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Self-similar growth of an alluvial fan fed with bimodal sediment

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At the outlet of mountain ranges, rivers flow onto flatter lowlands. The associated change of slope causes sediment deposition. As the river is free to move laterally, it builds conical sedimentary structures called alluvial fans. Their location at the interface between erosional and depositional areas makes them valuable sedimentary archives. To decipher these sedimentary records, we need to understand the dynamics of their growth.
We carried out a series of experiments to investigate the growth of alluvial fans fed with mixed sediments. The density difference between silica and coal sediments mimics a bimodal grain-size distribution in nature. The sediment and water discharges are constant during an experiment. During the run, we track the evolution of the surface pattern by digital imaging. At the end of each run, we acquire the fan topography using a scanning laser. Finally, we cut a radial cross section to visualize the sedimentary deposit.
We observe there is a distinct slope break at the transition that dominates the overall curvature of the fan surface. Based on mass conservation and observations, we propose that this alluvial fan grows in a self-similar way, thus causing the transition between silica and coal deposits to be a straight line. The shape of the experimental transition accords with this prediction.