Surficial Processes

- Erosion, transportation, deposition on the Earth's surface
- Create and destroy landscapes
- Involve atmosphere, water, gravity

- Agents:
  - Mass wasting, running water (streams), glaciers, wind, water waves, ground water

Mass Wasting

- Introduction to surficial processes
- Mass wasting – definition
- Controls
- Classification of mass wasting
  - soil creep
  - falls
  - slides and slumps
  - flows

Mass Wasting (land slides)

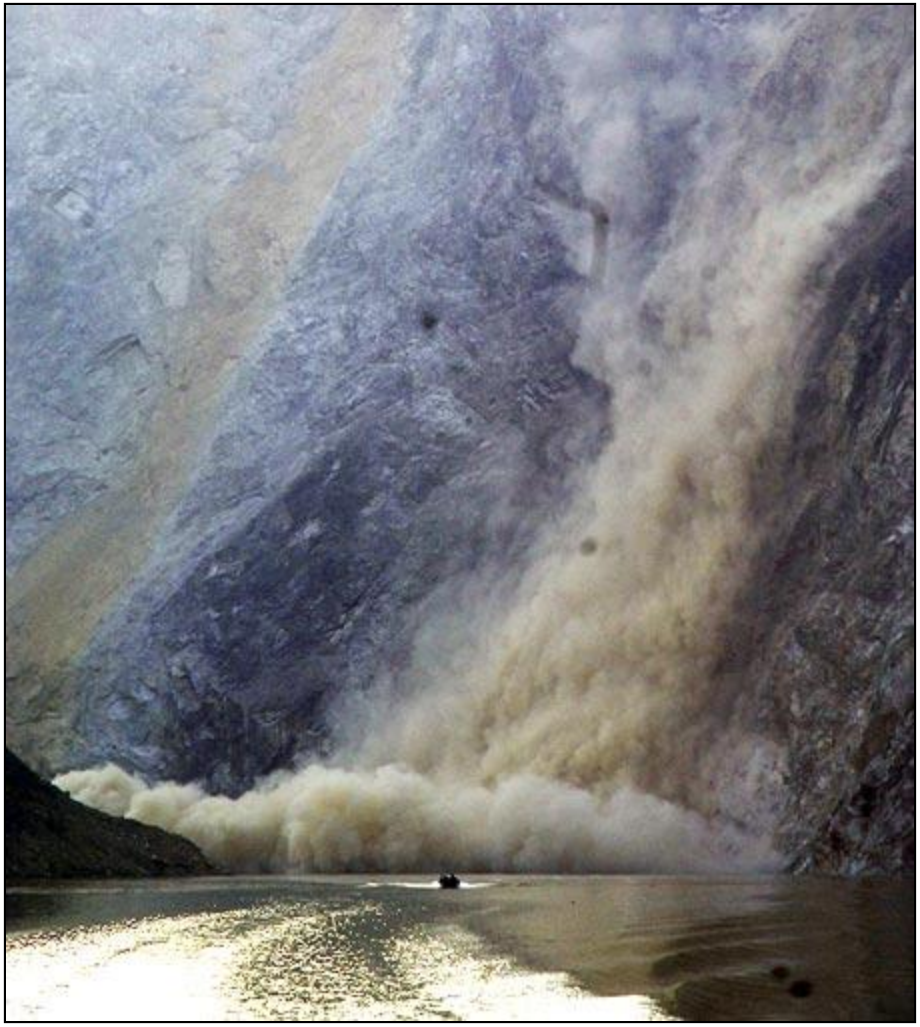
- **What is mass wasting?**
  - Masses of debris or bedrock moving downhill
- **Why is it important?**
  - Can be disastrous
  - Shapes landscapes
- **What drives mass wasting?**
  - Driven by *GRAVITY*

October 2007. La Jolla, CA

China. March 5th 2009

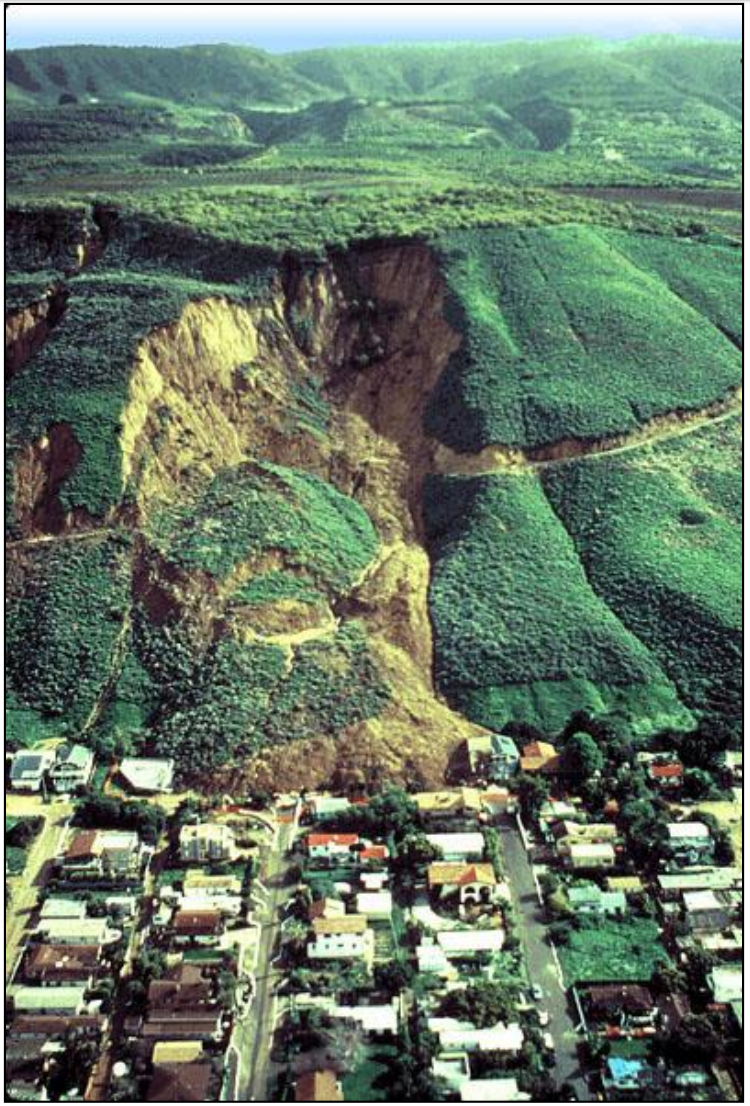
Mass Wasting

What factors control mass wasting?
In other words, what controls how stable a slope is?



Controlling factors

- Steepness of slope
- Relief (vertical elevation change acted on by gravity)
- Water:
  - Adds weight
  - Increases pore pressure



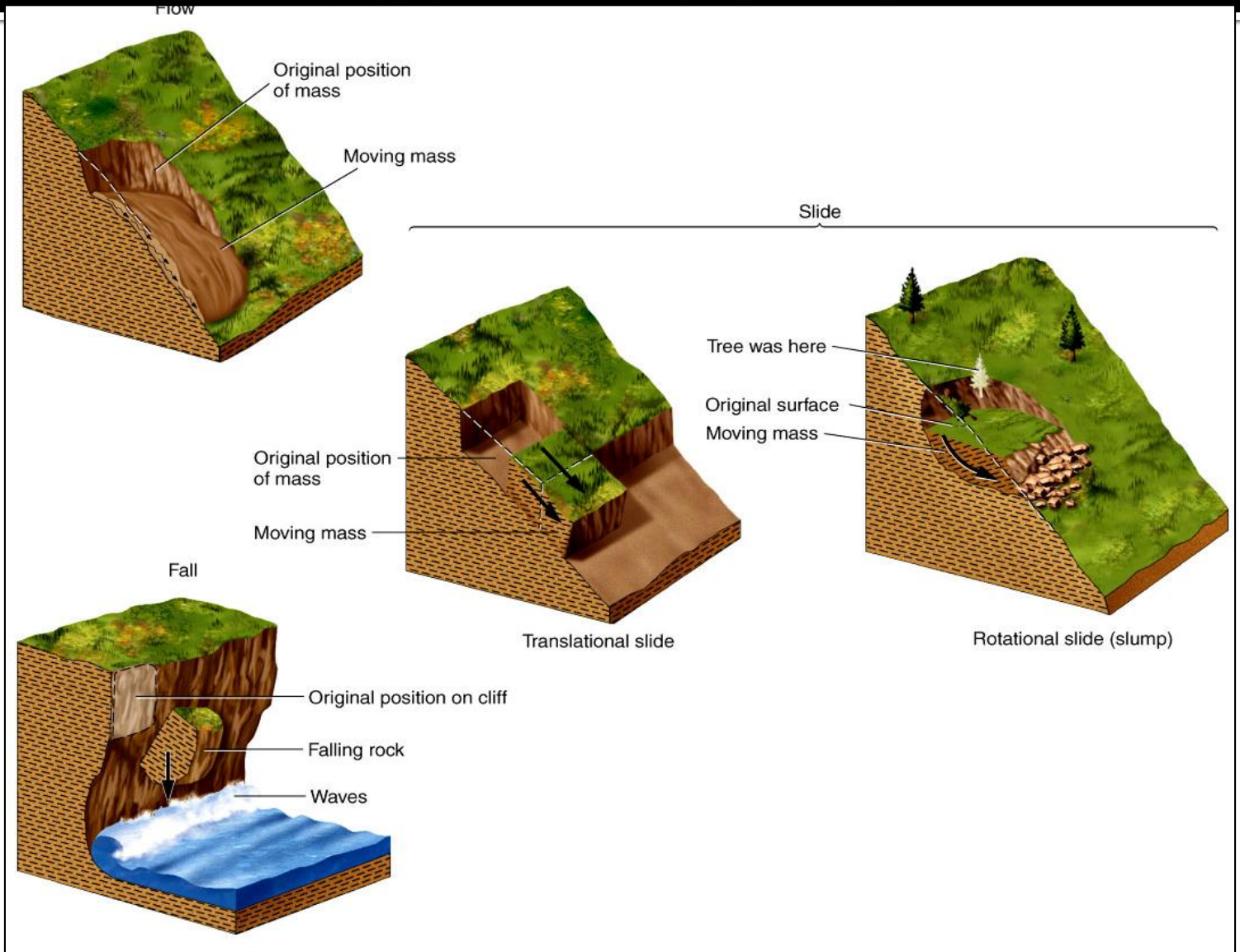
Controlling factors

- Vegetation
  - Roots hold soil together
  - Absorb water
  - Adds weight to slopes
- Triggers
  - Earthquakes and vibrations
  - Precipitation

Classification of mass wasting can be based upon:

- **TYPE OF MATERIAL**
  - Bedrock
  - Debris- ("soil", sediment)
- **TYPE OF MOVEMENT**
  - Fall
  - Slide
    - Translational slide
    - Rotational slide (Slump)
  - Flow
- **RATE OF MOVEMENT**
  - Fast *(avalanche* - very rapid >100 km/hour
  - Slow *(creep e*xtremely slow ~1mm/year

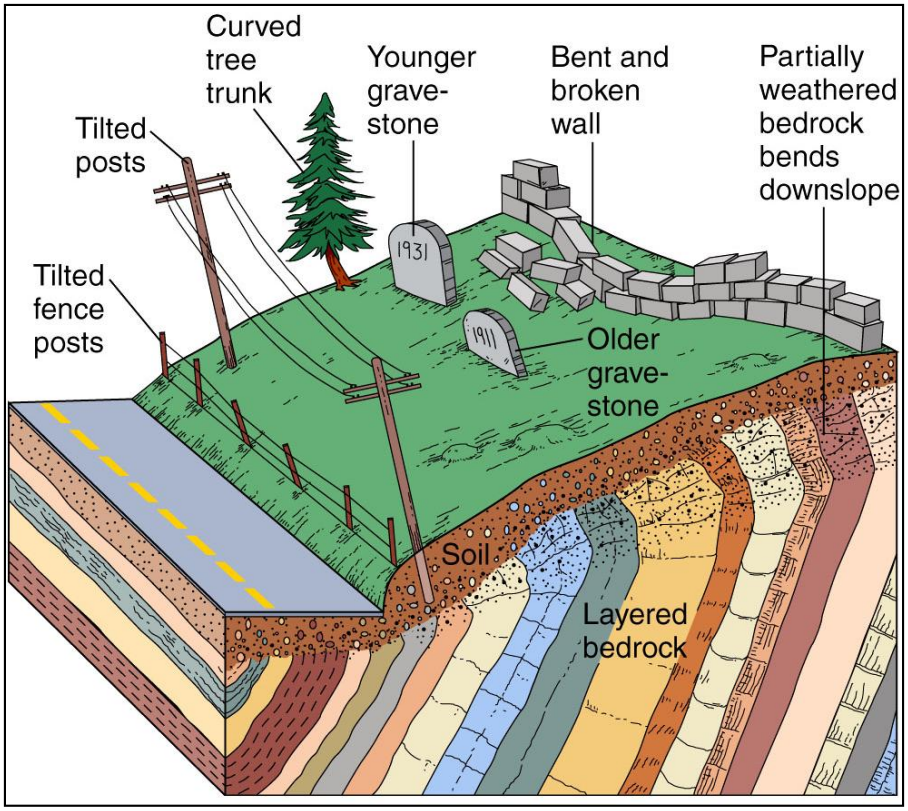
Classification by type of movement



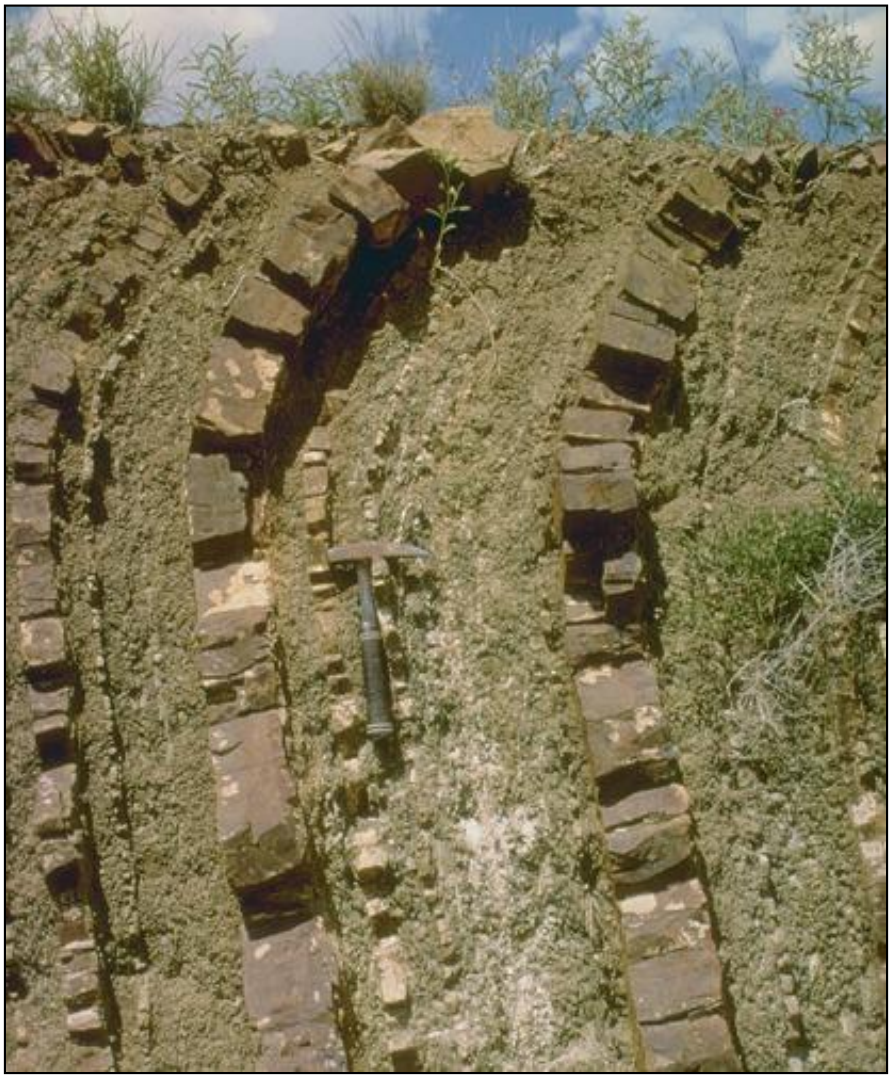
TYPES OF MASS WASTING

SOIL CREEP

- very slow *flow*
  - (< 1 cm/year)
  - facilitated by water in soil
  - or by freeze-thaw in colder climates
- Indicators of creep
  - tilted fence posts
  - curved tree trunks
  - bed rock bent downslope

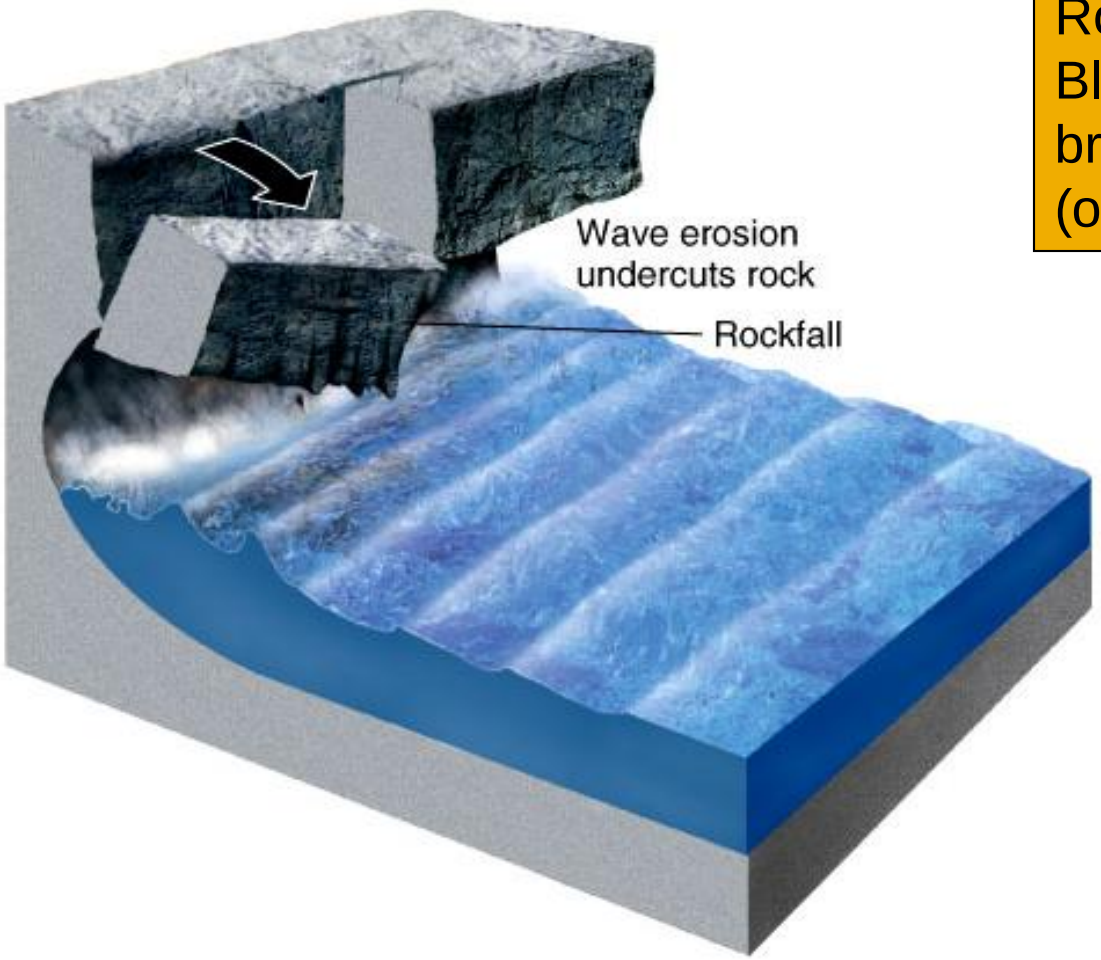


Soil Creep: Indicators



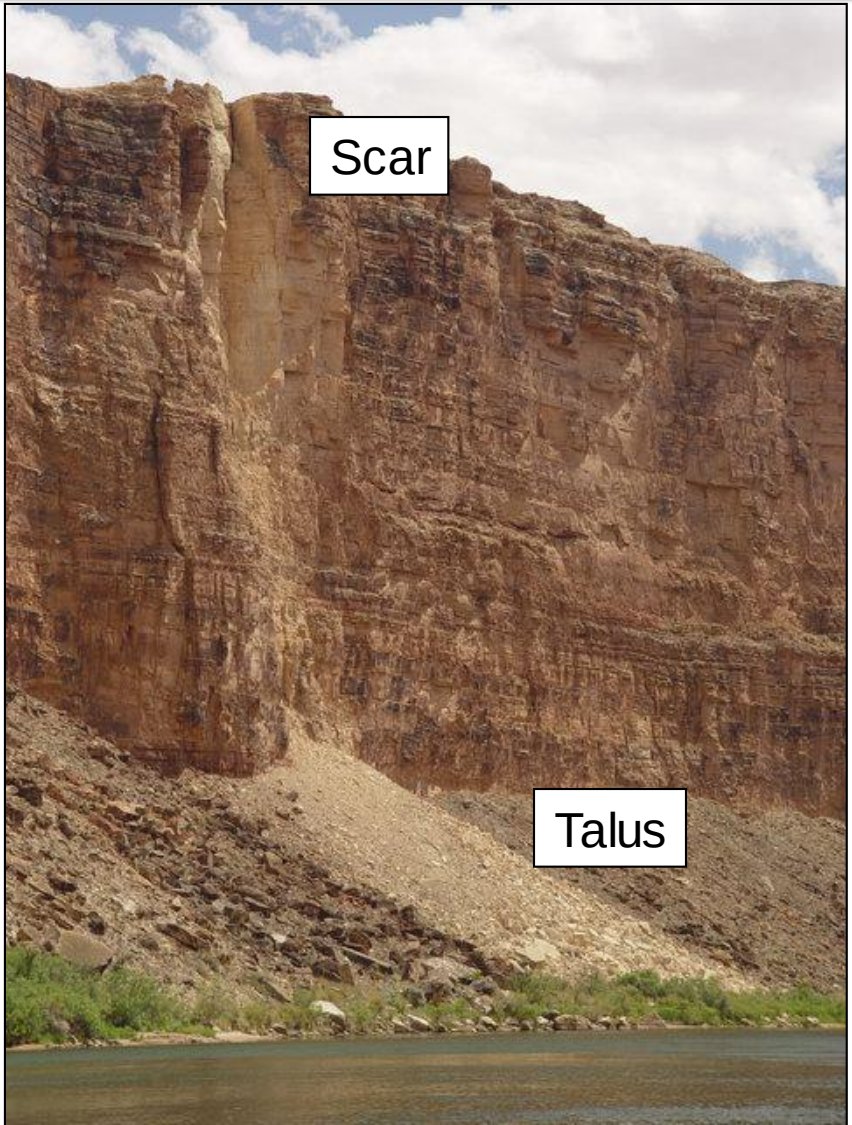
Soil Creep: Indicators

Falls

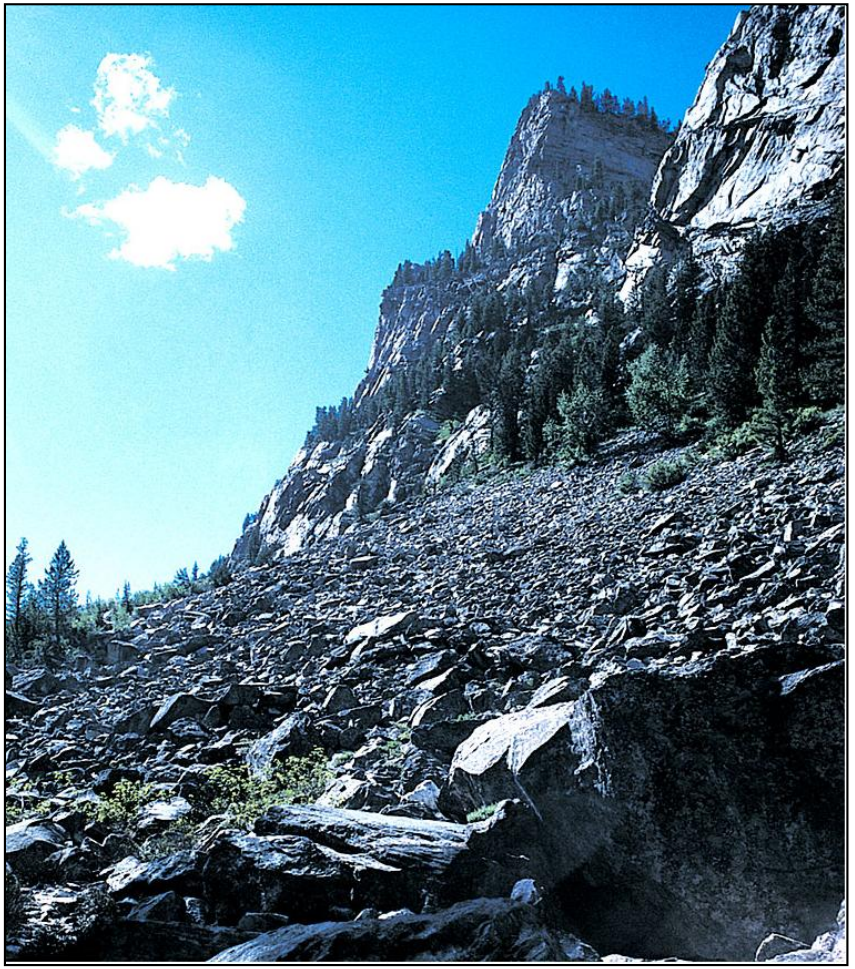


Rock Fall:
Block of bedrock that breaks off and falls freely (or bounces) down a cliff

Rock Fall



Rock falls in Yosemite



1999 Yosemite Rock Fall

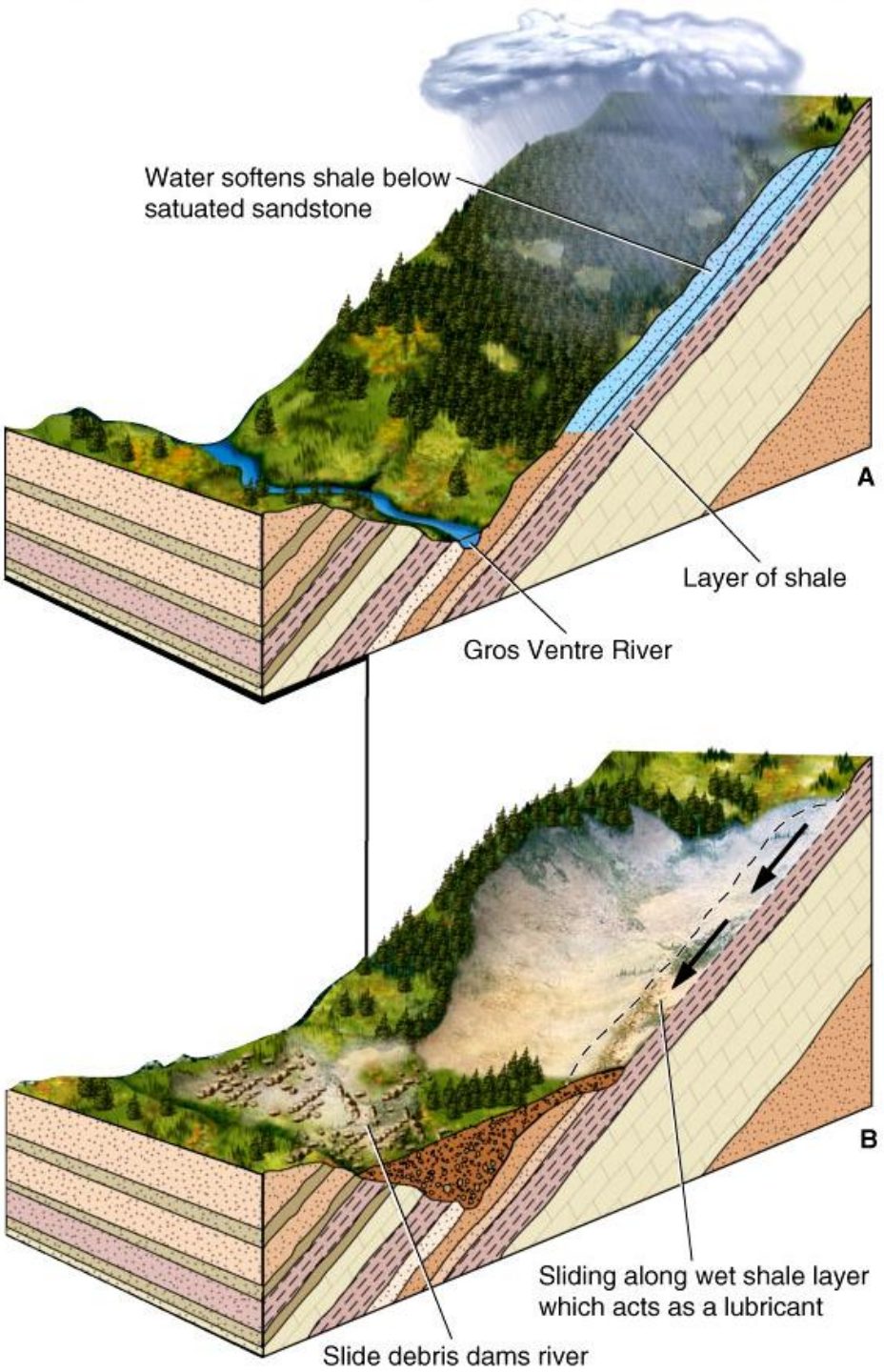
Exfoliation (sheet joints)

Talus slope

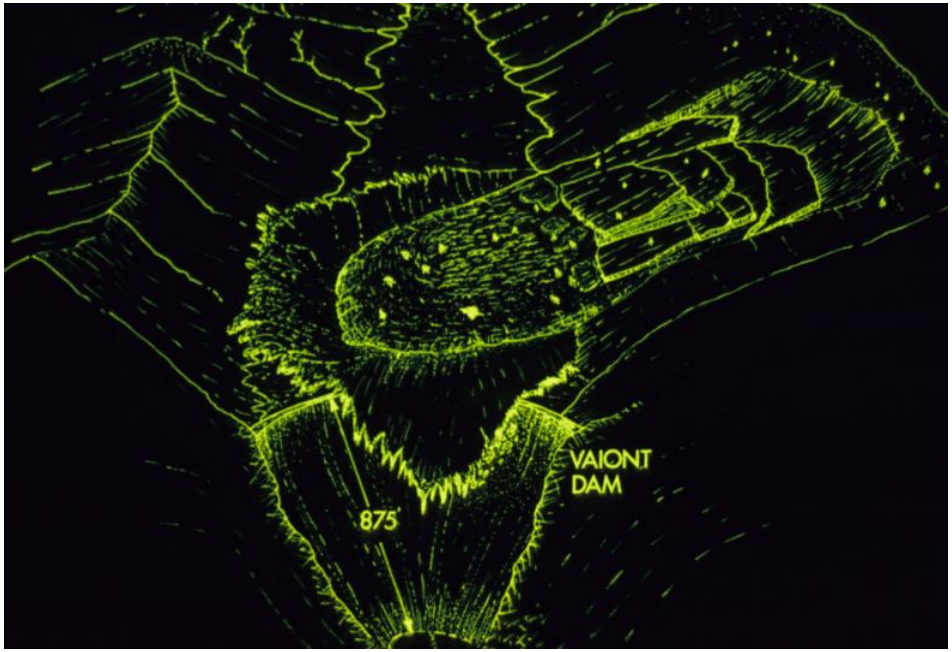
Curry Village

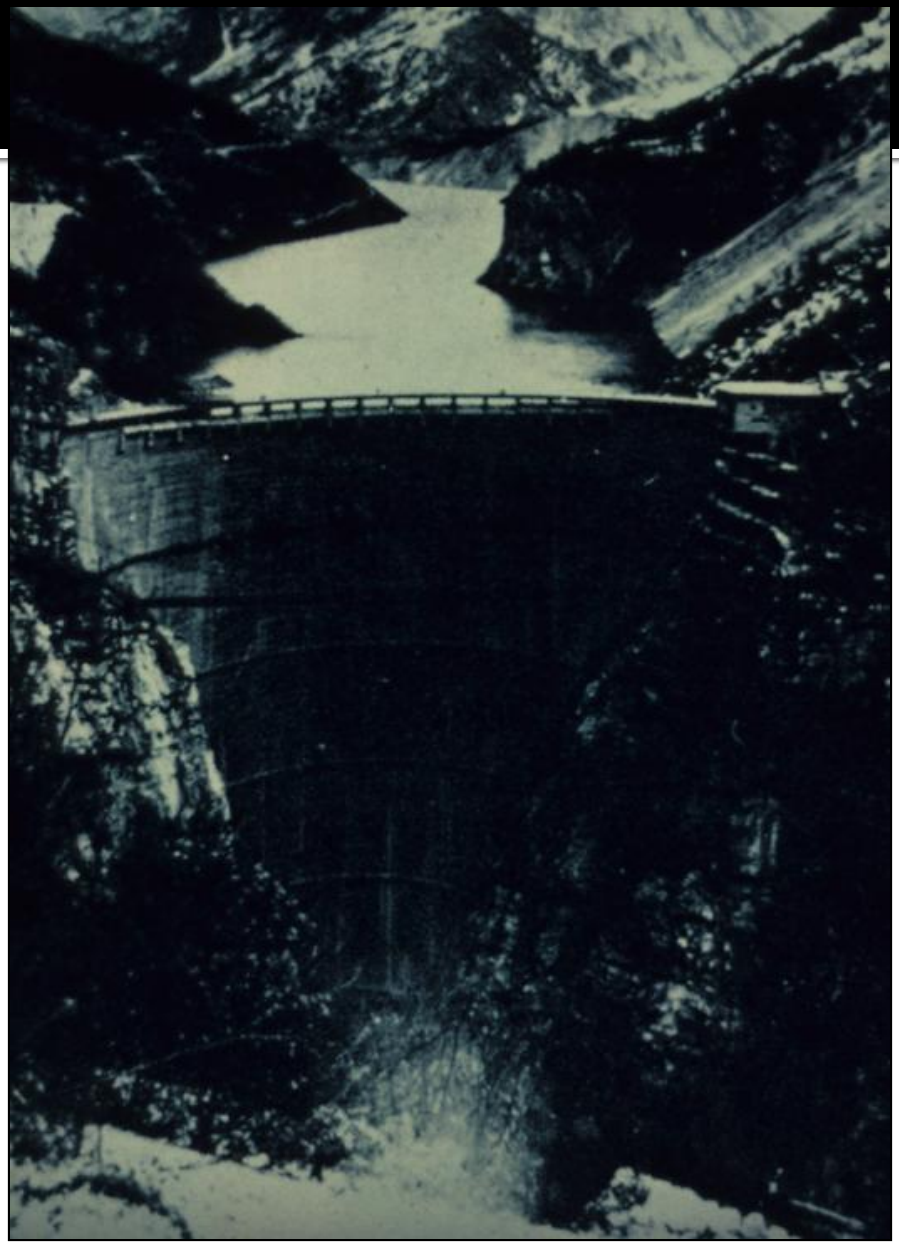
2008 Yosemite rock fall

Slides


Water softens shale below
satuated sandstone
A
Layer of shale
Gros Ventre River
B
Sliding along wet shale layer
which acts as a lubricant
Slide debris dams river

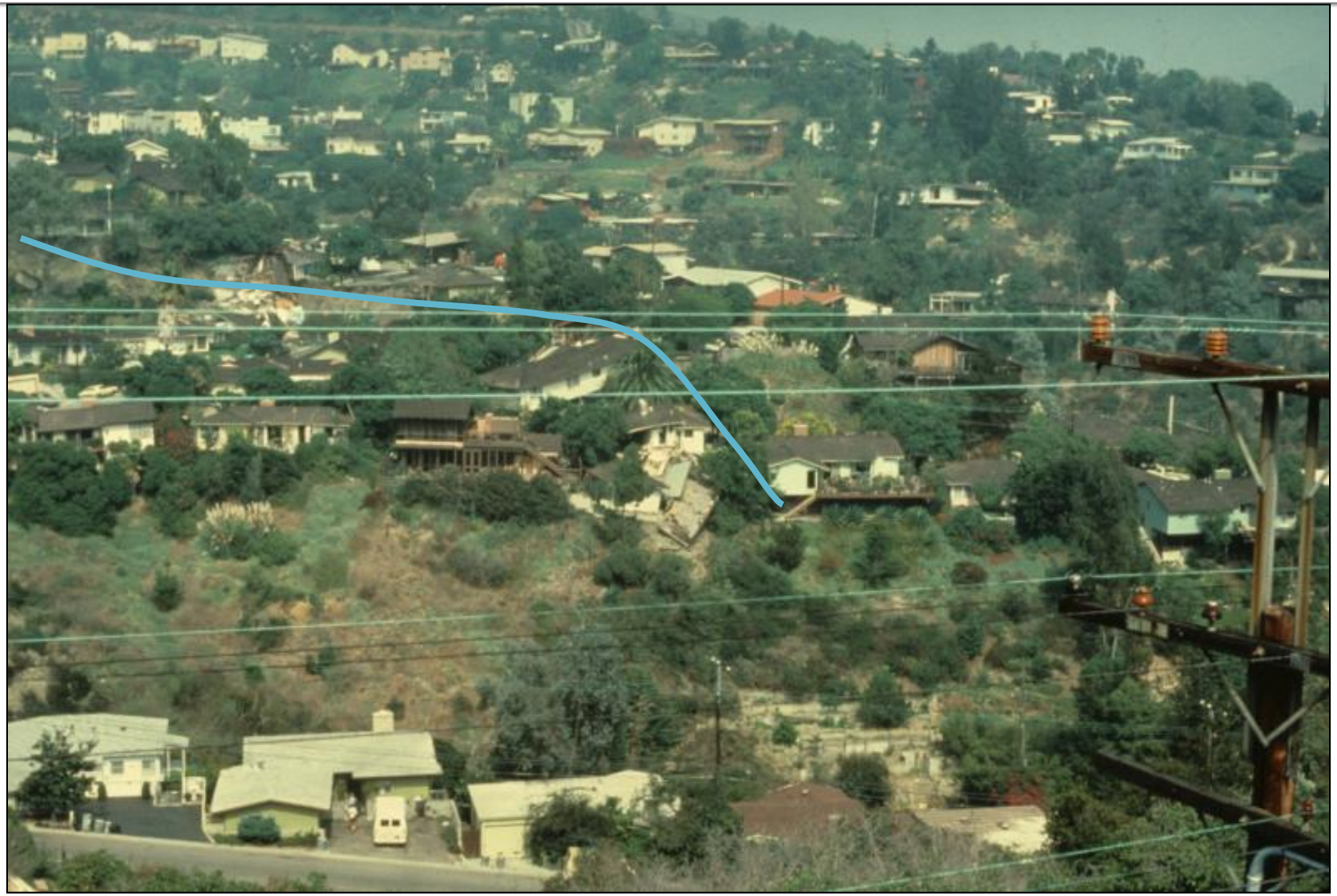
Vaiont Dam Disaster 1963





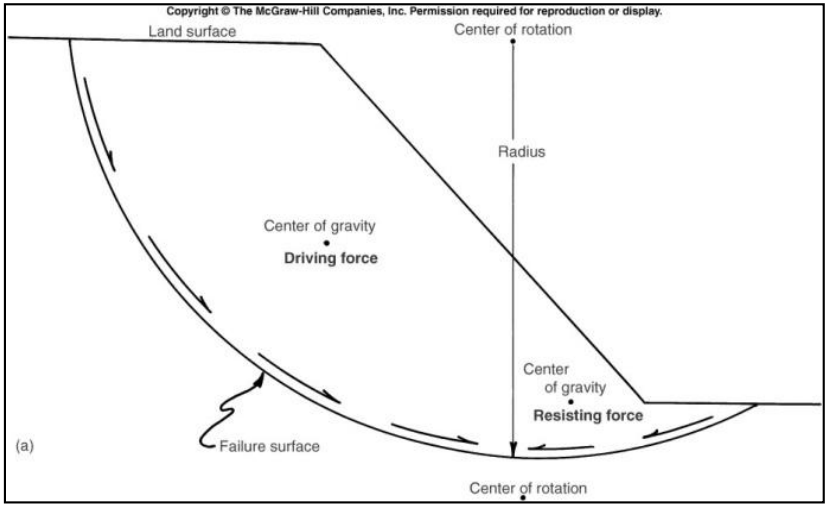
Limestone bed slid into reservoir
245 foot wave overtopped the dam
2500 people killed in villages downstream

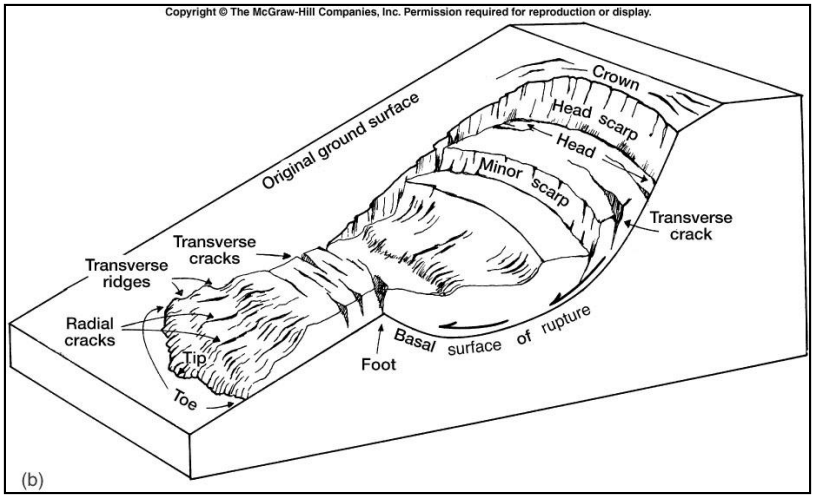
Bluebird Canyon Slide, June 2005

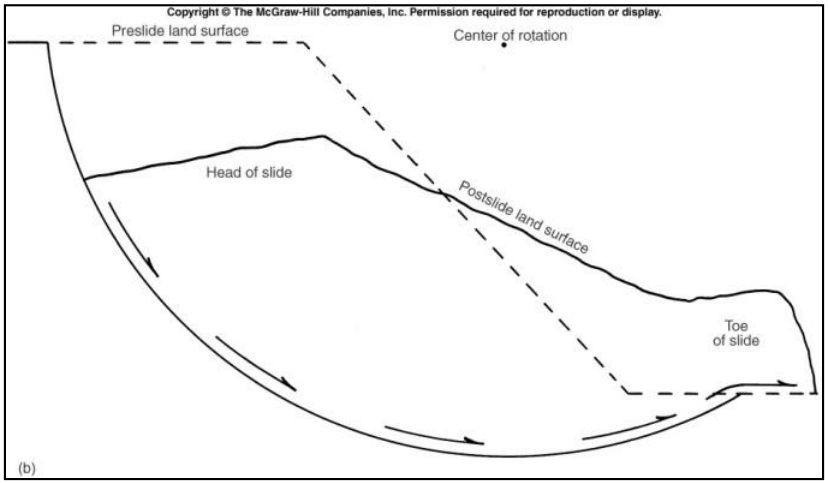


Slumps

- A slump is a slide that has a rotational component of movement

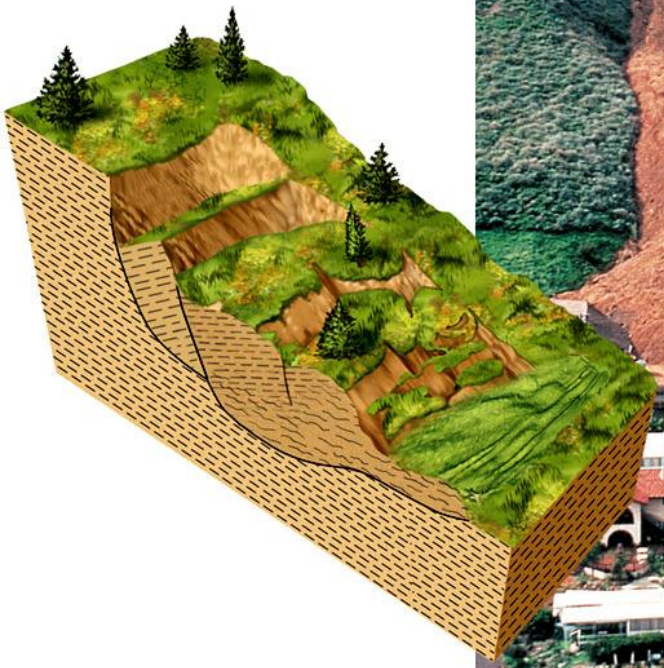






Slumps

La Conchita, CA. 1995



La Conchita, 2005 (earthflow)

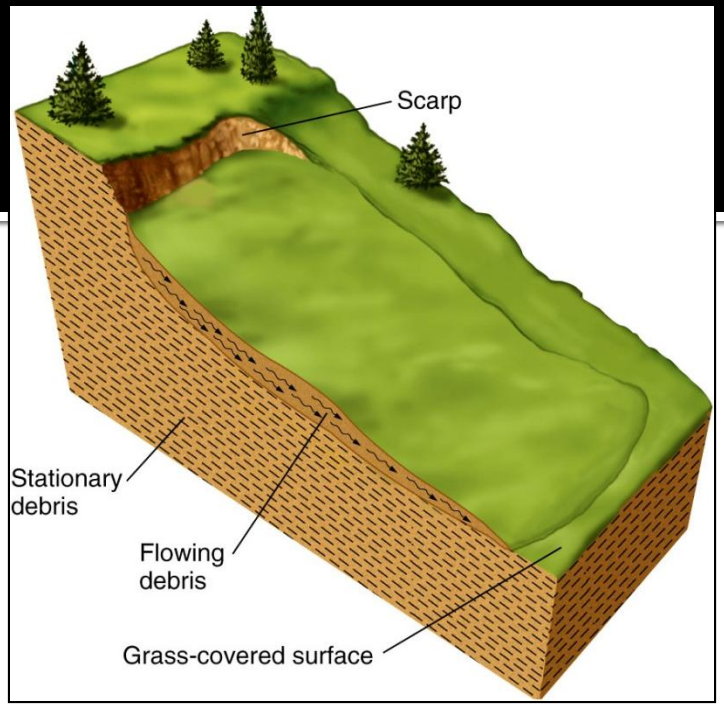
Flows

Flow: moving mass of unconsolidated material

- Earthflow
  - earth moves as viscous fluid
- Mudflow
  - flowing mix of soil and water
  - dominated by fine-grained material
- Debris Flow
  - flowing mix of debris and water
  - dominated by coarse-grained material

Earthflow

- Primarily *flow* of debris
- *Scarp forms* above
- *Hummocky surface* in lower part
- May be slow or fast moving



Rapid flows

- Debris Flows and Mud Flows
  - Motion taking place throughout moving mass
  - Occurs often in areas that lack vegetation:
    - Dry climates
    - Volcanoes (called Lahars)
    - After forest fires

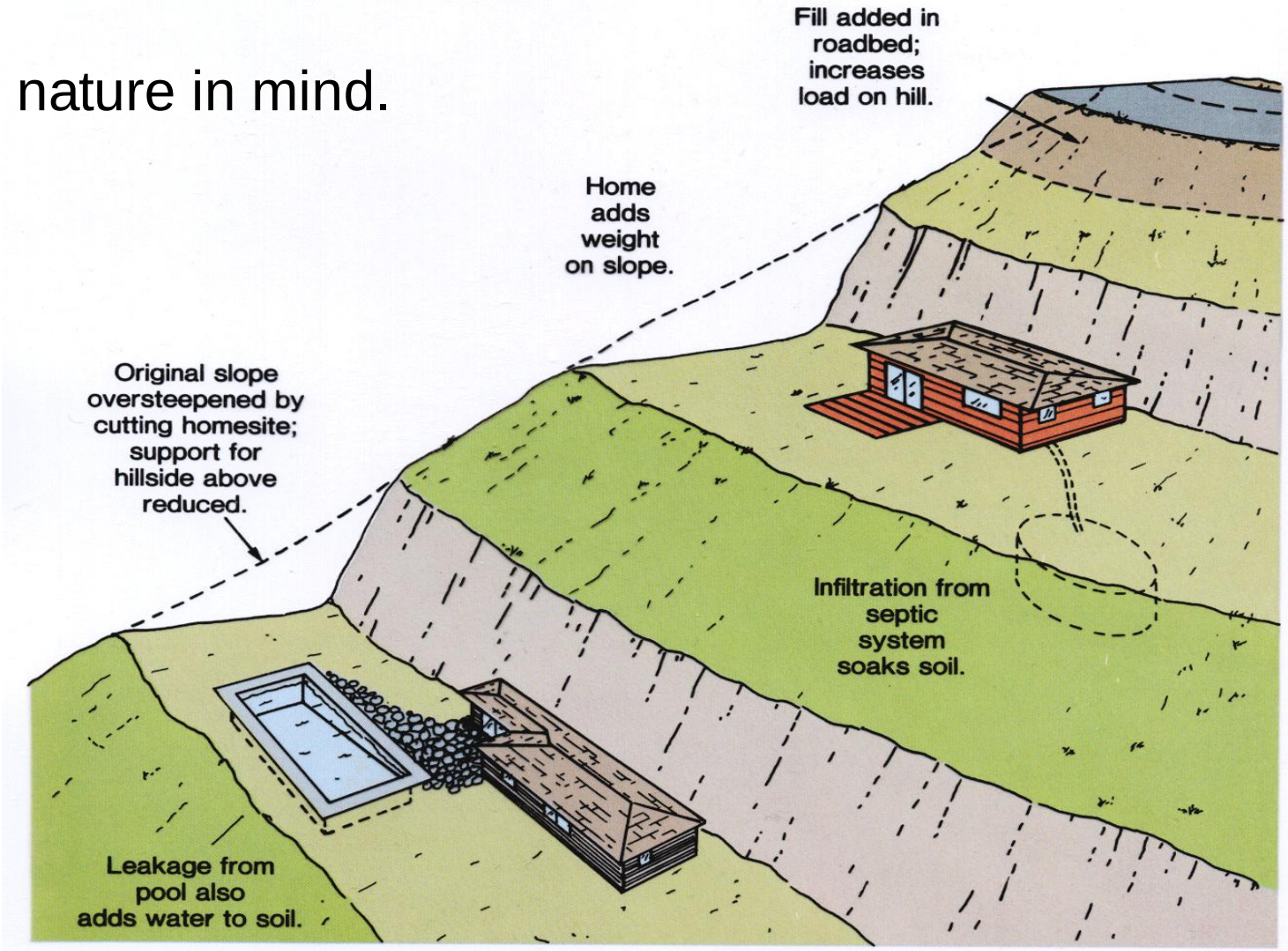
Fastest Type of Flow

DEBRIS AVALANCHE

- Very rapid, turbulent flow of debris
- Probably rides on a cushion of air
- Examples: Mt. St. Helens; Shasta; Lake Tahoe?

What to do?

Design with nature in mind.



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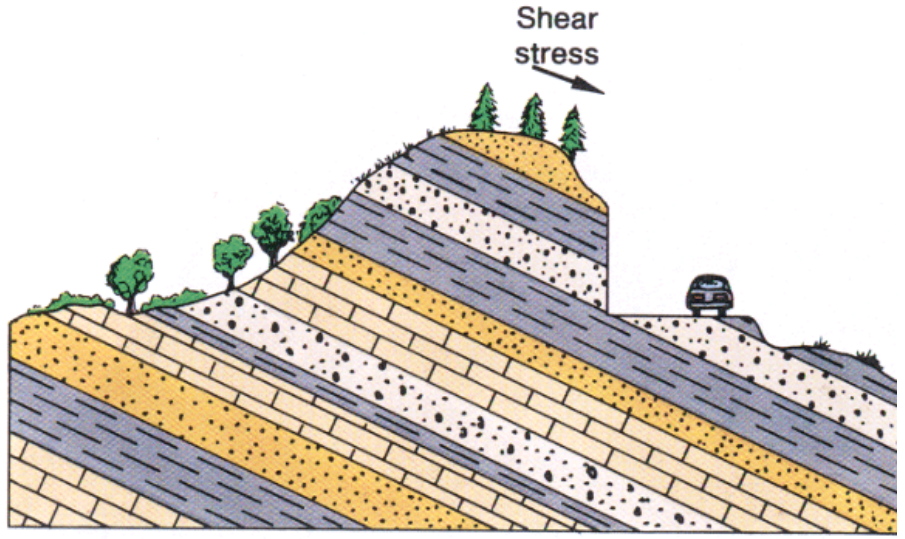

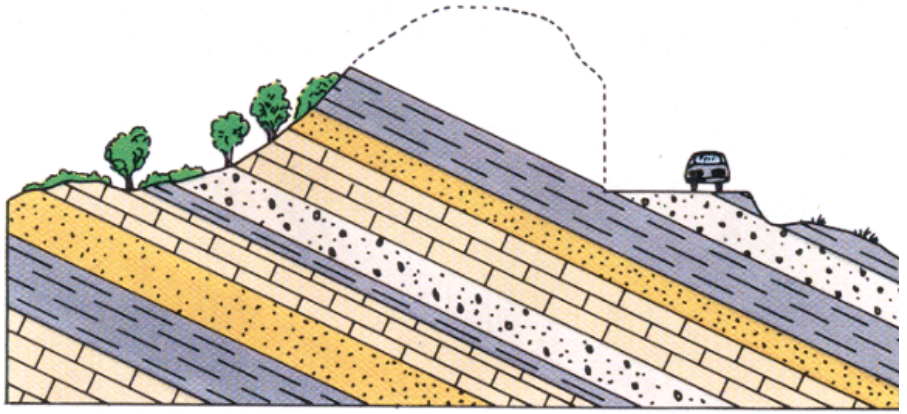

What to do?

Design with nature in mind.