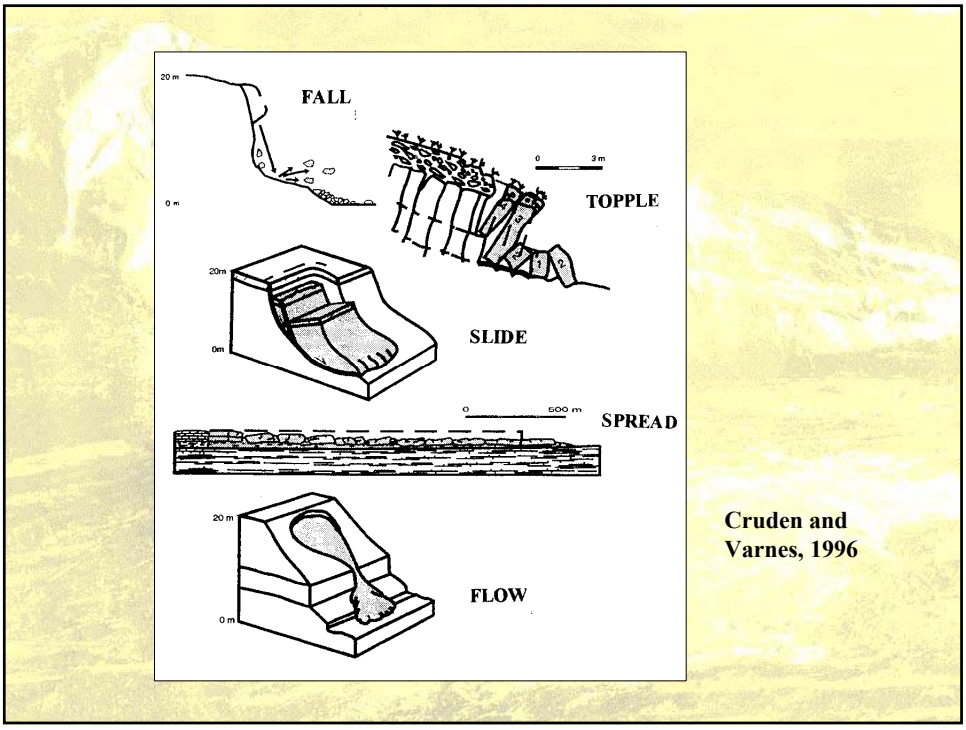

Landslide
Classification


FALL
TOPPLE
SLIDE
SPREAD
FLOW
Cruden and
Varnes, 1996

Varnes Classification

Landslide classification (Varnes, 1978) Code: ***RAPID,*** SLOW (IN MOST CASES)

	BEDROCK	DEBRIS (<80% sand and finer)	EARTH (>80% sand and finer)
FALLS	***ROCK FALL***	***DEBRIS FALL***	***EARTH FALL***
TOPPLES	***BLOCK TOPPLE*** FLEXURAL TOPPLE	-	***BLOCK TOPPLE***
SLIDES	ROCK SLUMP ***ROCK SLIDE***	***DEBRIS SLIDE***	EARTH SLUMP EARTH SLIDE
SPREADS	ROCK SPREAD	-	***EARTH SPREAD***
FLOWS	ROCK CREEP SLOPE SAGGING	***DEBRIS FLOW*** ***DEBRIS AVALANCHE*** SOIL CREEP SOLIFLUCTION	***WET SAND AND SILT FLOW*** ***RAPID EARTH FLOW*** ***LOESS FLOW*** DRY SAND FLOW EARTH FLOW
COMPLEX	***ROCK AVALANCHE*** EARTH SLUMP-EARTHFLOW		

Ref.: Varnes, D.J., 1978. Slope movement types and processes. *In* Landslides, Analysis and Control. Special Report 176, Transportation Research Board, Washington, pp. 11-33.

Velocity scale

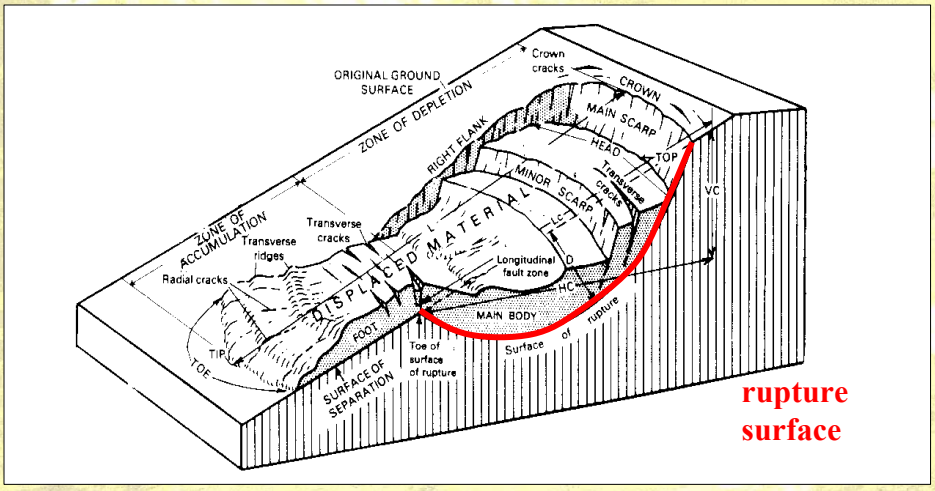
Landslide velocity scale (Cruden and Varnes, 1996).

Velocity class	Description	Velocity (mm/sec)	Typical velocity	Human response
7	Extremely Rapid	$5x10^{3}$	5 m/sec	Nil
6	Very Rapid	$5x10^{1}$	3 m/min	Nil
5	Rapid	$5x10^{-1}$	1.8 m/hr	Evacuation
4	Moderate	$5x10^{-3}$	13 m/month	Evacuation
3	Slow	$5x10^{-5}$	1.6 m/year	Maintenance
2	Very Slow	$5x10^{-7}$	16 mm/year	Maintenance
1	Extremely Slow			Nil

Ref.: Cruden, D.M. and Varnes, D.J., 1996. Landslide types and processes. *In* Landslides, Investigation and Mitigation. Special Report 247, Transportation Research Board, Washington, pp. 36-75.

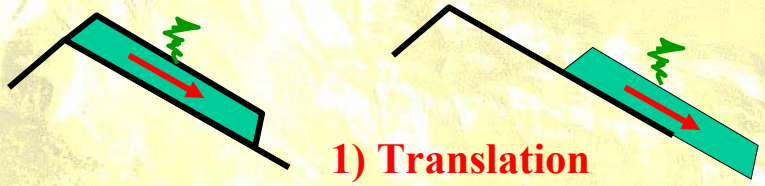
Landslide terminology

"Landslide" = any mass of earth material (soil or rock) displaced by gravity



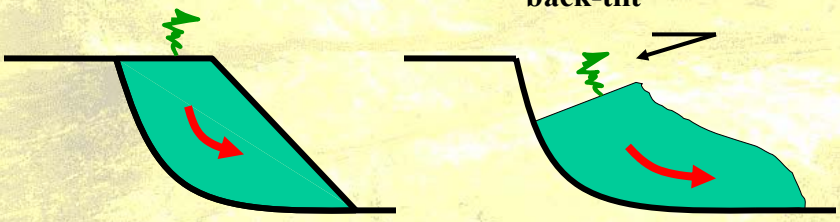
Cruden and Varnes, 1996

Sliding mechanisms



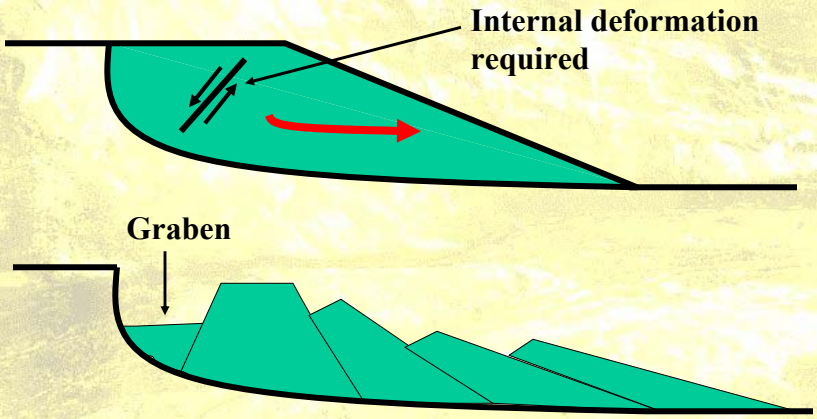
1) Translation

"back-tilt"



2) Rotation

3) Compound sliding

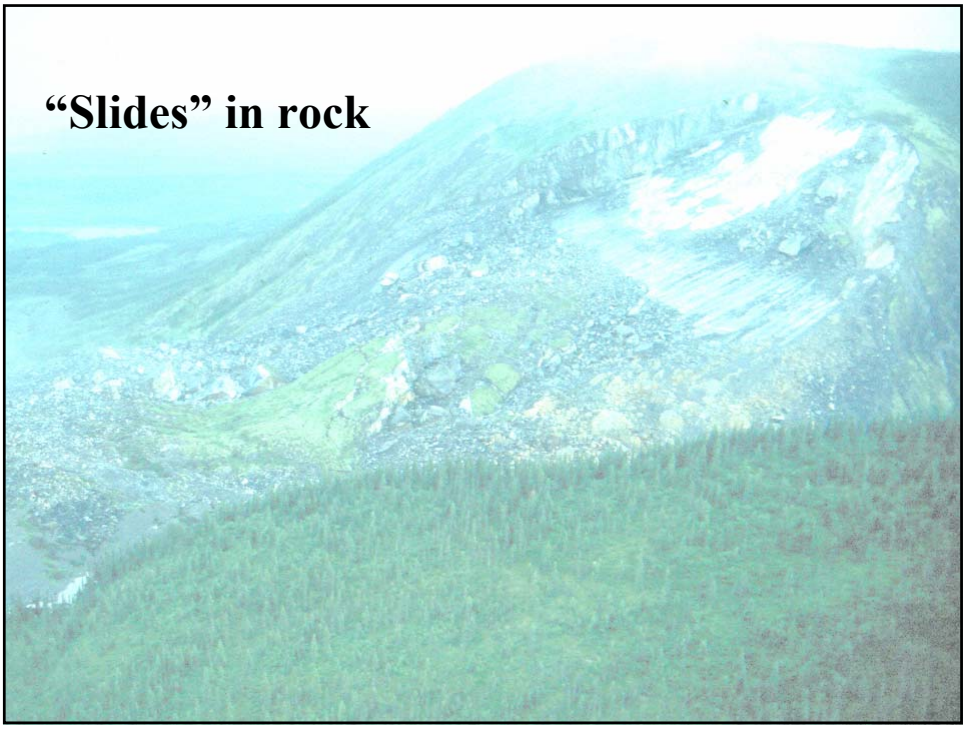


Recommended Landslide Classification

ROCK SLIDES	Translational (or Wedge) Rock Slide Rotational Rock Slide(Slump) Compound Rock Slide Rock Collapse
FALLS AND TOPPLES	Rock (Debris) Fall Rock Block Topple Rock Flexural Topple
SOIL SLIDES	Clay Slump (Rotational) Clay Slide (Compound) Sand (Gravel, Talus, Debris) Slide
FLOWS	Dry Sand (Silt, Gravel, Talus, Debris) Flow Sand (Silt, Debris, Peat) Flow Slide Sensitive Clay Flow Slide Debris Avalanche Debris (Mud) Flow Debris Flood Earth Flow Rock Avalanche Rock Slide-Debris Avalanche

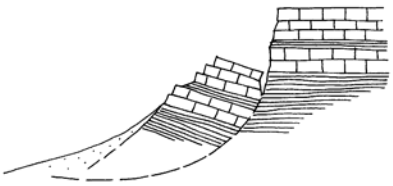
(modified from Varnes, 1978, Hutchinson, 1988, Hungr et al., 2001)

“Slides” in rock



Translational rock slide, Wedge slide

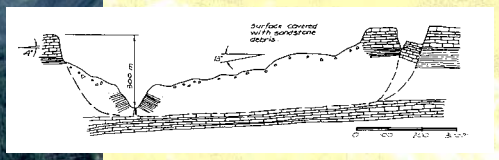
Sliding of a mass of rock on a planar rupture surface, or a wedge of two planes with downslope-oriented intersection. Rupture surface may be stepped. No internal deformation. The slide head may be separating from stable rock along a deep, vertical tension crack. Usually extremely rapid.



Rock slump (rotational slide)

Sliding of a mass of weak rock on a cylindrical or ellipsoidal rupture surface which is not structurally-controlled. Little internal deformation. A large main scarp and characteristic back-tilted bench at the head. Usually slow.

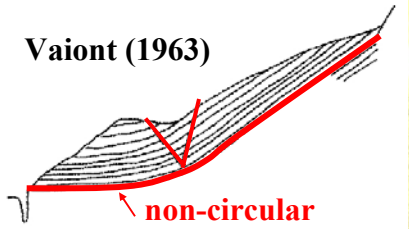
Scatter River, North-east British Columbia
(Hungr et al., 1984

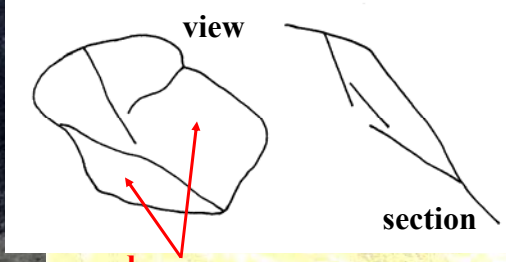


Compound rock slide

Sliding of a mass of rock on a rupture surface consisting of several planes, or a surface of uneven curvature, so that motion is kinematically possible only if accompanied by significant internal distortion of the moving mass. Horst-and-graben features at the head and many secondary shear surfaces. Parts of the rupture surface may develop by shearing through the rock structure. Slow or extremely rapid.

Isometry of rupture surface
(after Hendron and Patton, 1985)





Rock collapse

Sliding of a rock mass on an irregular rupture surface consisting of a number of randomly-oriented joints, separated by segments of intact rock ("rock bridges"). Occurs in strong rocks with non-systematic structure. Failure mechanism is very complex and often difficult to describe. Some toppling may also occur. Very sudden and extremely rapid.

Mt. Cayley, British Columbia, dacite breccias

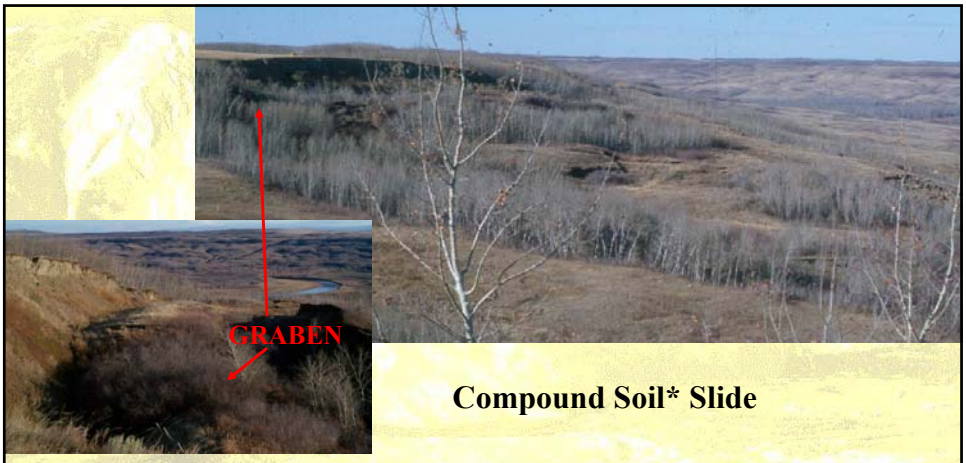
Mt. Cayley, British Columbia, dacite breccias

Salmon Arm, B.C., 1996

Rotational Soil* Slide ("Soil* Slump"):

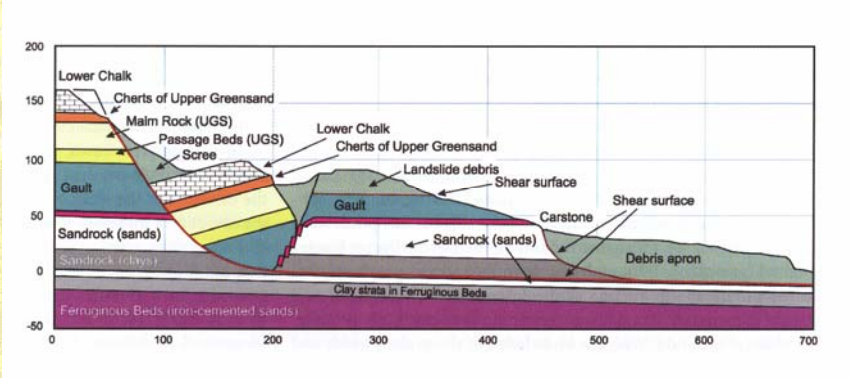
Sliding of a mass of (usually cohesive) soil on a cylindrical or ellipsoidal rupture surface. Little internal deformation. Normally slow, but may be extremely rapid in sensitive or collapsive soils.

*** The word "Soil" may be replaced in the definition by a specific term such as "Clay, Silt, Sand, Debris or Earth"**



Compound Soil* Slide

Sliding of a mass of soil on a rupture surface consisting of several planes, or a surface of uneven curvature, so that motion is kinematically possible only if accompanied by significant internal distortion of the moving mass. Horst-and-graben features at the head and many secondary shear surfaces. The basal segment of the rupture surface often follows a weak horizon in the soil stratigraphy.

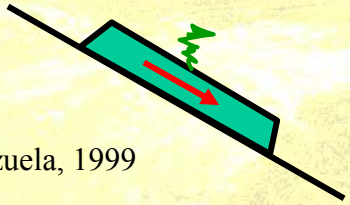


Compound slide in Cretaceous clays (southern England) **from Bromhead, 2006**

Compound sliding surface, cross-section

Translational slide
(Debris slide)
Sliding of a thin surficial layer over strong substrate

B.C.



Venezuela, 1999

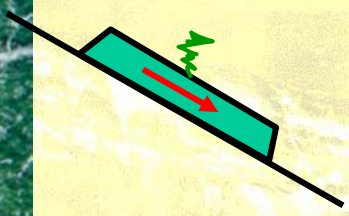
Definitions of sliding type mass movements in rock

Rotational Rock Slide ("Rock Slump"): Sliding of a mass of weak rock on a cylindrical or ellipsoidal rupture surface which is not structurally-controlled. Little internal deformation. A large main scarp and characteristic back-tilted bench at the head. Usually slow.

Translational Rock Slide ("Block Slide, Wedge Slide"): Sliding of a mass of rock on a planar rupture surface, or a wedge of two planes with downslope-oriented intersection. No internal deformation. The slide head may be separating from stable rock along a deep, vertical tension crack. Usually extremely rapid.

Compound Rock Slide: Sliding of a mass of rock on a rupture surface consisting of several planes, or a surface of uneven curvature, so that motion is kinematically possible only if accompanied by significant internal distortion of the moving mass. Horst-and-graben features at the head and many secondary shear surfaces. Parts of the rupture surface may develop by shearing through the rock structure. Slow or extremely rapid.

Rock Collapse: Sliding of a rock mass on an irregular rupture surface consisting of a number of randomly-oriented joints, separated by segments of intact rock ("rock bridges"). Occurs in strong rocks with non-systematic structure. Failure mechanism is very complex and often difficult to describe. Very sudden and extremely rapid.



Debris slide

Sliding of a mass of granular material on a shalow, planar surface parallel with the ground. Usually, the sliding mass is a veneer of colluvium or weathered soil resting on a stronger substrate. Many debris slides become flow-like after moving a short distance and transform into debris avalanches.