 orders of magnitude (Fig. 12), which connects from underwater to above water, across experimental and field scales. Additionally, our proposed empirical formula (Fig. 13), when compared with 26 representative canyon systems worldwide and using the latest modern data to predict fan volumes, yields estimations within a reasonable range, indicating the absence of scale issues.

The 38-degree angle of repose refers to the natural angle at which materials in a laboratory reach a stable slope. It indicates that the phenomenon is simply controlled by gravity and naturally collapses. It is not suitable to directly analogize it to the 38-degree angle in the field. On the other hand, in areas affected by saline underflows, the depicted slopes are much smaller than the angle of repose. The difference between the two is evident.

Our current experimental approach is to set up an active fault at the position x = 400 mm. The upstream and downstream boundaries will not affect the evolution of submarine canyons and hanging wall fans in the middle. Although there may be sand leakage caused by the uplift and subsidence on the left and right sides, we have confirmed that the displacement on both sides will not have any impact on our observation area.

3. To be able to put results into a general context it would be helpful to also show a reference model without fault movement. What sort of morphology is produced and how does it compare to those with fault slip?

Reply: In our experiment, all canyon morphology starts with the fault slip generated by increasing relief. However, a closer look can be had at the continental shelf in our experiment, i.e., the footwall region (Fig. 4). This area is where there is no fault movement. When saline underflows flow through this area, there will be no changes in morphology. The underflows will bypass the continental shelf until they encounter the shelf-slope break. This is one of the key elements in our experimental approach. Our new results fully agree with the conclusion of Lai et al. (2016) that in order to generate developing submarine canyons in the laboratory, both increasing relief and density underflows are necessary.

4. In section 3.3 it is stated "A similar trend was also established for submarine fans (Fig. 10)". How was this trend determined for submarine fans? On field data? From where - only Haida Gwaii? This comment relates to comment 1.

Reply: We rephrased our statement.

5. I am not familiar with Hack's law. Maybe explain briefly so that non-specialists understand.

Reply: We have added Fig. 12 and explained the relationship and application of Hack's Law.

References cited in our reply:

Lai, S. Y. J., Gerber, T. P., and Amblas, D.: An experimental approach to submarine canyon evolution, Geophys. Res. Lett., 43, 2741-2747, https://doi.org/10.1002/2015GL067376, 2016.