Interaction of turbidity currents and contour currents in flume-tank experiments; deposits, grainsizes and turbidity current concentrations

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Background

The interaction of turbidity currents and contour currents results in large sediment deposits along the continental slope. Several conceptual models have been published that hypothesize how this interaction works and how this affects depositional patterns. These models remain largely untested. Furthermore, a clear link between process and deposit is missing. Experiments can add to the understanding of depositional patterns of mixed systems by linking the flow dynamics to turbidity current concentrations and deposits, which is often impossible in field measurements. This study focused on three-dimensional flume experiments (Fig. 1) of turbidity current – contour current interaction in which two parameters are tested, namely, channel depth and contour current velocity.

Results

1. More sediment is deposited in the channel and on the downstream overbank when a contour current is present. Not a strong but a weak contour current results in most sediment on the downstream overbank (Fig. 2).
2. The grainsize of the deposited sediment is larger in the channel and smaller on the downstream overbank when a contour current is present (Fig. 3). It is seen that not a strong but a weak contour current results in finest sediment on the downstream overbank.
3. The concentration profiles show that turbidity currents become thicker and have a higher concentration above the downstream overbank when a contour current is present (Fig. 4).

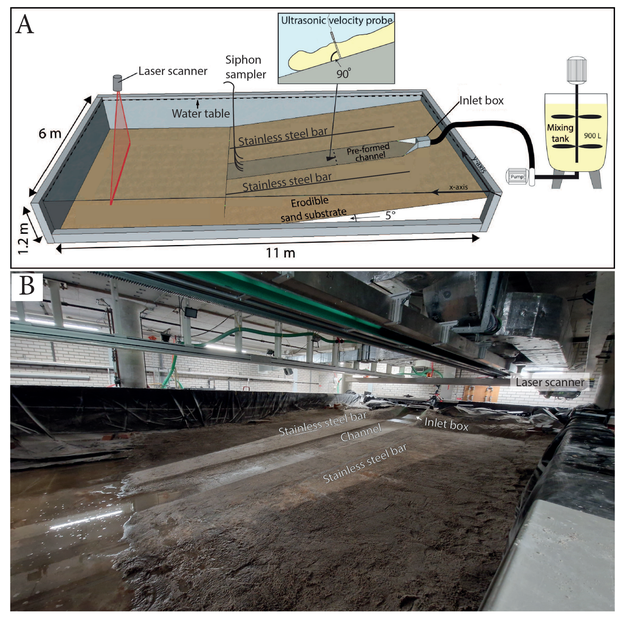

Figure 1 | (A) Overview of the experimental setup, figure modified from de Leeuw et al. (2018). (B) Photo of the set-up before the experiment has run.

1. Deposit volumes

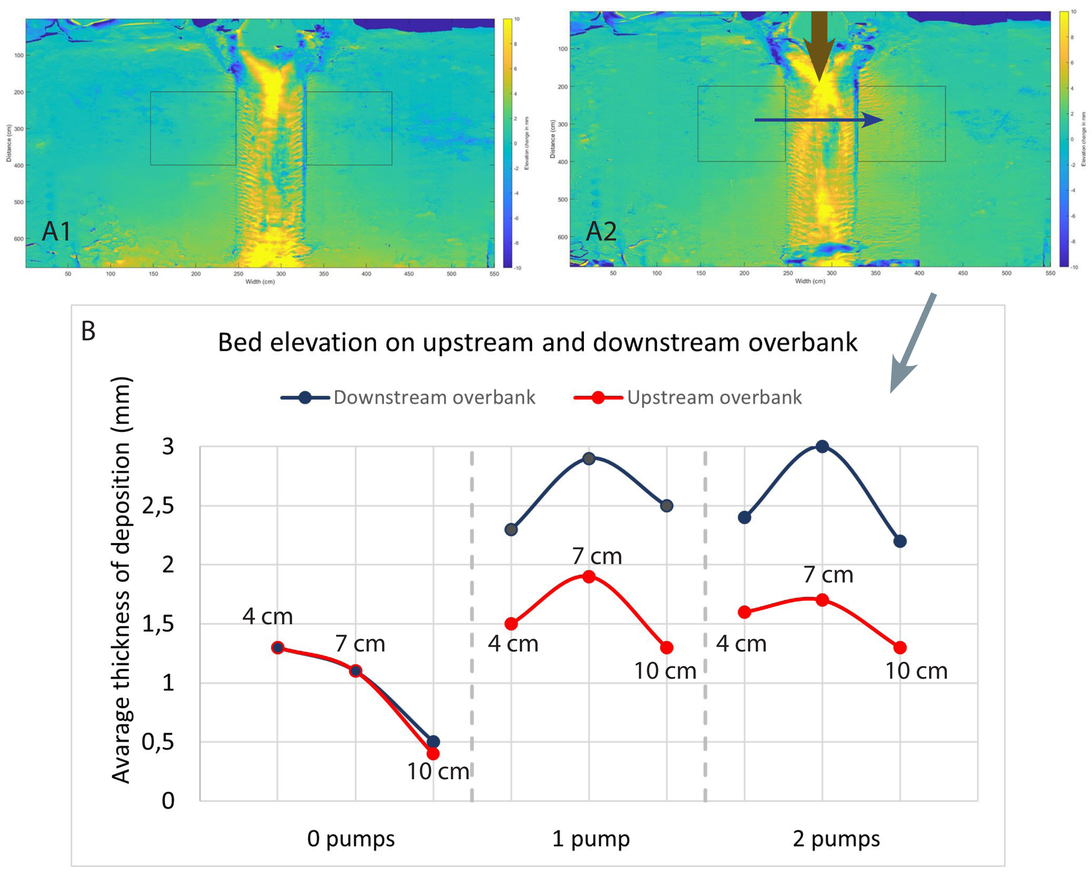

Figure 2 | (A) Scans of the bathymetry without (A1) or with (A2) a contour current. Yellow colors indicate deposition. With a contour current more sediment is deposited on the downstream overbank. The blue arrow is the direction of the contour current. Brown arrow is the inlet of the turbidity current. (B) Quantification of the enhanced deposits in the squares shown in figure A2. The turbidity current is better confined with a deeper channel when no contour current is present. With a 7 cm deep channel most sediment is deposited on the overbanks when a contour current is present.

2. Deposit grainsizes

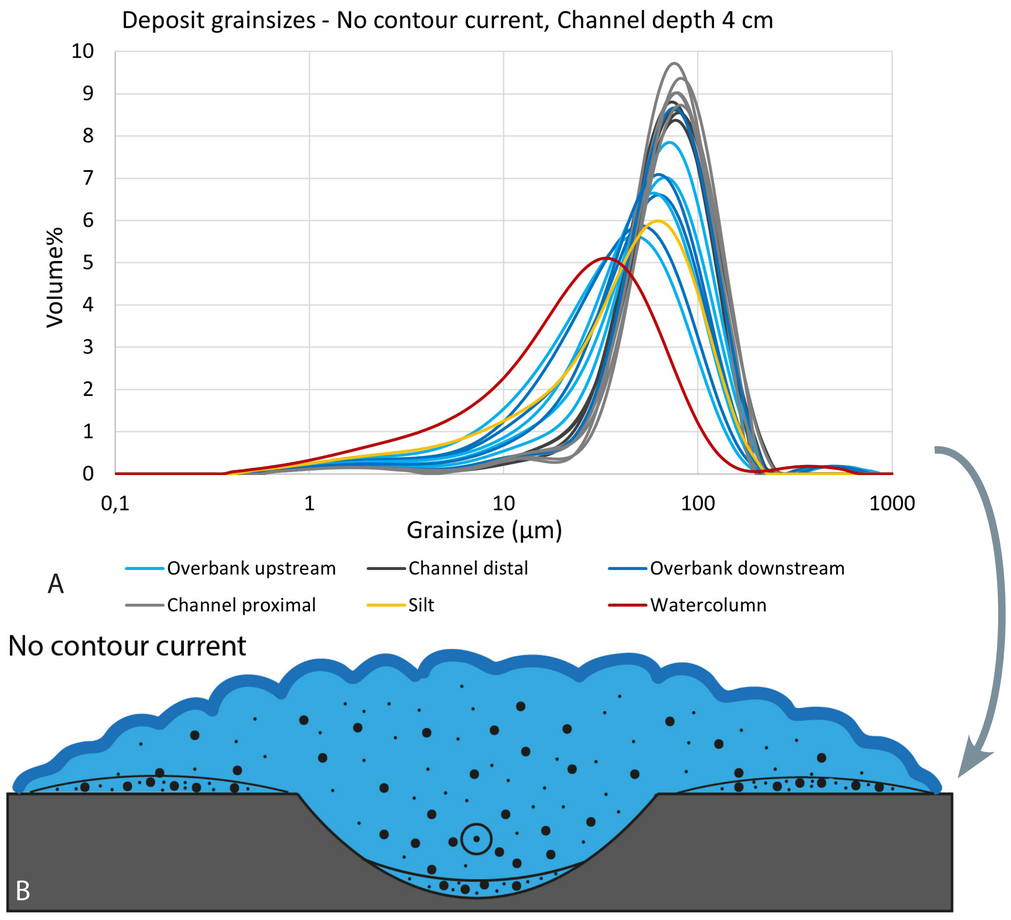

Figure 3 | Grainsize distributions without (A) or with (C) a contour current. When a contour current is present the grains are sorted before deposition. (B) Interpretation of the deposition without sorting. (D) Interpretation of the sorting mechanism. The smaller grains are transported to the downstream overbank when a contour current is present.

3. Concentration of turbidity current

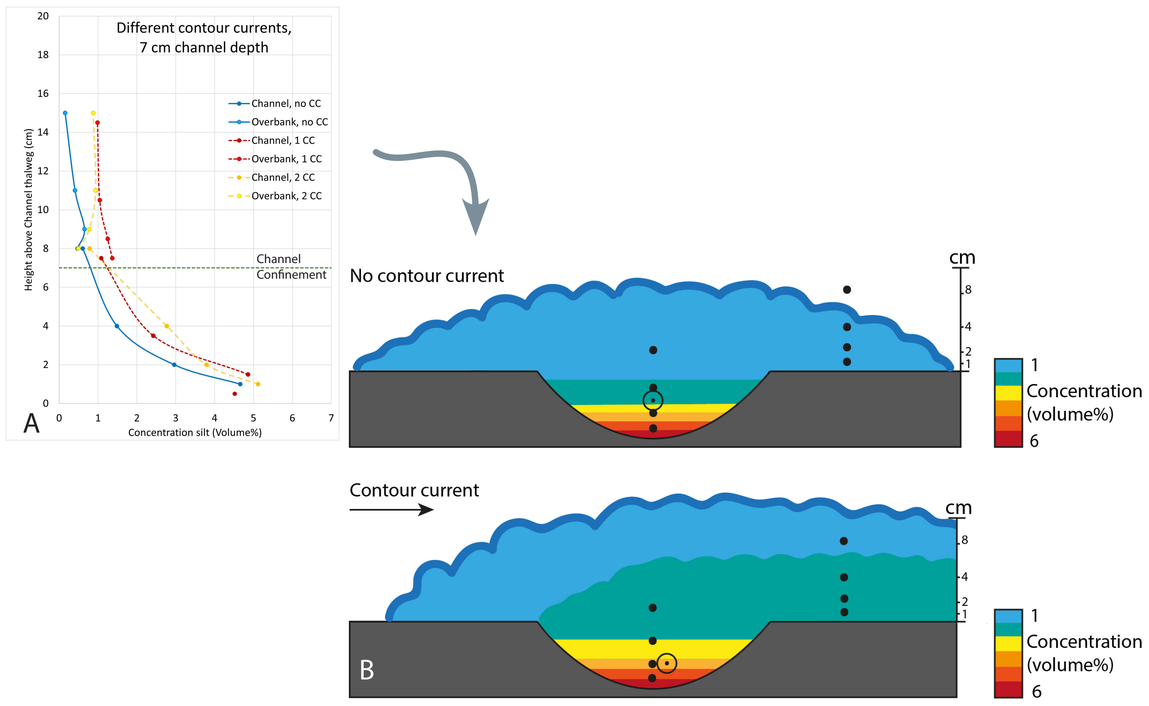

Figure 4 | (A) Measured concentration of the turbidity current in the channel and on the downstream overbank without and with a contour current. (B) Interpretation of the concentration inside the turbidity current without or with a contour current.

References:

Leeuw, Jan de, Joris T. Eggenhuisen, Yvonne T. Spychala, Maarten S. Heijnen, Florian Pohl, and Matthieu J.B. Cartigny. 2018. "Sediment Volume and Grain-Size Partitioning Between Submarine Channel–Levee Systems and Lobes: An Experimental Study." Journal of Sedimentary Research 88 (7): 777–94. https://doi.org/10.2110/jsr.2018.46.

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