Evolution of river deltas and submarine canyons driven by hyperpycnal flows: a sandbox experiment

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Hyperpycnal flows easily appear in small mountainous rivers along active margins because of the high uplift and erosion rates (Milliman and Syvitski, 1992; Dadson et al., 2003; Mulder et al., 2003). The flows contain abundant suspended sediment and can plunge into the receiving basin (lakes or the sea) to form an underwater flow transporting terrestrial sediment to deep marine. However, only a few studies address the physical processes of how unconfined hyperpycnal flows shape the landscape and seascape. To fill this gap, we design a unique sandbox experiments to investigate and visualize how river deltas and submarine canyons evolve under the influence of unconfined hyperpycnal flows. In our experiments, terrestrial and submarine domains jointly respond to block uplift and rainfall runoff. The hyperpycnal runoff is generated by salt water in which the liquid is distinguished by the density of the applied rainfall relative to the density of the ambient water. Detailed evolving processes are recorded by time-lapse photography every 5 seconds. Bed topography of each experimental stage is reconstructed to form high resolution digital elevation models by using laser-scan imaging technique. Our preliminary results show that unconfined sediment-laden flows generate a line of prograding hyperpycnal deltas at the shoreline. At the submarine downstream end, hyperpycnal flows dissipated retrogressive breaching and generate a series of deeply incised submarine canyons. We found that the combination of differential uplift and hyperpycnal flow is necessary to provide a viable valley-canyon forming mechanism. We hope our novel and unexpansive experiments can stimulate new questions and motivate more future research.

References:

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