Mudflow Transport Behavior and Deposit Morphology: Role of Shear Stress to Yield Strength Ratio in Subaqueous Experiments

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ABSTRACT

We developed an approach to trigger subaqueous mudflows from sloping 10-cm thick mud beds for which we know the shear stress and shear strength *a priori*. We illuminate how the difference between shear stress and shear strength, defined as the Flow Factor (F_f = shear stress/yield strength), controls the resulting dynamic mudflow and the morphology of the deposit. We capture the processes of initiation, failure, and deposition with video, photos and detailed surface laser scans. A key result is that low, medium, and high F_f experiments produce unique transport behaviors and deposit morphologies. This has important implications for hazard assessments and for interpreting depositional history of past mudflows.

CLICK ON IMAGE FOR LARGER VIEW

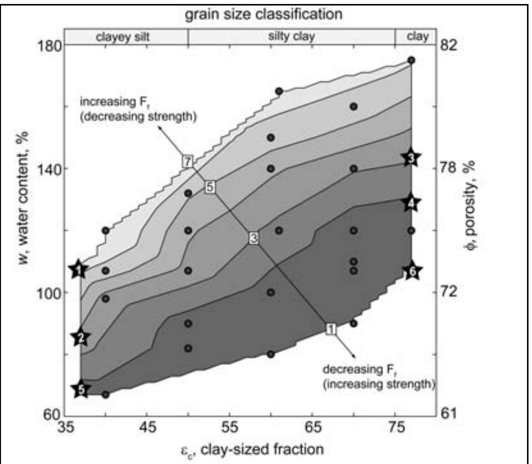

Fig. 1: Flow factor contours are overlain on a cross plot of clay fraction (ε_c) versus water content (w) (and porosity, ϕ).Flow factor is determined by the ratio of gravitational shear stress to yield strength (determined by viscometer). Figure 2 shows results of experiments 1 (high F_f), 3 (med. F_f), and 4 (low F_f).

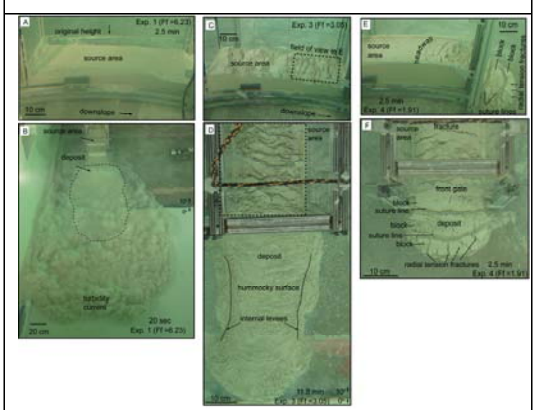

Fig. 2: **A, B**: High F_f mudflow produced a rapid mudflow that accelerated away from the source area and produced a prominent turbidity current. **C,D:** . Medium F_f produced a long-duration (11.8 minutes) retrogressive failure. **E,F:** Low F_f, produced a short-duration (2.5 minutes) blocky failure.

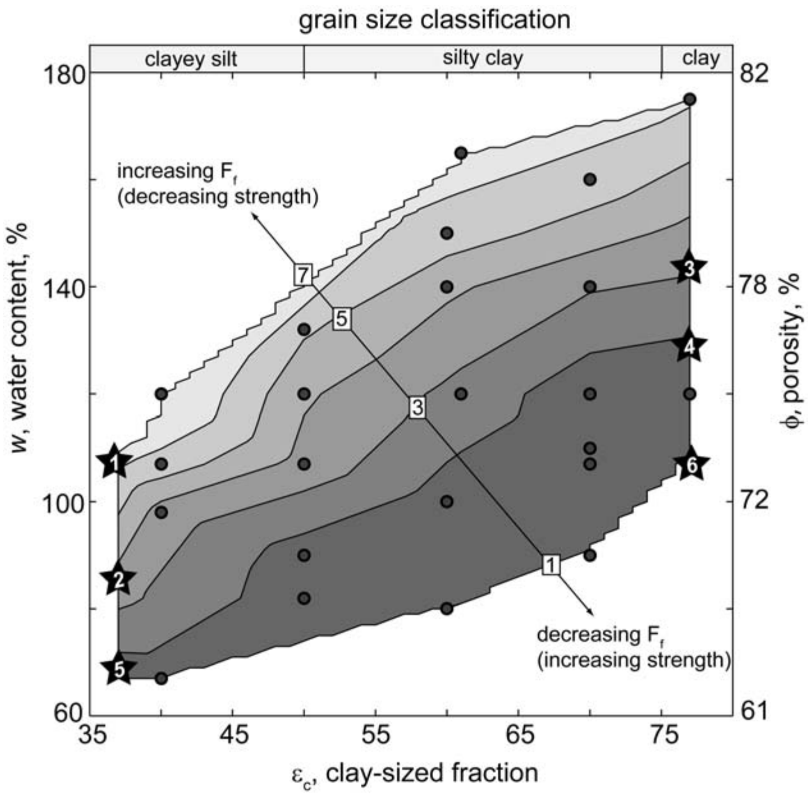

Fig. 1: Flow factor contour plot.
Flow factor contours (labeled in white boxes) are overlain on a cross plot of clay fraction (ε_c) versus water content (*w*) (and porosity, ϕ).Flow factor is determined by the ratio of gravitational shear stress to yield strength (determined by viscometer). Note that each mudflow experiment also corresponds to a viscometer test. Grain size classification is according to Shepard, 1954. Figure 2 shows results of experiments 1 (high F_f), 3 (med. F_f), and 4 (low F_f).

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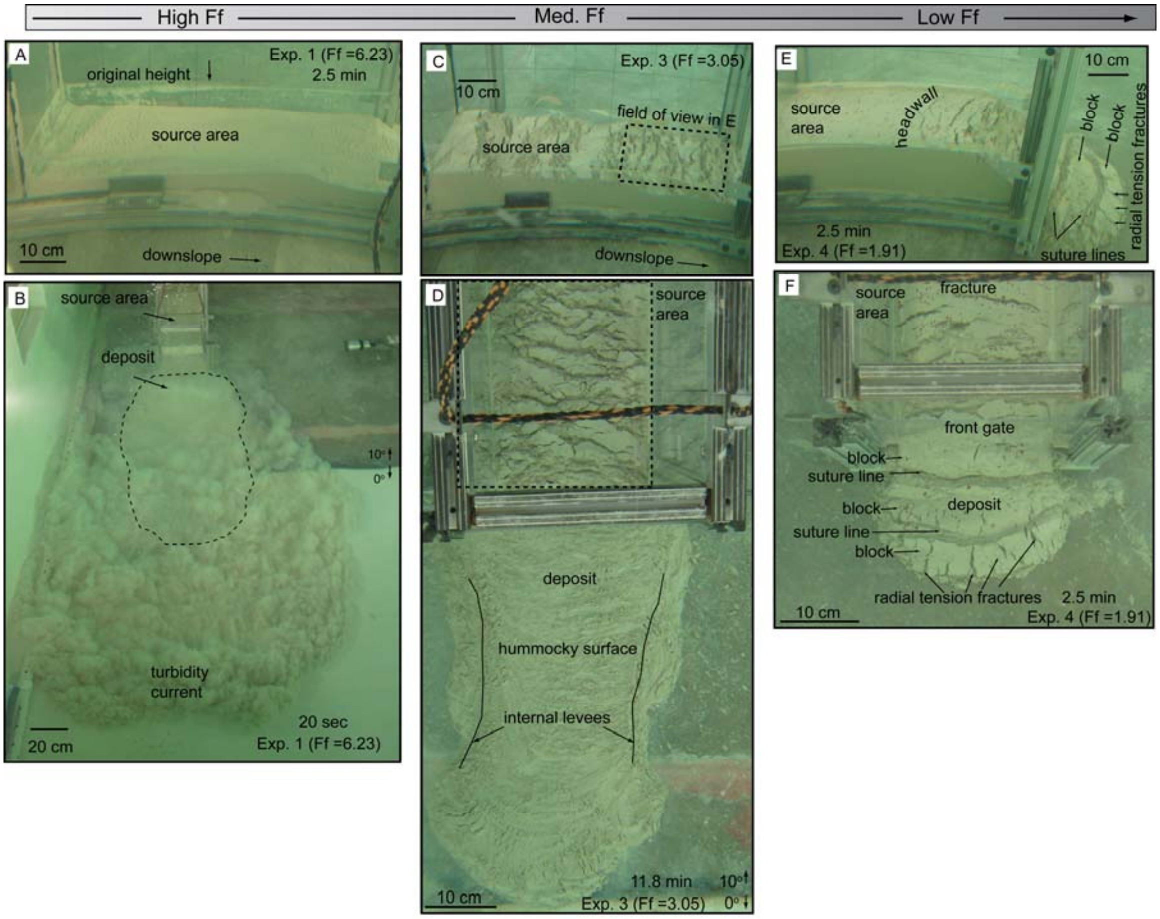

Fig. 2: Characteristic features of flow experiments.
A, B: High F_f mudflow (experiment 1) produced a rapid mudflow that accelerated away from the source area immediately upon gate opening and produced a prominent turbidity current. **C,D:** . Medium F_f (experiment 3) produced a long-duration (11.8 minutes) retrogressive failure (C) that constructed a long and narrow blocky deposit (D). **E,F:** Low F_f (experiment 4), produced a short-duration (2.5 minutes) blocky failure. Three individual fault blocks evacuated the source area (E) and accumulated piece-by-piece in the lobe deposit (F).

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