New Topic Today

Mass Movement = Mass Wasting
= colluvial processes
= slope processes
= slope failures
= LANDSLIDES

U.S. Landslide Risk

Which states have lots of landslide damage?

Landslides by U.S. Region

• California 40% of U.S. damage
• West Virginia 13% of U.S. damage
WV Has 1st or 2nd Highest Landslide Damage Per Capita

- $100-300/person/yr
- About Same as UTAH

Main Problems
Road Failures
Building Damage
Construction Cost Over-Runs

Strength of Slope = Cohesion + Strength of Material

- Strength of Material Varies with Moisture
- Poor Drainage: Slope Instability

Angle of Repose
(Angle of Internal Friction)
Stable Angle of Slope for a Material
Angle of Repose

Sandstone = 70-90°
Shale = 30° (57% Slope)

Angle of Repose
Sandstone = 80-90°
Shale = 30° or 57% Slope

Angle of Repose Landslide Deposits = 5-25°

Mount St. Helens debris avalanche deposits
Angle of Repose for Clay = 1° to 10°

Shear Strength/Shear Stress = Factor of Safety

Creep

Tully (New York) Landslide 1993 USGS Photo
### Evidence of Creep

**Type of Motion**

- Fall
- Topple
- Planar Slide
- Rotational Slide
- Flow
- Avalanche

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## Basic Landslide Classification

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## Material

**Rock:** Bedrock  
**Soil:** Unconsolidated Material  
**Debris:** >20% Big Stuff (>2 mm)  
**Earth:** <20% Big Stuff (>2 mm)

## Landslides

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Landslides

Landslides - Topple

Landslides - Fall

Landslides - Topple
Rockslide at Yosemite National Park, CA, kills 1, injures 4 in 1999

Gerald F. Wieczorek, U.S. Geological Survey and James B. Snyder, National Park Service


Photograph taken from across the canyon by rock climber Lloyd DeForrest while dangling on rope 2000 feet above the valley floor
Landslides - Rock Fall

70 ton Boulder: “Mon” Blvd., 10 March 1994

“Mon” Blvd. Rock Fall, January 1983
Dominion Post Photo
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**Landslides**

Planar Slide = “Slide”

Rotational Slide = “Slump”
Landslides

Planar Slide = “Slide”

Rotational Slide = “Slump”

“Slump”
Typical WV Landslide. Slump scarp is at the head, and earthflow is at the toe. (Illustration by Paul Queen, WV Geol. Surv.)

http://www.wvgs.wvnet.edu/www/geohaz/geohaz3.htm

Earth Flow, Columbia Parkway, Cincinnati, Ohio.
Earth Flow, US 52, Cincinnati, Ohio. Cincinnati: highest per capita loss of any city in US.

(Photo by Aaron Mitten, Ohio Department of Transportation.)

Penn Hills, Allegheny Co., Photo by John Harper, PaGS.

Zion National Park, Utah
USGS Landslide Images
Slump Headscarp near McClure Pass, Colorado

La Conchita Landslide showing fractures in ridge behind the scarp.

Slump, La Conchita, California
Geomorphic Thresholds

Intrinsic:
- e.g. collapse of cave

Extrinsic:
- e.g. climate, humans

Real world geomorphic systems not as simple as in the lab! = the frustration = the attraction of geomorphology
Big Slump, New River Gorge
July 2001

Elverton Slump, New River Gorge, July 2001

Landslides | Rock | “Soil”
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Las Colinas Debris Slide-Flow, Santa Tecla, El Salvador, 13 Jan 2001 Earthquake
Source: Reuters, via search.news.yahoo.com/

La Guaira, Venezuela: Dec 1999
July 2001, Kanawha Valley, Glenn Ferris, WV

If you pictures or video, see Dr. Kite

Kanawha City Debris Flow: 3 Dead 1973

Stopped Here 20 Feb 2003: Mt. St. Helens Lahar, 1982
Mount Rainier, WA

Lahar
(= Debris Flow & Debris Avalanche)
Hazard in the Seattle Area

This Image: http://vulcan.wr.usgs.gov/Imgs/Rainier/Outreach/screen_poster_lahar_haz.jpg

Wet-slab avalanche, Quandary Peak, Colorado
Colorado Avalanche Information Center photo by Pete Wynne
http://www.caic.state.co.us/photos.html

Avalanches Ride Almost Frictionless on a Cushion of Compressed Air

Battleship Avalanche Track, February 28, 1987, Red Mountain Pass, Colorado

Colorado Avalanche Information Center photo by Tim Lane
http://www.caic.state.co.us/photos.html
Mt. Huascaran, Peru, 1970

17,000 dead

How Fast?

Armero, Colombia, near Nevado del Ruiz Volcano, Nov. 1985

23,000 Dead

Armero, Colombia, destroyed by lahar on November 13, 1985. More than 23,000 people were killed in Armero when lahars (volcanic debris flows) swept down from the erupting Nevado del Ruiz volcano. http://vulcan.wr.usgs.gov/Volcanoes/Colombia/Ruiz/description_eruption_lahar_1985.html
**U.S. Landslide Risk**

WV Has 1st or 2nd Highest Landslide Damage Per Capita

Main Problems Are

- Road Failures
- Building Damage
- Construction Cost Over-Runs
Retaining Wall Landslide Remediation
I-64, Afton Mountain, Virginia Blue Ridge.
http://www.mme.state.va.us/dmr/docs/hazard/slide.html

Regional Causes of Landslides

- Steep Topography
  - Mountains
  - Incision by Rivers
- Materials
  - Red Shales - Expansive Clays
- Stupid or Ignorant People
  - Oversteepening of Slopes
  - Poor Drainage Management
  - Lack of Geotechnical Consulting

Solutions to Landslide Problems

- Don’t Be Stupid – Use What You Learn from GEOL 101
- Seek Geotechnical Help From Geologists or Civil Engineers