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Equilibrium condition for high-concentration turbidity currents

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This research theoretically explore formative conditions and characteristics of high-concentration turbidity current. Generally, it has been suggested that suspended load even in very high-velocity flows such as tsunamis or turbidity currents cannot exceed 1-5 vol.%. This is because density stratification due to suspended load inhibit turbulence in flows.

However, it was revealed that flow can attain very high concentration (˜30%) of suspension because of hindered settling. When calculation starts from very high-concentration and high turbulent kinetic energy, positive feedback between sediemnt entrainment from a bed and hindered settling occurs, and finally flows reach the equilibrium condition in which suspended load is around 30 vol.%. This equilibrium condition requires (1) small grain-size (<200 micron meter), very high initial concentration (>20 vol.%), (3) high flow velocity (>5 m/s).

The origin of two types of turbidity currents, i.e. low- and high-concentration flows, has been subject to debate for sedimentologists. This research implies that two types of flows are generated from different initial conditions. For example, tsunami-generated turbidity currents are supposed to be low-concentration initally, so that they cannot increase their concentration even if the self-acceleration mechanism works. On the other hand, turbidity currents generated by subaqueous debris-flows are supposed to have very high concentration of suspension, and therefore they may sustain their high-energy and concentration for long distance.

Keywords: turbidity current, hindered settling, turbulence, suspension, turbidite