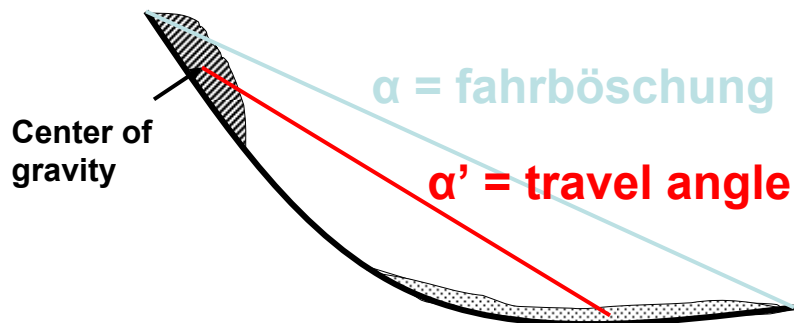
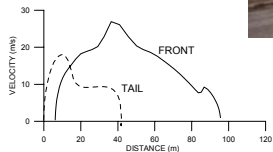
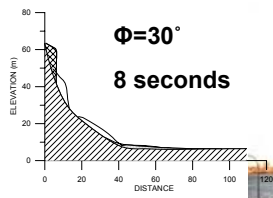


Landslides-Flows

Landslide mobility

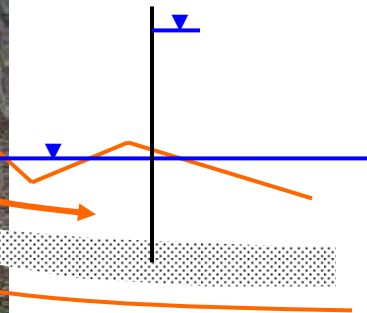
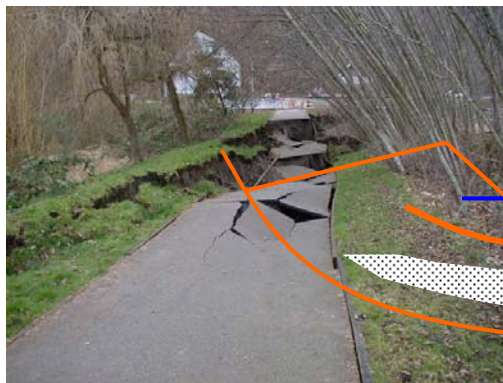


Theoretically, in a frictional material (dry sand, broken rock), the travel angle should equal the angle of friction, φ .
The angle α equals approximately α' .
If the travel angle is less than φ , pore-pressure is involved



Dry (or non-liquefied) sand (silt, gravel or debris) flow

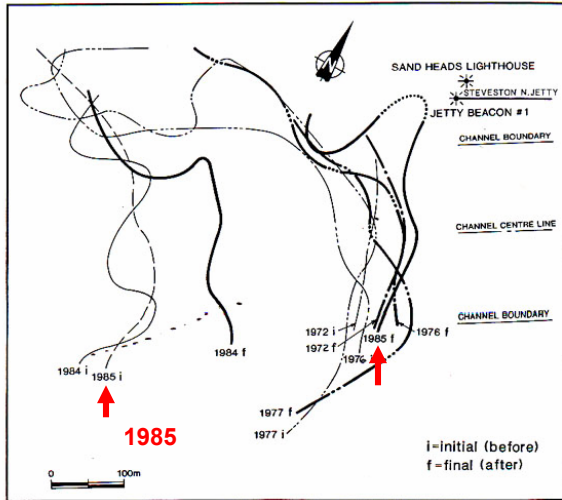
A flow-like movement of loose dry or moist, sorted or unsorted granular material, without significant excess pore-pressure.



Sand (silt, debris, weak rock) flow slide

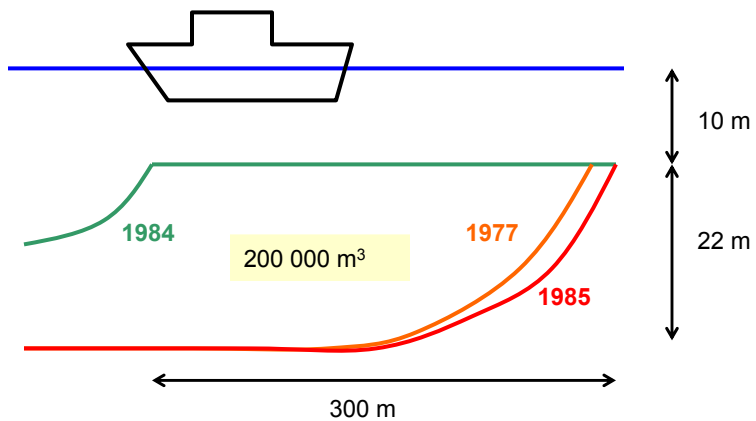
rapid to extremely rapid flow of sorted or unsorted granular material on moderate slopes, involving excess pore-pressure or liquefaction of material originating from the landslide source.

Submarine flow slide, Fraser Delta

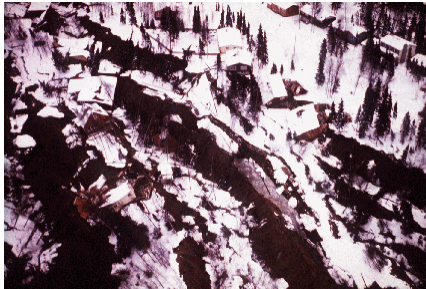
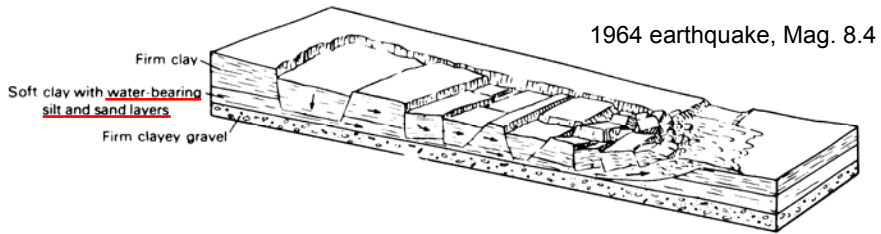


McKenna et al., 1992

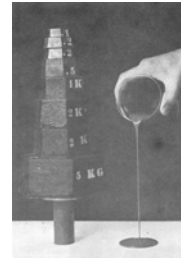
Shipping channel profile changes



Turnagain Hts. Slide, Anchorage, Alaska



(Seed and Wilson, 1967)



(Photo: S.G. Evans, GSC)

Clay flow slide is a very rapid to extremely rapid flow of liquefied sensitive clay, at, or close to its original water content."

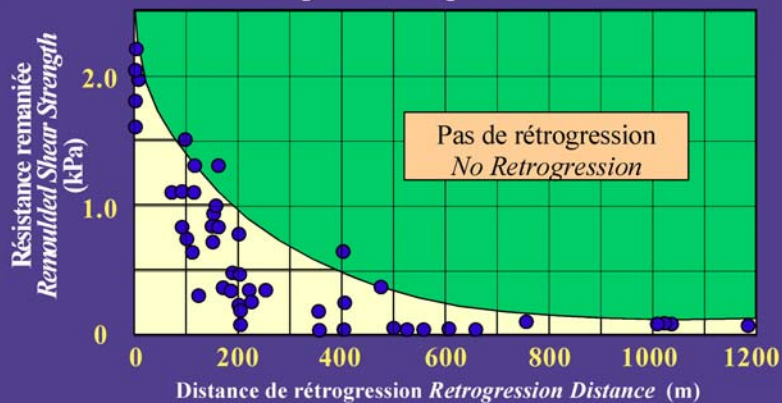
Verdal flow slide, Norway, 1983



55 mill. m³
 3 km³ scar
 9 km³ deposit
 4 km³ water
 116 lives



Estimation de la distance de rétrogression Estimating the Retrogression Distance

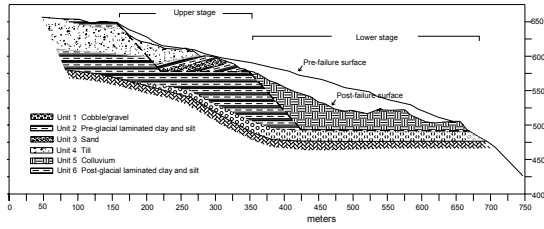


Tel qu'indiqué par Carson (1977) et Leblais *et al.* (1983), la résistance remaniée est un paramètre important qui contrôle de la rétrogression.
 As indicated by Carson (1977) and Leblais *et al.* (1983) the remoulded shear strength has an essential control on retrogression distance.

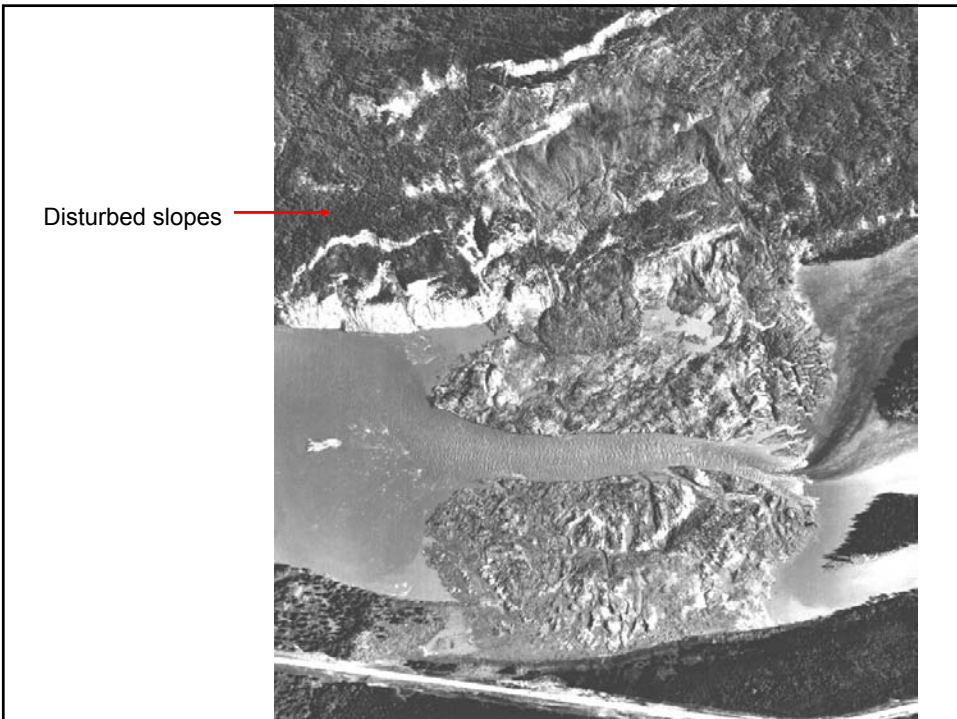


see also Mitchell and Markel, 1974

Is this a flow slide? Overconsolidated clay



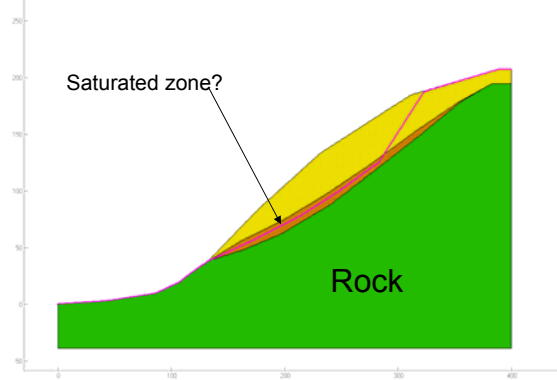
Attachie Slide
Fletcher
et al., 2001



Is this a flow
slide?

Loess
(Sale Shan, China)

Dijkstra et al., 1994



Earth flow is a rapid or slower, intermittent flow-like movement of plastic, clayey earth.

Earth flow complex



Motion on
discrete slip
surfaces
("mudslide")

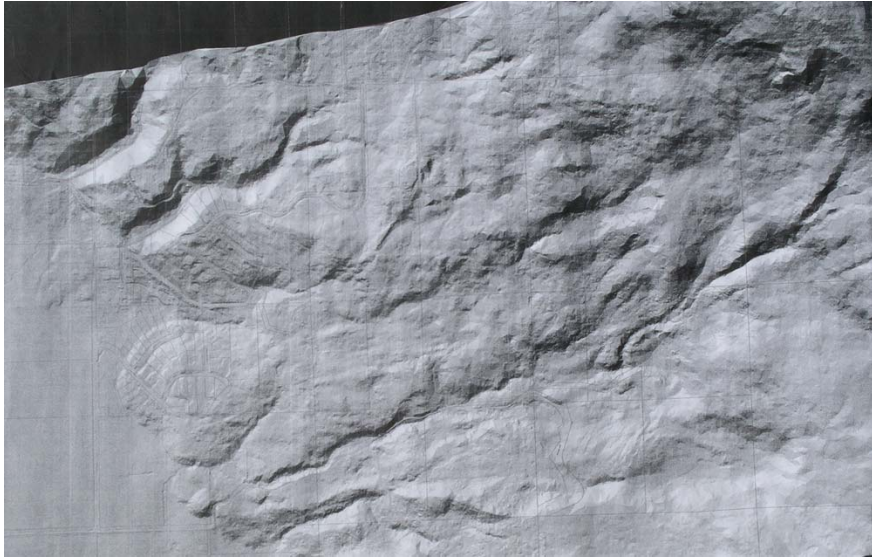
"Earth" – plastic
clayey debris



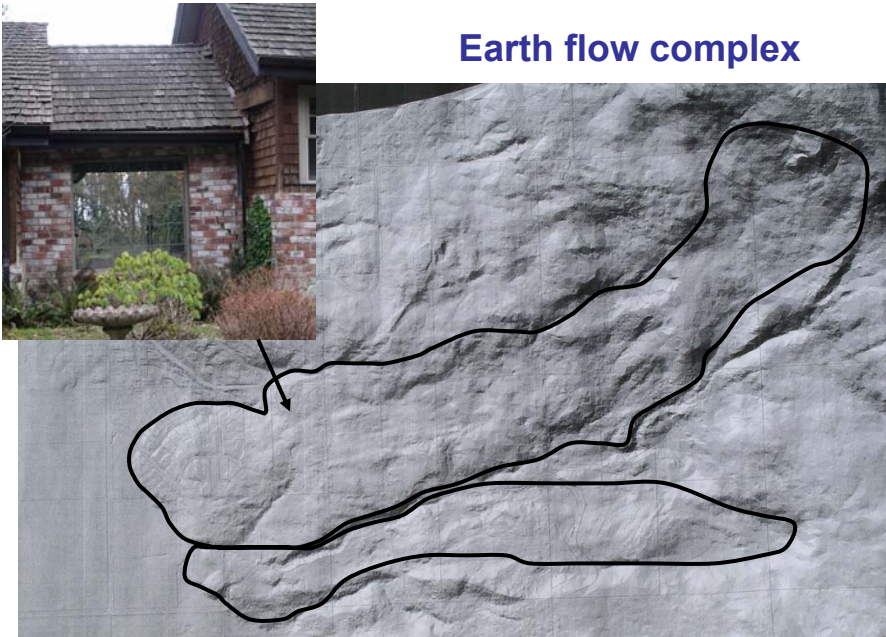
Earth flow complex: Lidar, first return



Earth flow complex: Lidar, last return



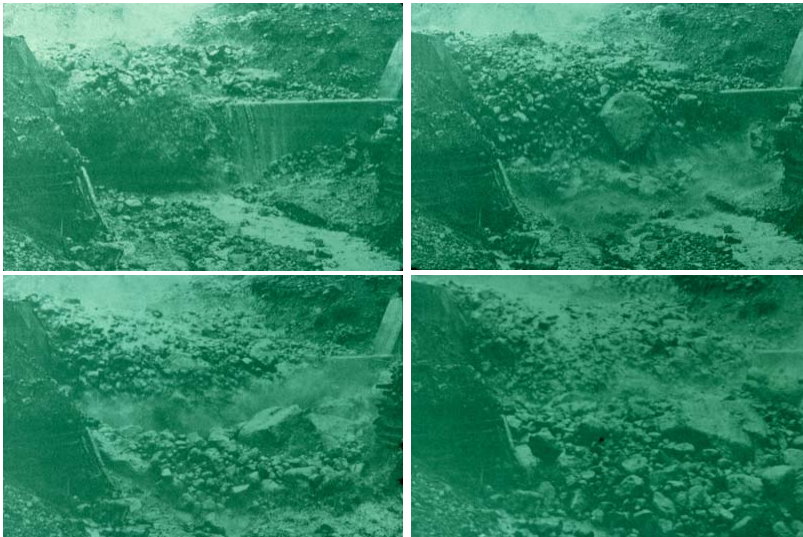
Earth flow complex





Debris flow is a very rapid to extremely rapid flow of saturated non-plastic debris in a steep channel. (Plasticity Index < 5% in sand and finer fractions)

Debris flow surge



(Prof. T. Takahashi)

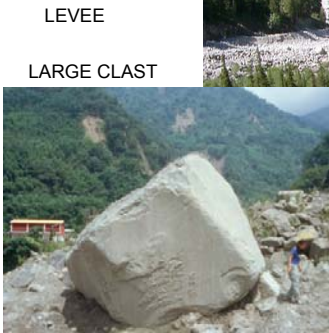
Debris fan features



LEVEE



BOULDER
TRAINS,
ABANDONED
CHANNELS



LARGE CLAST



(Photo H. Hubl, Vienna)



QUINDICI, Italy

Mud flow is a very rapid to extremely rapid flow of saturated plastic debris in a channel, involving significantly greater water content relative to the source material (Plasticity Index > 5%)



Debris flood is a very rapid, surging flow of water, heavily charged with debris, in a steep channel.



Debris avalanche is a very rapid to extremely rapid shallow flow of partially or fully saturated debris on a steep slope, without confinement in an established channel

Debris avalanche clusters



Rock avalanche is an extremely rapid, massive, flow-like motion of fragmented rock from a large rock slide or rock fall.



Flow-like movement



Rock avalanches
in open-pit mines