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Self similar growth of a 1D granular fan under laminar flow near threshold

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Alluvial fans are major sedimentary bodies that make the transition between the reliefs and the sedimentary basins. They are found at the outlet of some drainages catchments, where rivers are free to diverge and avulse, and to depose part of their sedimentary load. Understanding their dynamics of formation and evolution is a great problem of sediment transport. Rivers and fan profiles are usually described as diffusive systems but this is only true if the shear stress exerted on the bed is high compared to the critical shear stress. This might be the case for sand bed rivers, but not for gravel bed rivers, for which it is known that the shear stress is only slightly higher than the critical one. This is why we need to develop a new model to describe the evolution of alluvial fans built by gravel bed rivers. To do this analytically, we work in 1D, with a laminar flow and one grain-size in order to be able to describe both the fluid and the sediment transport. In addition, the conditions of the experiments insured that the boundary shear stress is near the critical value for motion inception of the granular material. Using Taylor expansion, we show that for asymptotically long times, the fan growth is self-similar and can be decomposed into a triangular “threshold" shape plus a small quadratic deviation. We performed experiments with glass beads and glycerol to test and successfully validate this theory.