

Natural Hazards and Disaster

Class 7: Landslides and Ground Instabilities

- Landslides
- Slumps
- Rock Falls
- Debris Flows
- Avalanches
- Remediation
- Precarious Rocks
- Sinkholes
- Other Planets



May 25, 2017

<http://www.cnn.com/2017/05/24/us/california-landslide-scenic-highway/index.html>

16 Dec. 1920: The Haiyuan earthquake triggered loess flows and landslides over an area of 50,000 km². Failures in loess caused extreme fissuring, landslide dams, and buried villages. More than 100,000 people were killed by the landslides.

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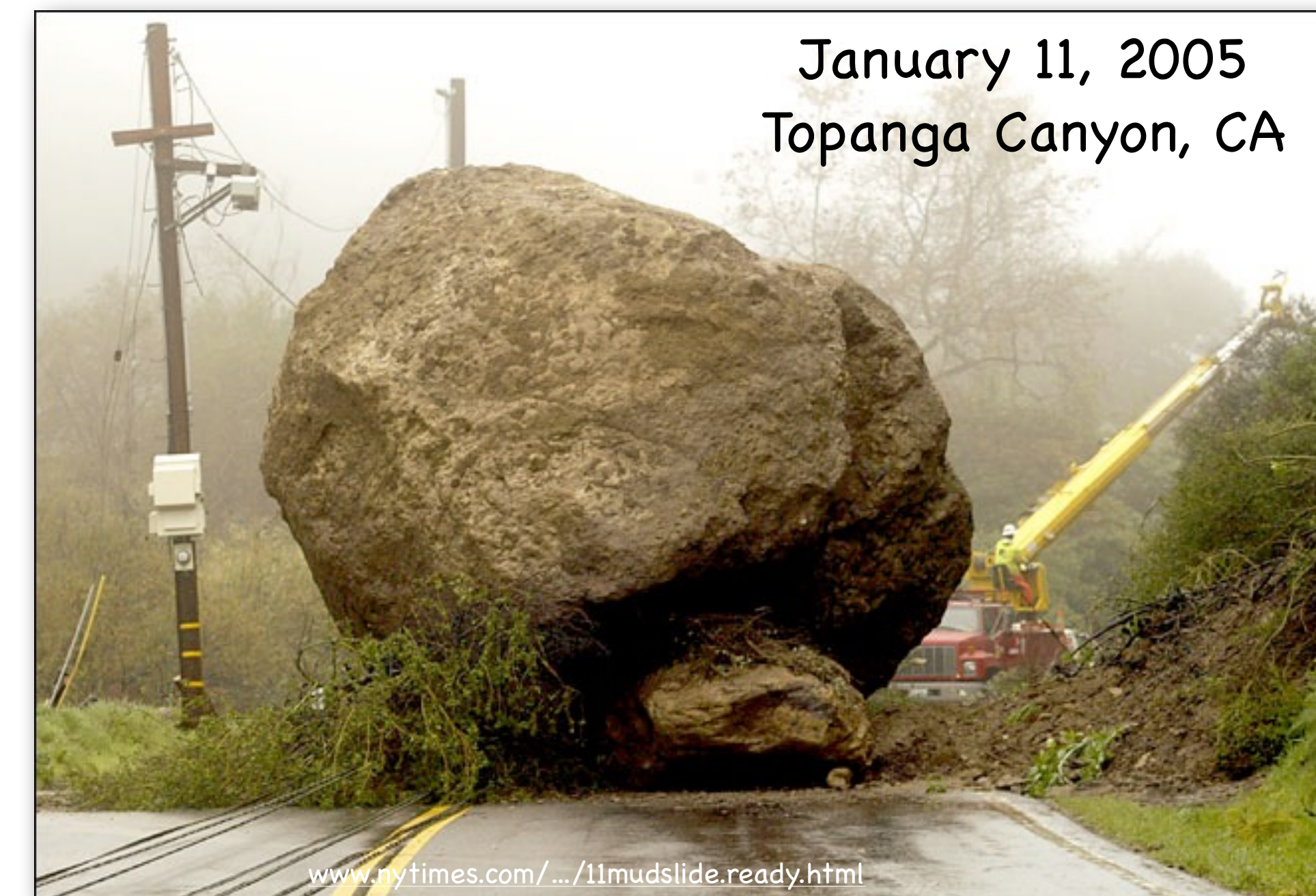
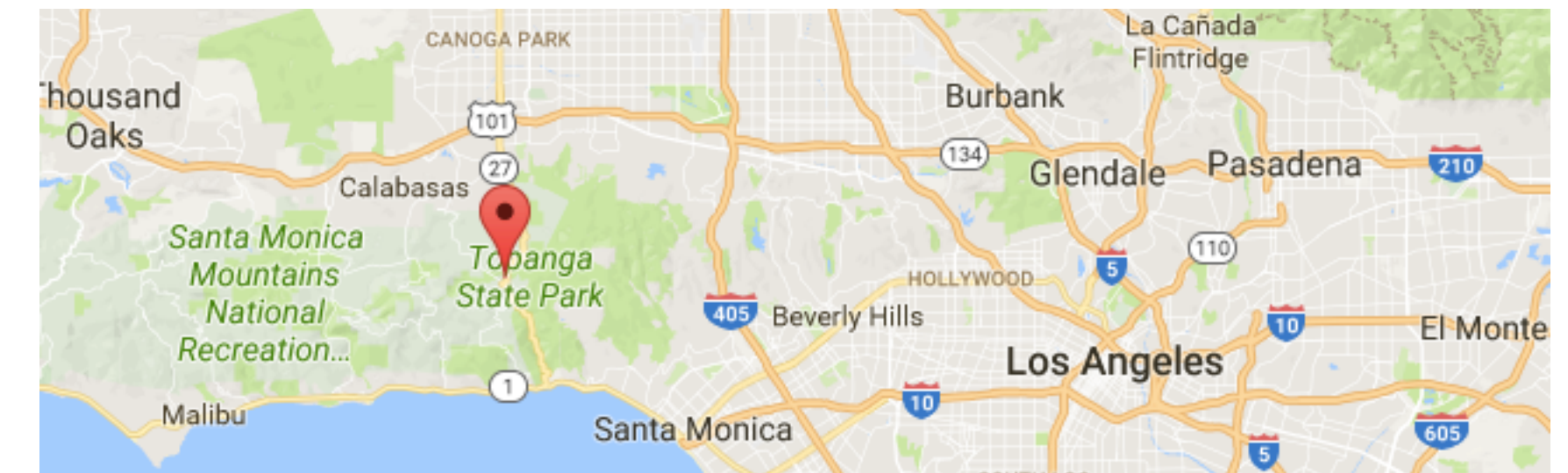


Yungay Viejo, Peru, (2500 m) as seen from the cemetery hill. The tinted area shows the location of the landslide (ice, mud, debris avalanche) on 31.05.1970, caused by an earthquake, in which a part of the western flank of Huascarán Norte broke (6652 m). Yungay Nuevo is behind the shaded area in the center. The debris avalanche buried the town of Yungay, killing 20,000 people.

Landslides



<http://www.timesfreepress.com/news/2009/nov/10/rock-slide-closes-highway-64-east-tennessee/>



Special Alert

DUE TO A ROCK SLIDE, I-40 IS CLOSED IN BOTH DIRECTIONS BETWEEN EXIT 20 (U.S. 276), 24 MILES WEST OF ASHEVILLE, IN NORTH CAROLINA AND EXIT 421 (I-81 INTERCHANGE), EAST OF KNOXVILLE IN TENNESSEE

Travelers can still reach Western North Carolina.

Both directions of I-40 are closed between Exit 20, West of Asheville in North Carolina, and Exit 421 (I-81 Interchange) East of Knoxville in Tennessee due to a rock slide at mile marker 2.6 on I-40 in North Carolina. The road is not expected to reopen for several months.

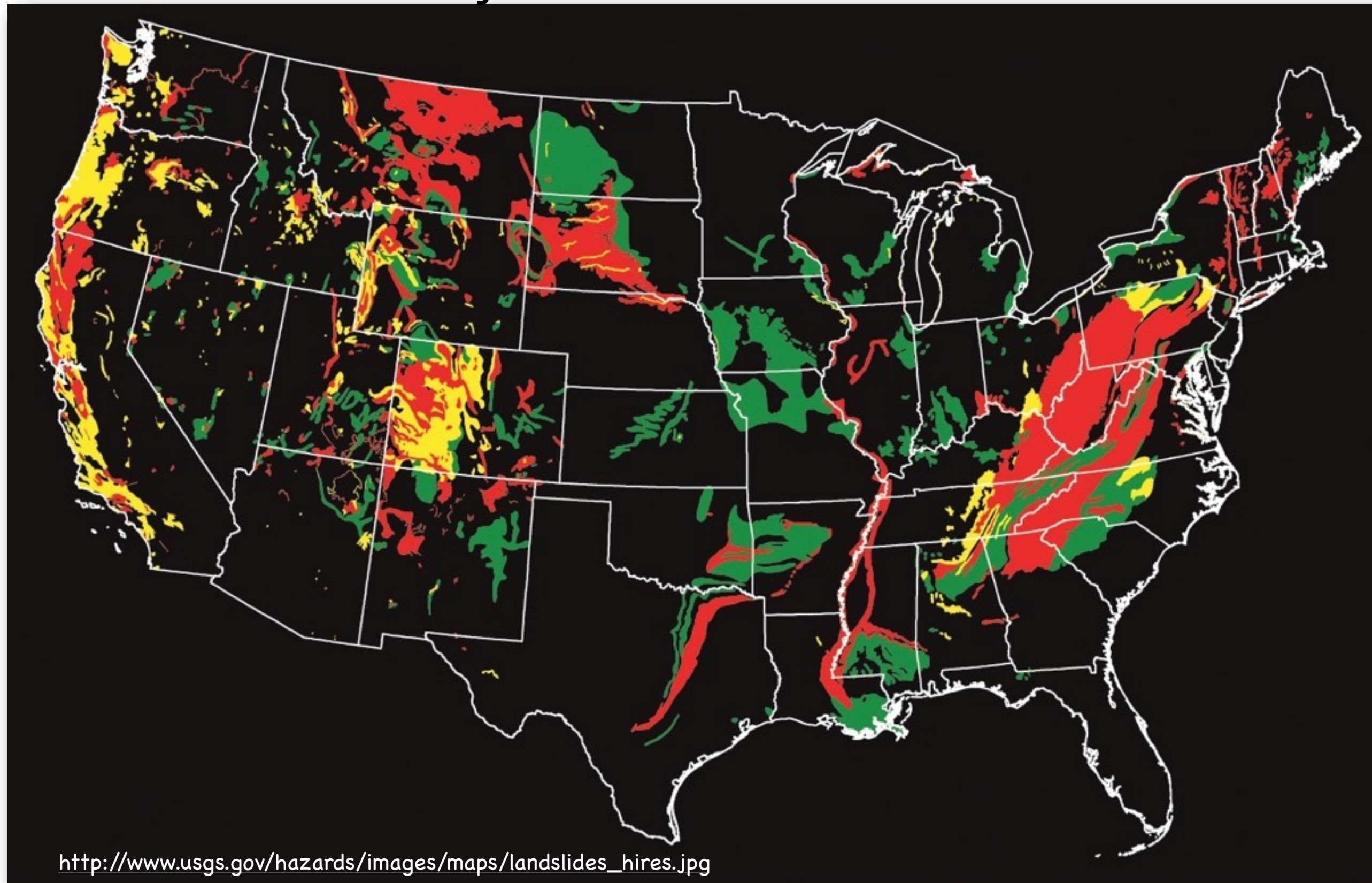
Official Detour: Motorists traveling on I-40 West are advised to take Exit 53B, I-240 West. Follow I-240 West to Exit 4A, I-26 West. Follow I-26 West (a North Carolina Scenic Highway) to I-81 South. Take I-81 South and follow back to I-40, Mile Marker 421, in Tennessee. This route is 53 miles longer than I-40.

notice on NC Dept. of Transportation site, November 20, 2009

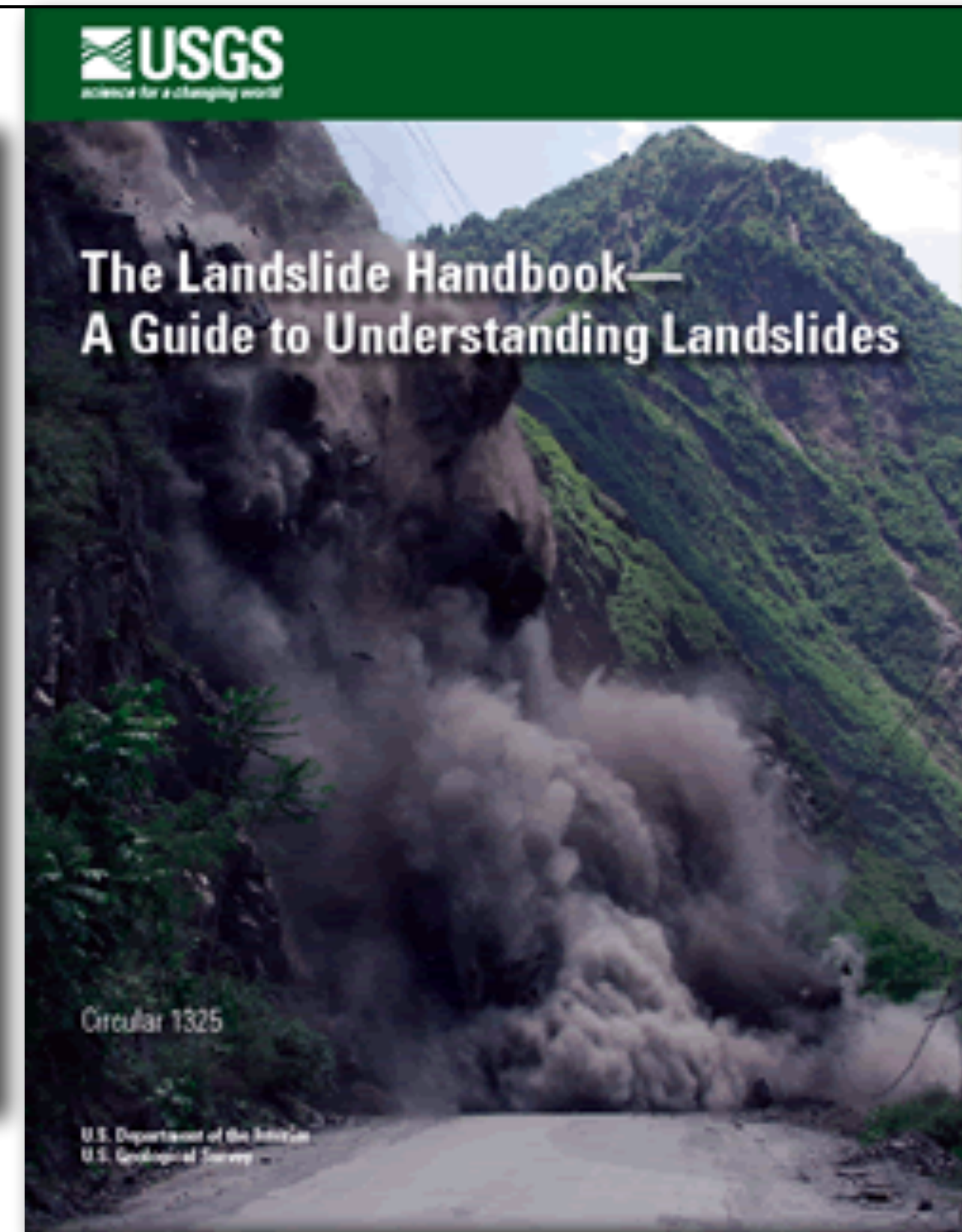




Where do they occur?



- Mainly in mountainous or very hilly areas
- On steep coastline cliffs
- Along river banks



Any steep slope!

What causes landslides?

GRAVITY - aided by:

- water
- weak material strength (sands, soils, fractured rock)
- steepness of slope
- loss of friction
- vibrations

La Conchita, CA
January 10, 2005

A major slump occurred the day after torrential rains

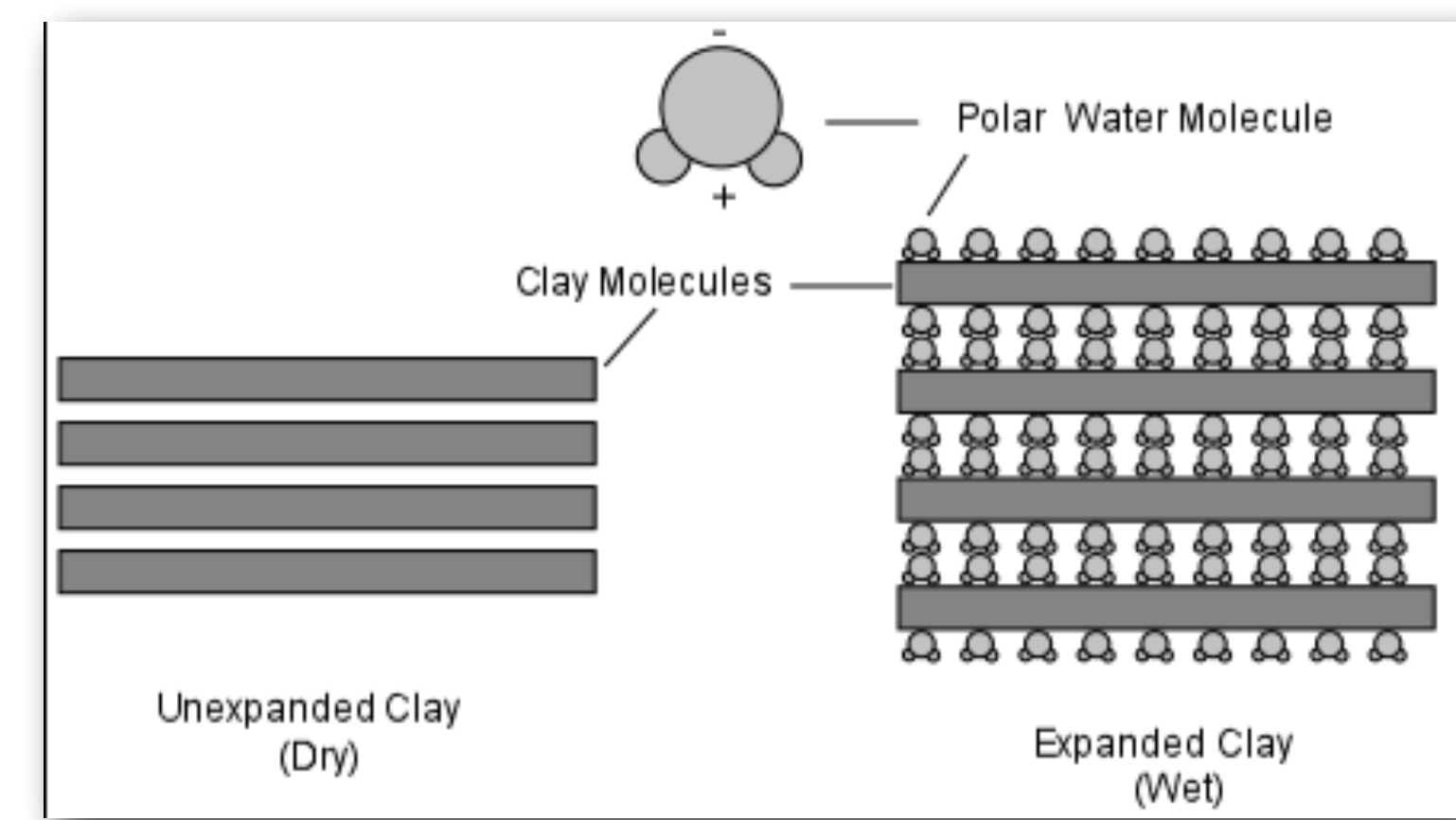


Landslides

The role of materials:

Clays - weak, soft, expand when wet

Clays become 'slippery' - with enough water, may turn into a wet slurry with little or no strength



<http://www.tulane.edu/~sanelson/geol204/slopestability.htm>

Volcanic ash is mainly clay!



http://marianna68.files.wordpress.com/2009/05/potter_pottery_clay_238298_l.jpeg



Armero,
Columbia,
1985

http://upload.wikimedia.org/wikipedia/commons/8/8d/Armero_Lahar.jpg

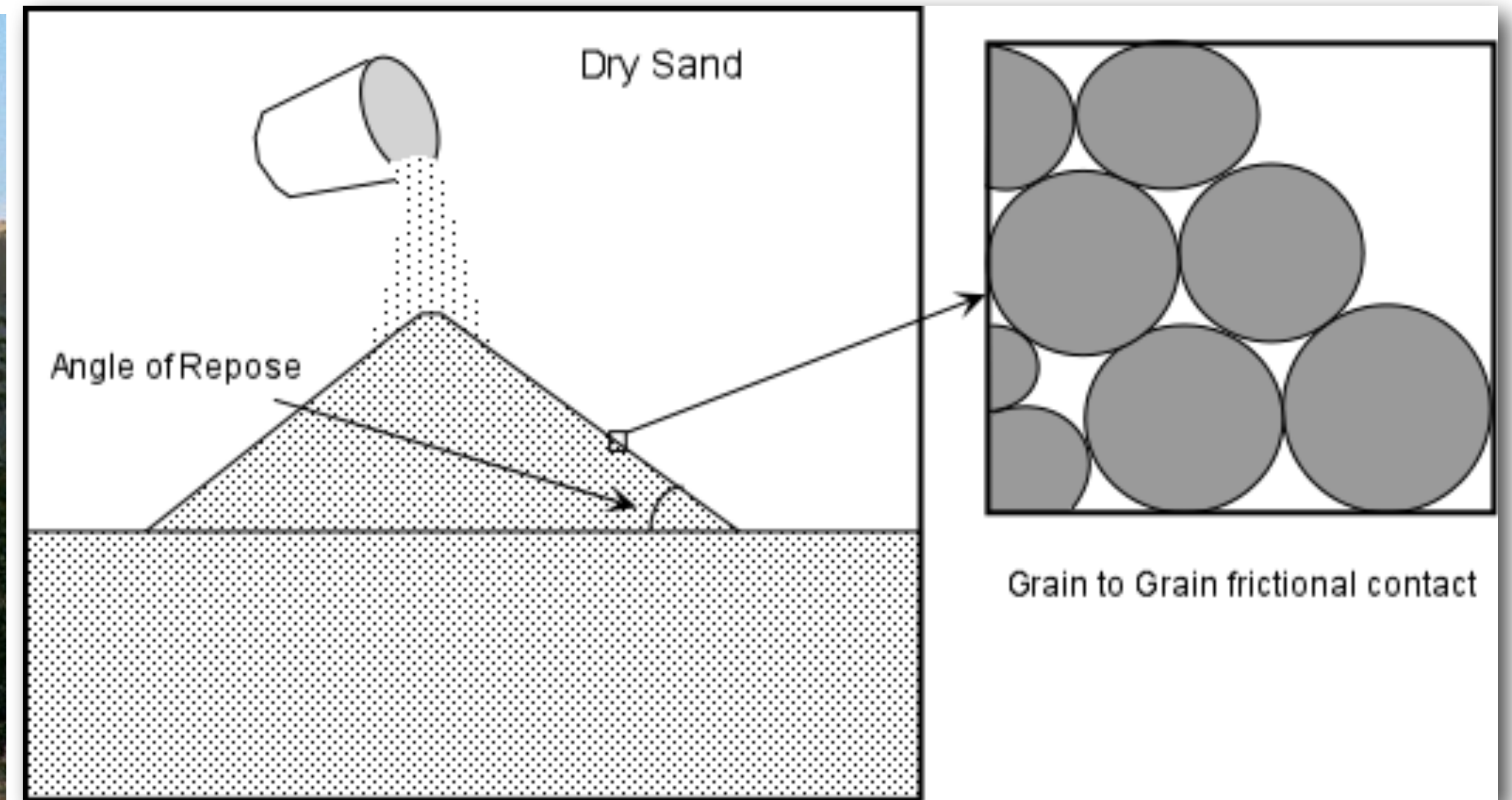
The role of materials:

Sands - weak, granular material



© Rick Scott

http://members.cox.net/theuniverse/landscape/so_cal_sand_dunes.jpg



<http://www.tulane.edu/~sanelson/geol204/slopestability.htm>

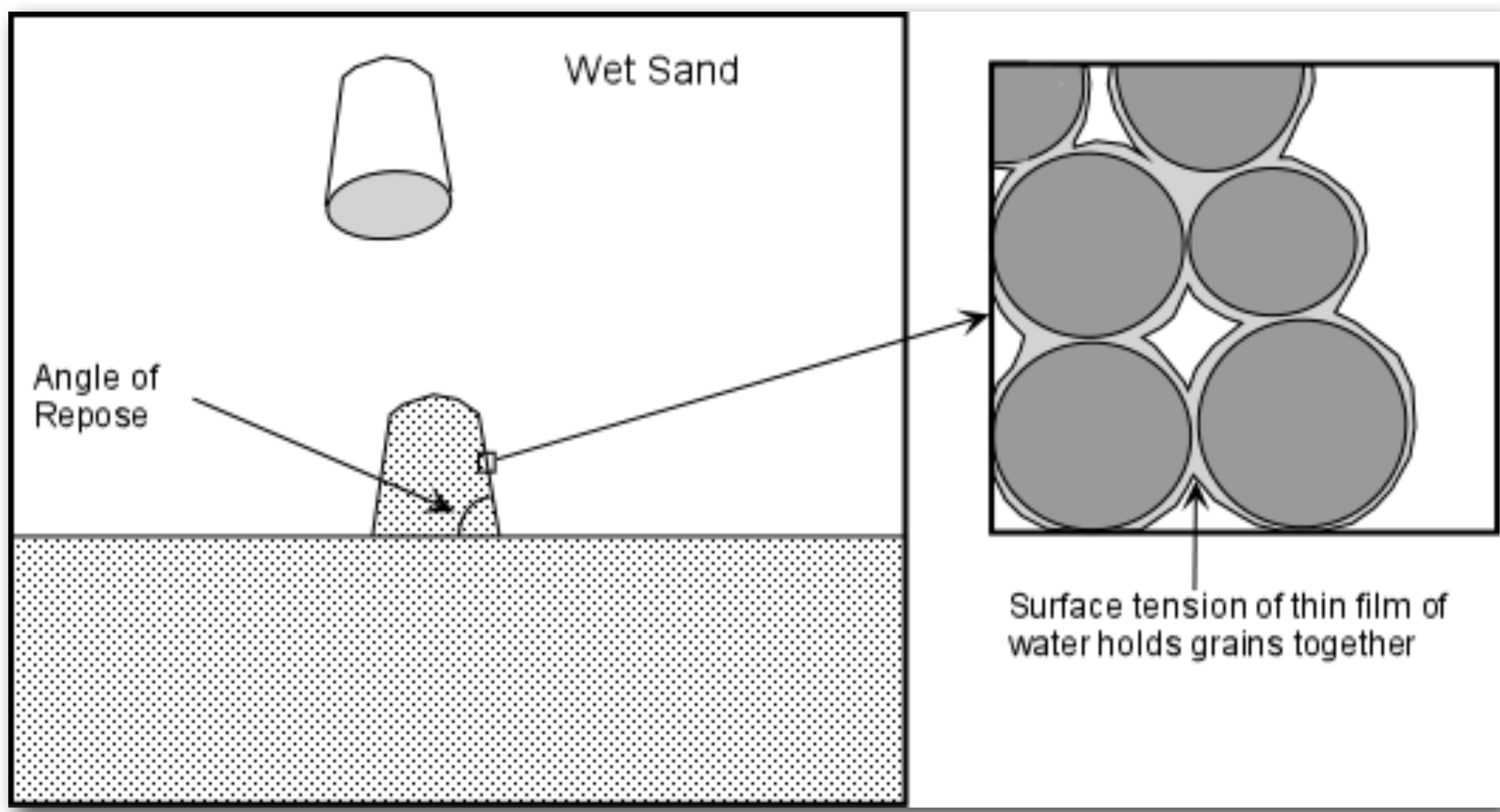
Too dry to build sand castles

Dry sand will collapse if the slope is too steep

Landslides

The role of materials:

Sands - weak, granular material



<http://www.tulane.edu/~sanelson/geol204/slopestability.htm>

Sand has temporary strength when slightly wet, but amount of water is critical



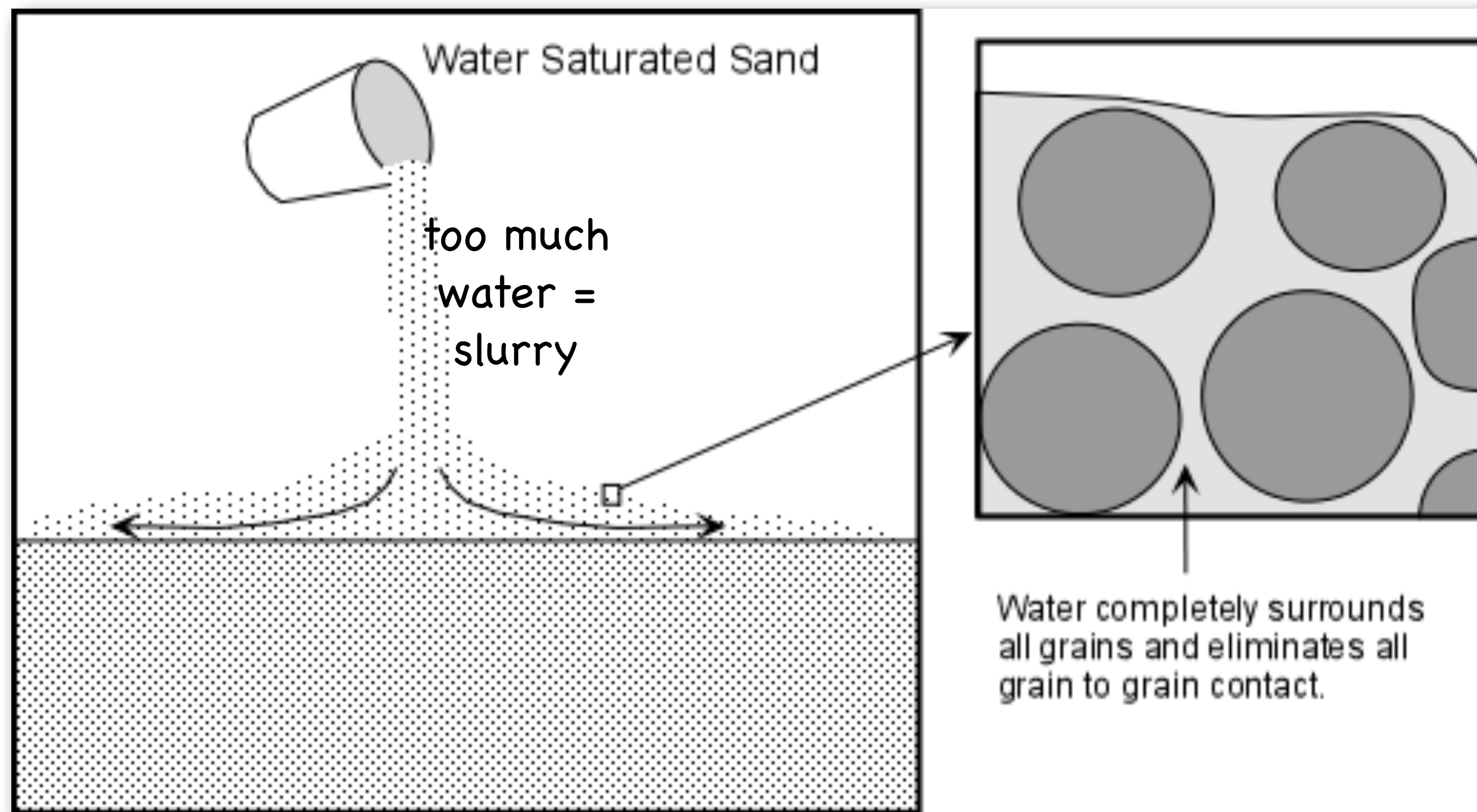
http://world.std.com/~eva/florida/sand_castle.jpg

Just right for sand castles!

The role of materials:

Sands - weak, granular material

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<http://www.tulane.edu/~sanelson/geol204/slopestability.htm>

Too much water leads to collapse

http://www.cnsu.edu/departments/geology/people/bperry/geology303/_derived/geol303text.html_txt_SandCastleKidsS.gif

Landslides

The role of materials:

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© Rick Scott
http://members.cox.net/theuniverse/landscape/so_cal_sand_dunes.jpg

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The role of materials:

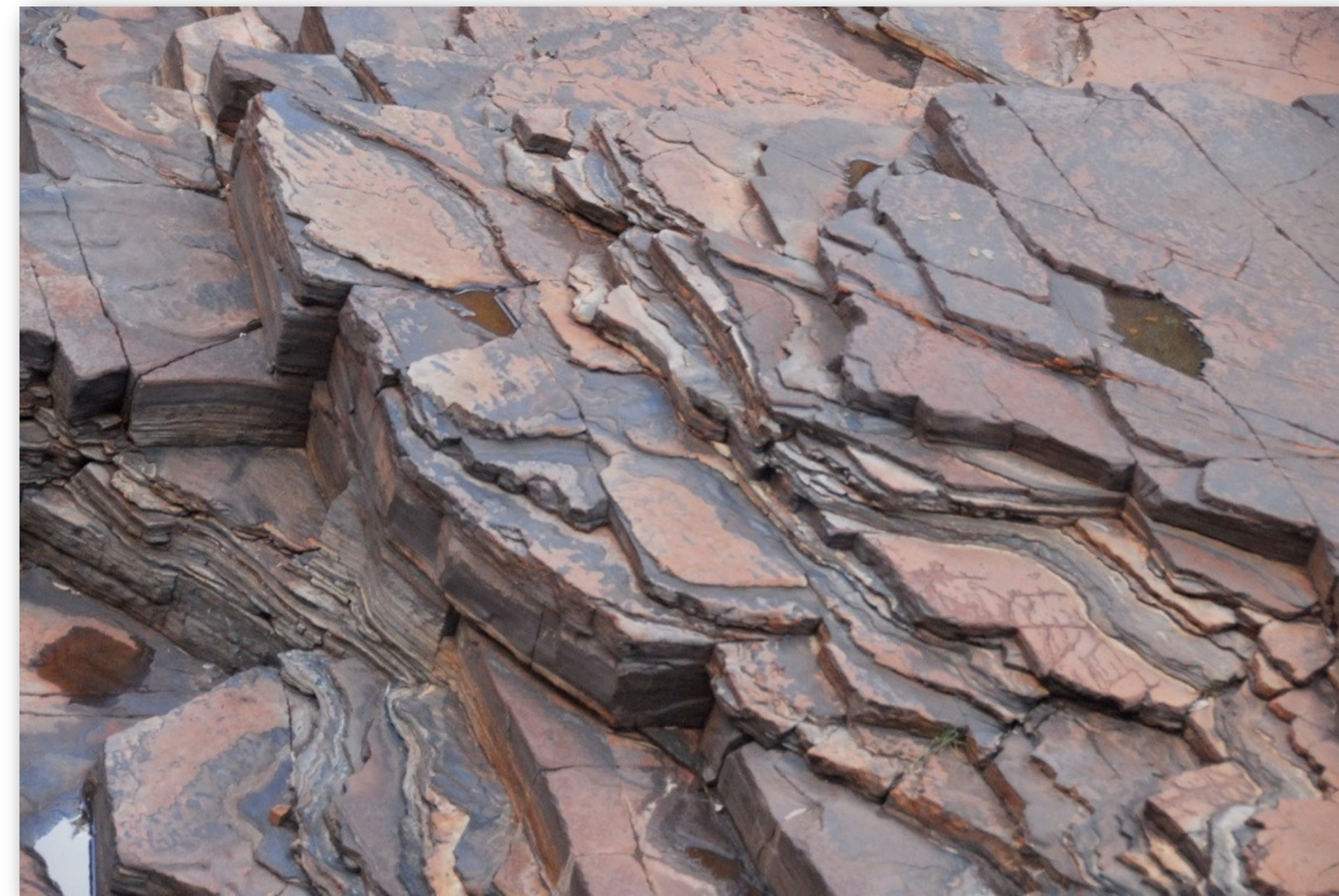
Rocks - strong, unless already fractured or laminated

strong



Granite forming Half Dome, Yosemite, CA

weak - likely to slide

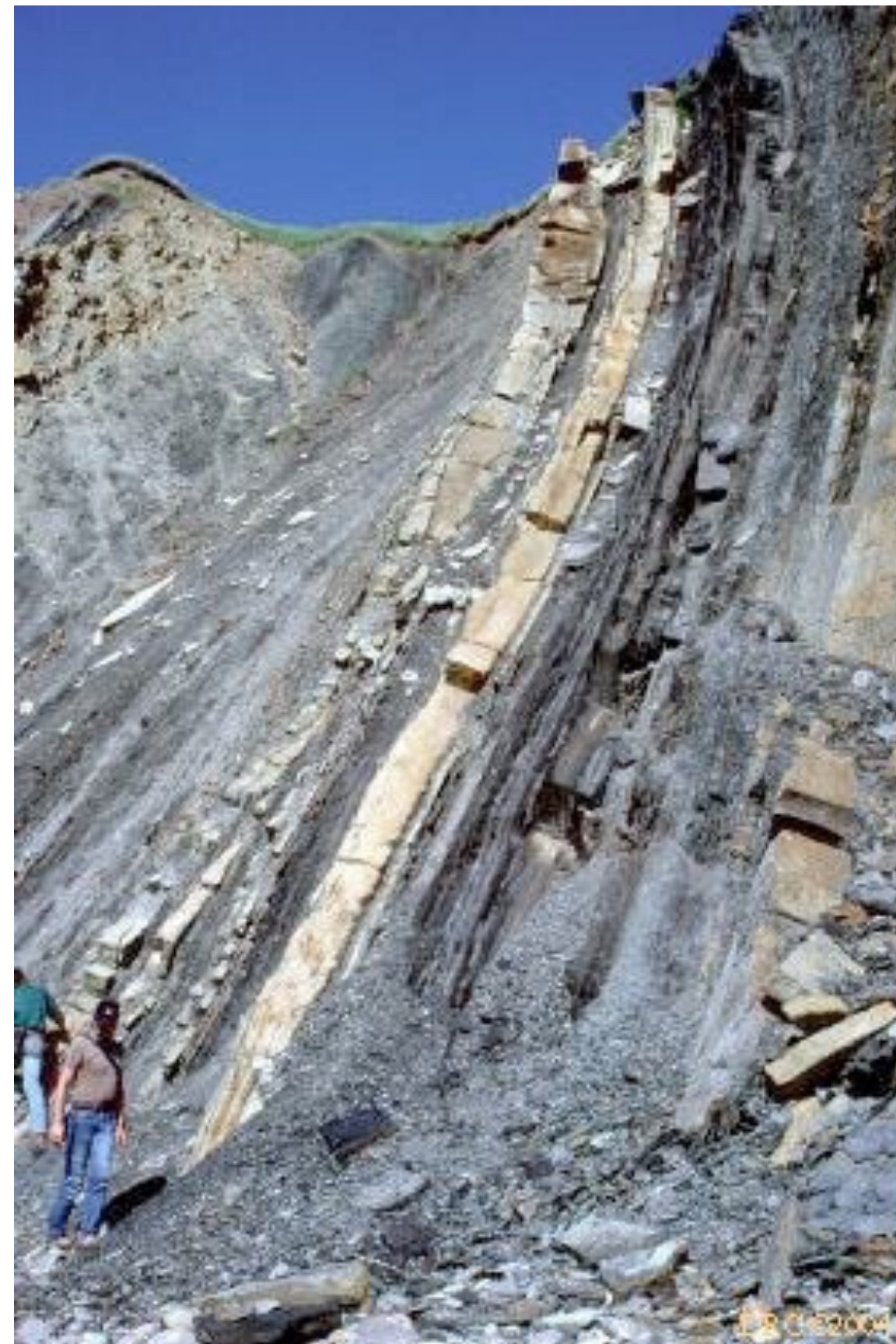
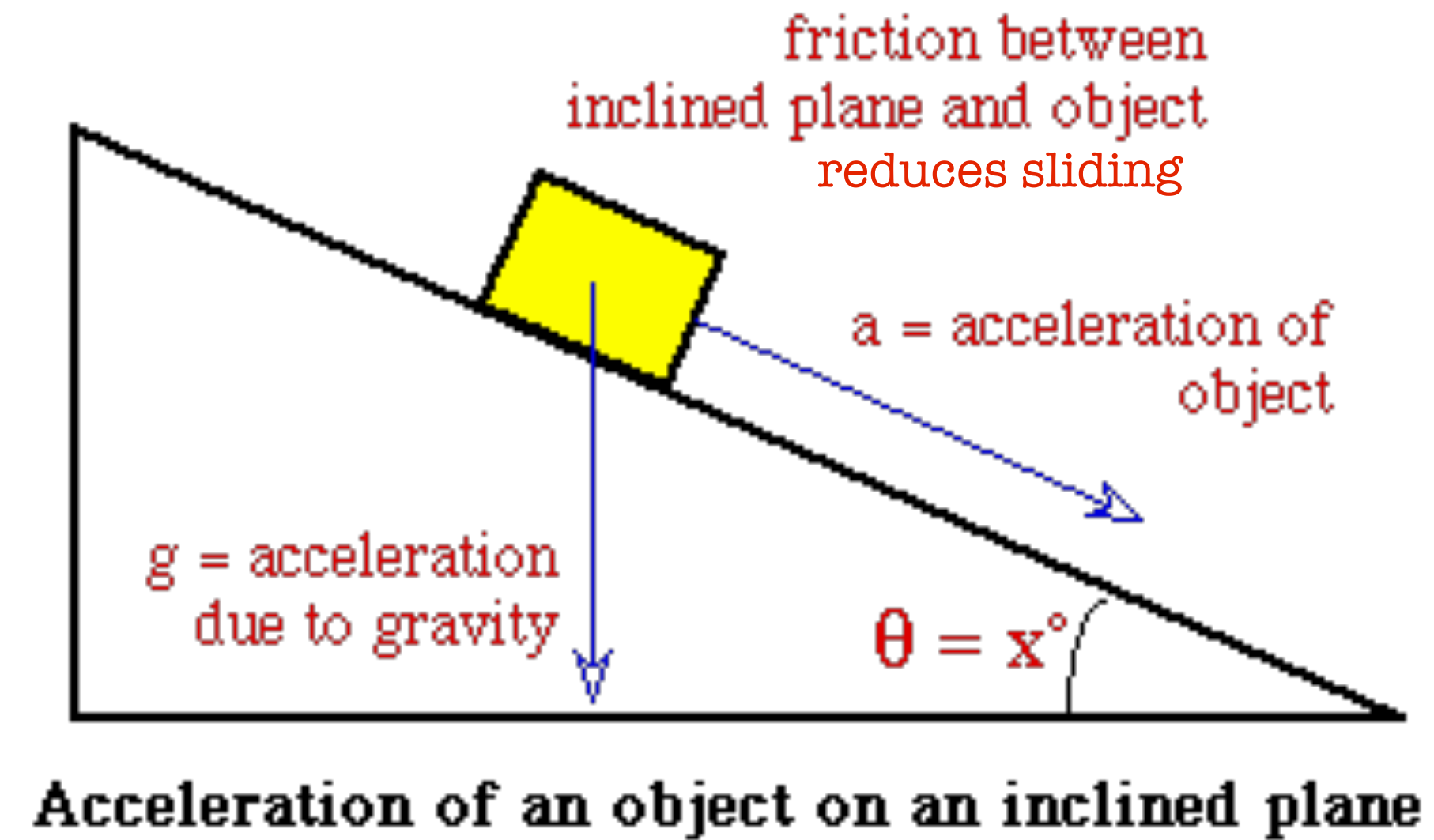


thinly bedded shales

http://lh5.ggpht.com/_g6GrNK3INBQ/SJLB9IeW-aI/AAAAAAAAAChU/reCWi_R0rFs/PHE_4852.JPG

The role of slope angle

Steeper slopes are more likely to slide



<http://www.uky.edu/OtherOrgs/KPS/pages/conferences/novascotia/nov026c.jpg>



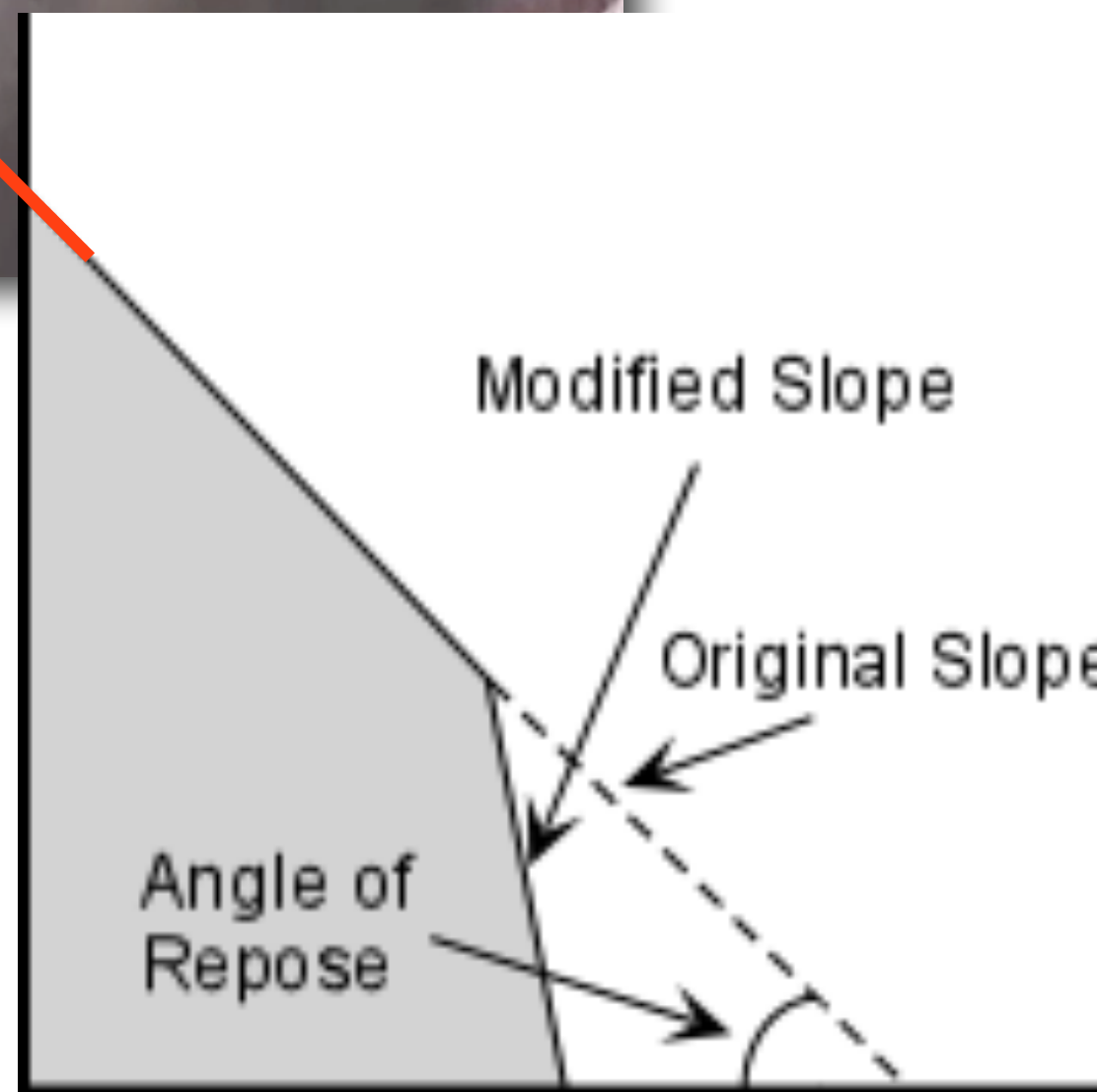
<http://www.aegweb.org/images/Geologic%20Hazards/rockslide.gif>

Undercut slopes become oversteep

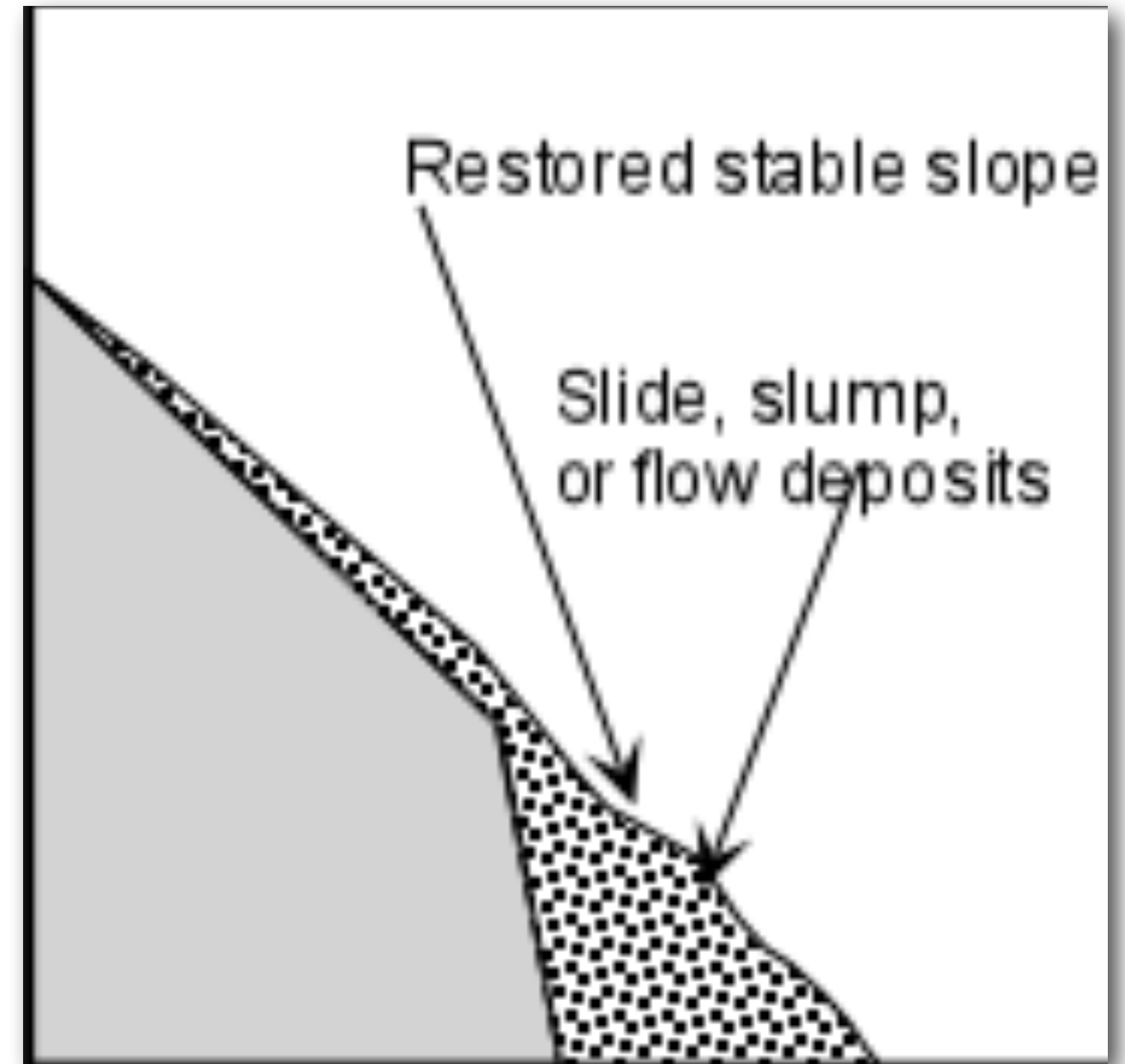
original
slope



modified
slope

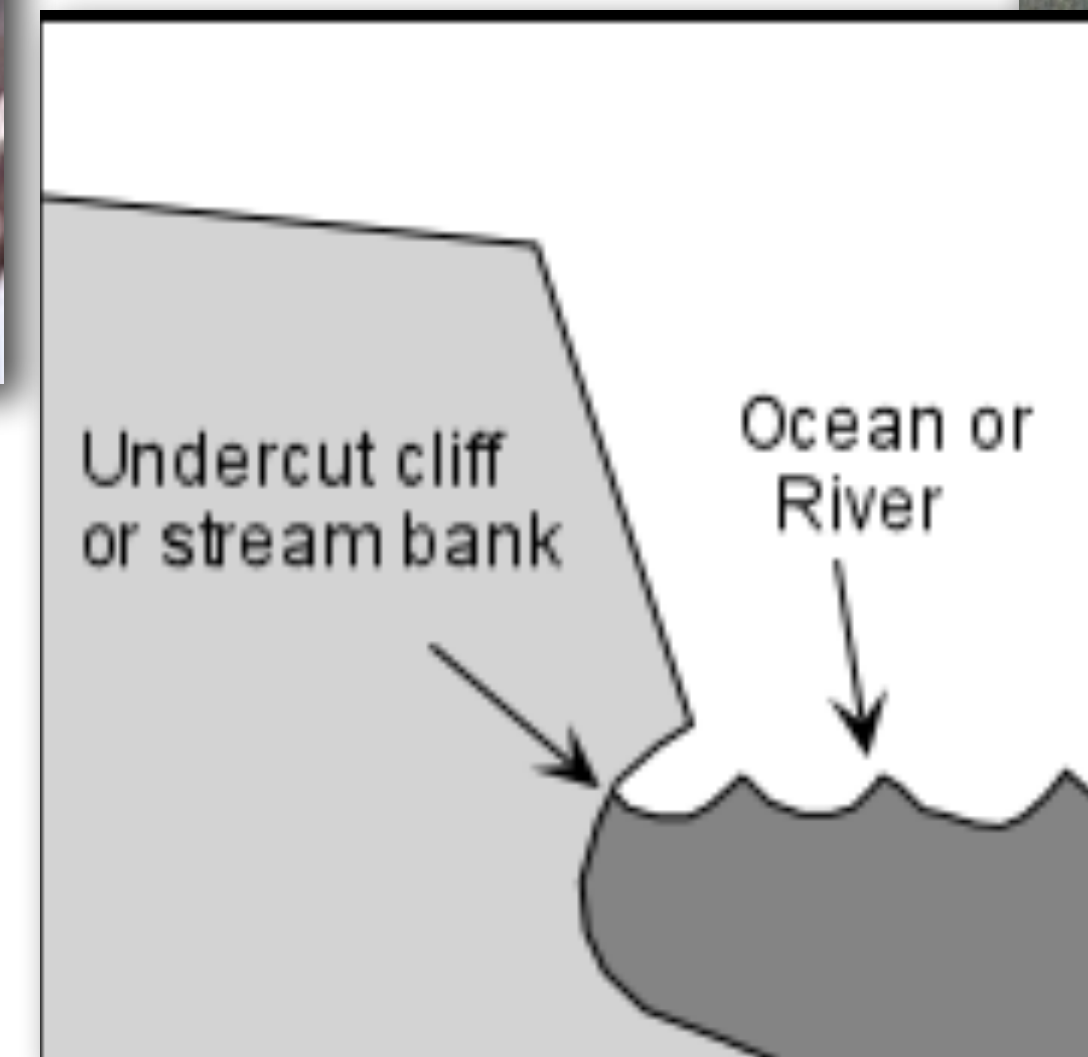


Undercut slopes become oversteep



especially likely to slide when wet!

Undercutting occurs naturally, too



http://gsc.nrcan.gc.ca/landslides/photos/littlesalmon_lake.jpg

Subaerial Landslides and Tsunamis

Why are submarine landslide tsunamis extreme?

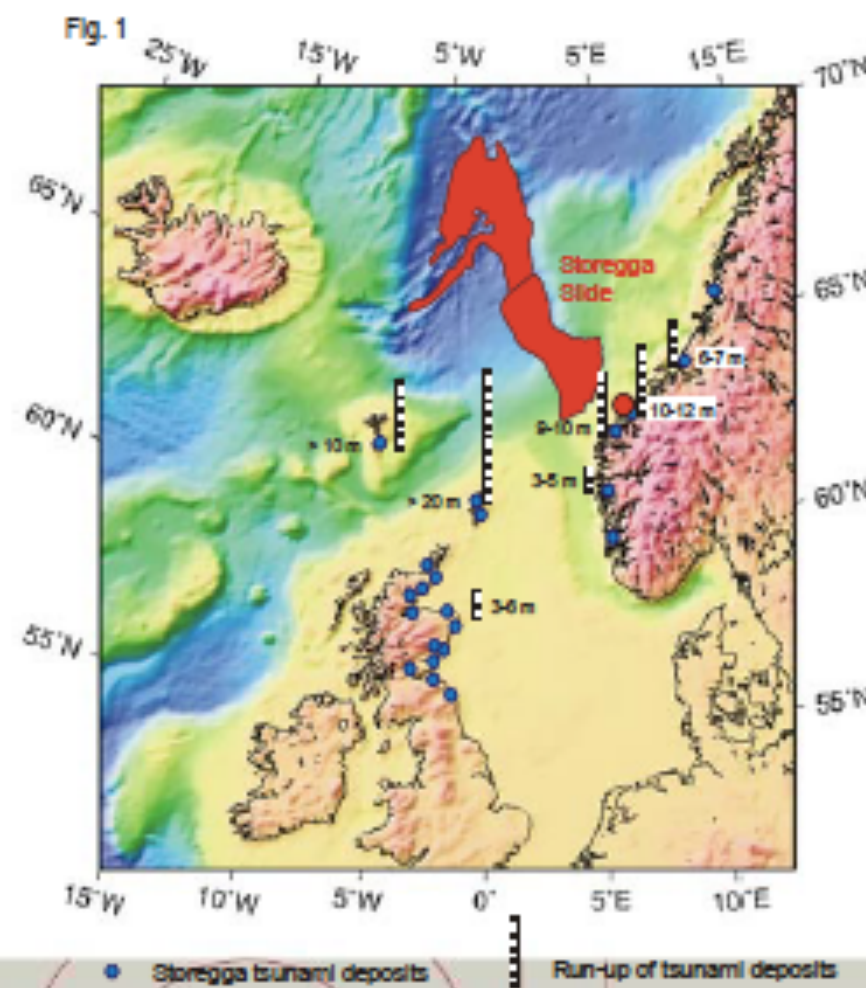
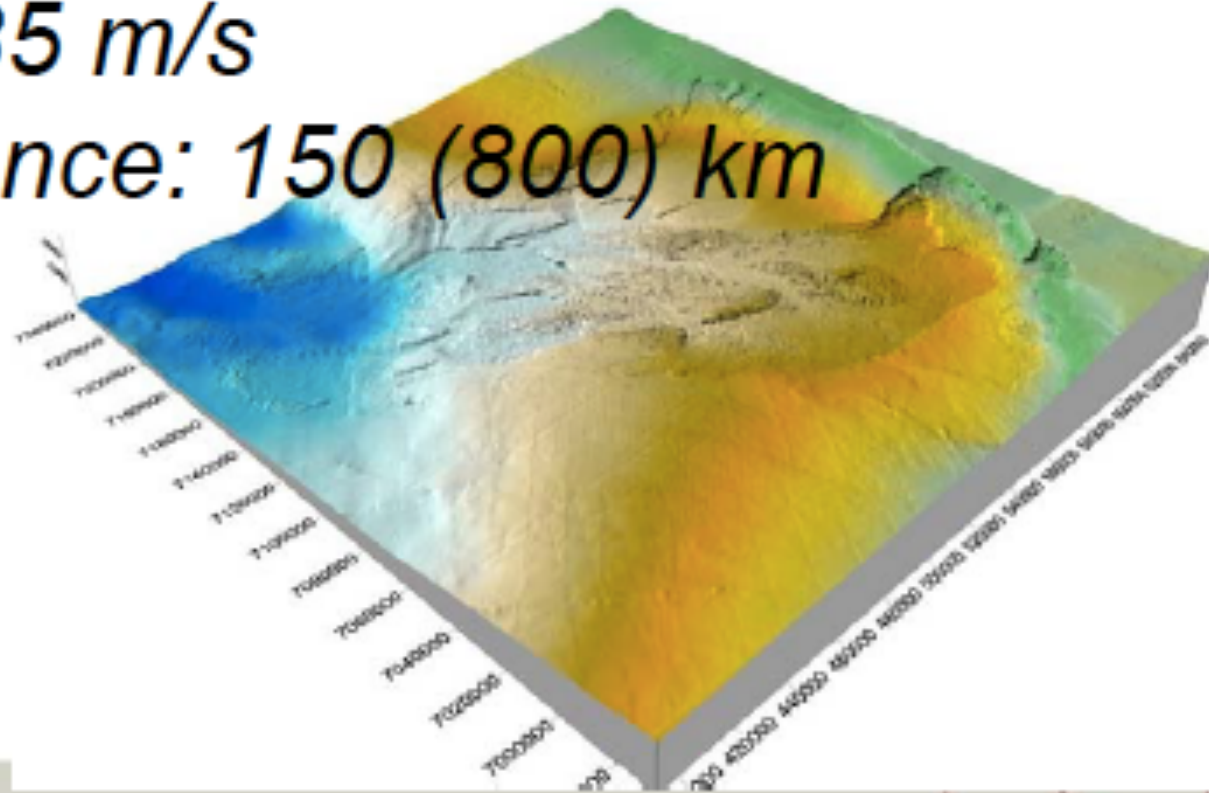
- The landslides
 - May occur "anywhere" on the continental margins, also on very gentle slopes
 - Have extreme volumes, velocities, and travel distances
 - "Unpredictable" \Rightarrow Unprepared \Rightarrow Extreme consequences

The 8200 BP Storegga slide

Volume: 2400 km³

Max speed: 35 m/s

Run-out distance: 150 (800) km



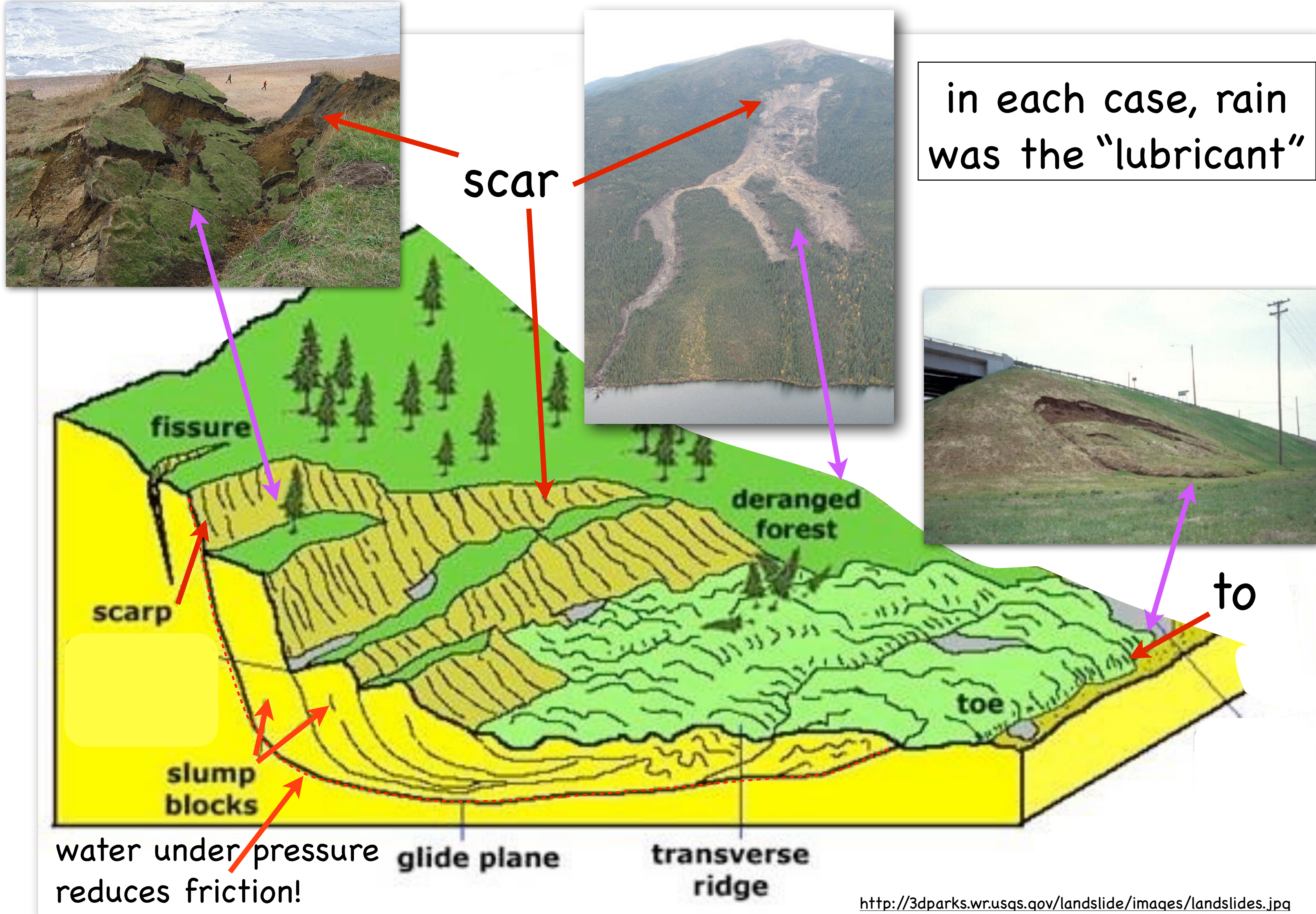
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Slumps

Caused by sliding downhill on a curved plane



<http://www.soton.ac.uk/~imw/jpg-Charmouth/6CHM-Evans-landslide.jpg>

http://earthsci.org/flood/j_flood04/masswa/slump.jpg

<http://3dparks.wr.usgs.gov/landslide/images/landslides.jpg>

<http://frank.mtsu.edu/~cdharris/GEOL100/erosion/slmp1-99.jpg>

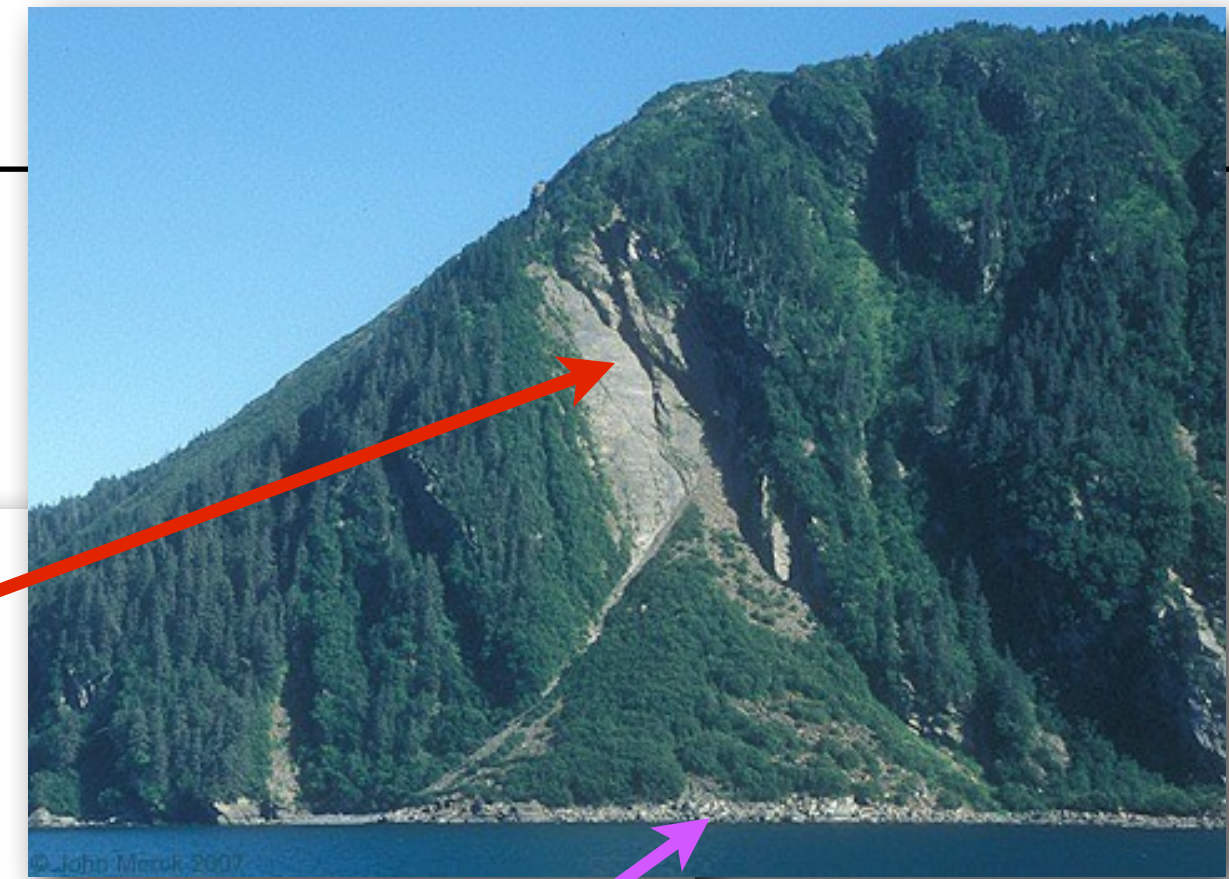
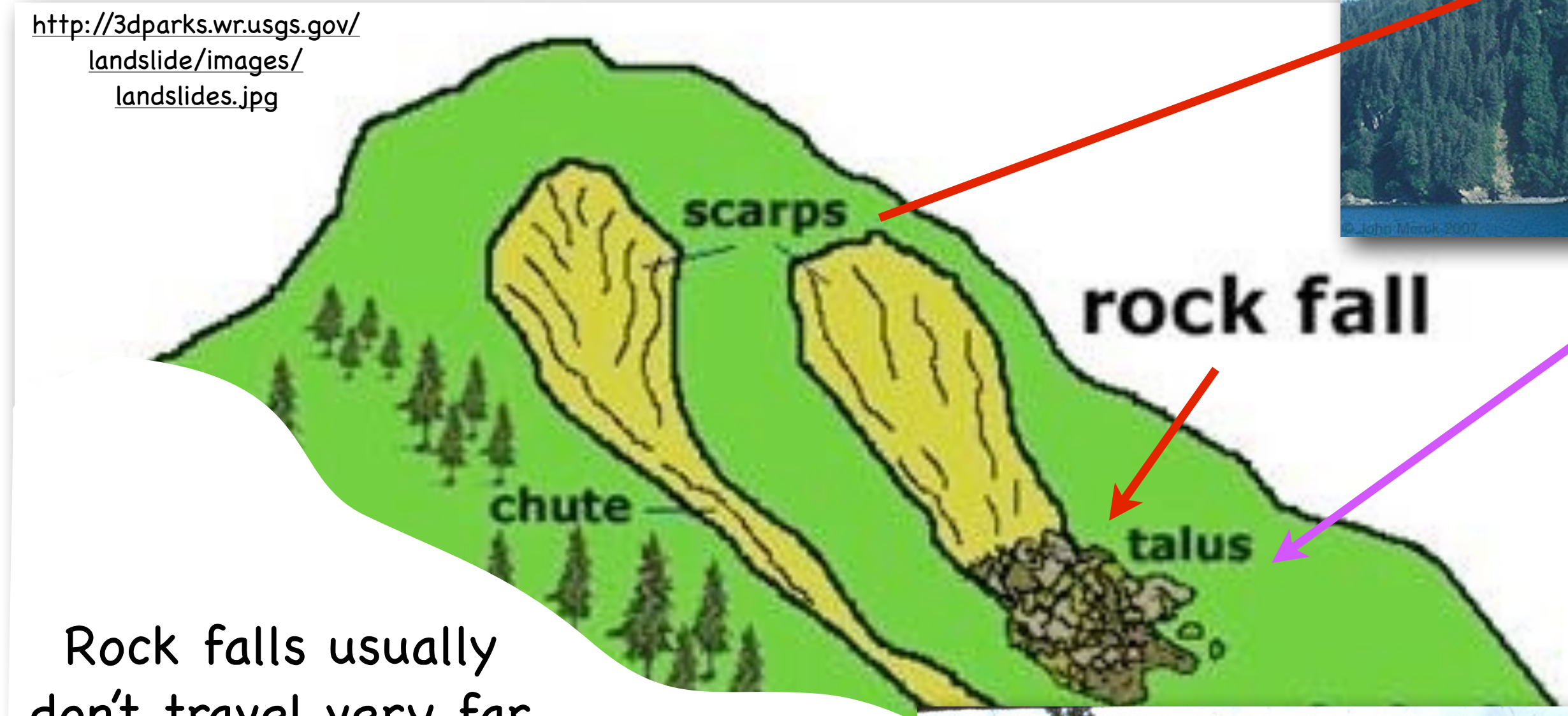
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Rock falls

Rock falls produce talus (piles of smaller rocks)



<http://www.geol.umd.edu/~jmerck/nature/landscapes/images/landslide24392s.jpg>

Rock falls usually don't travel very far from their source



tho' sometimes they do...



http://www.geo.wvu.edu/~jtoro/geol101/mass%20wasting/house_rock_slide.jpg

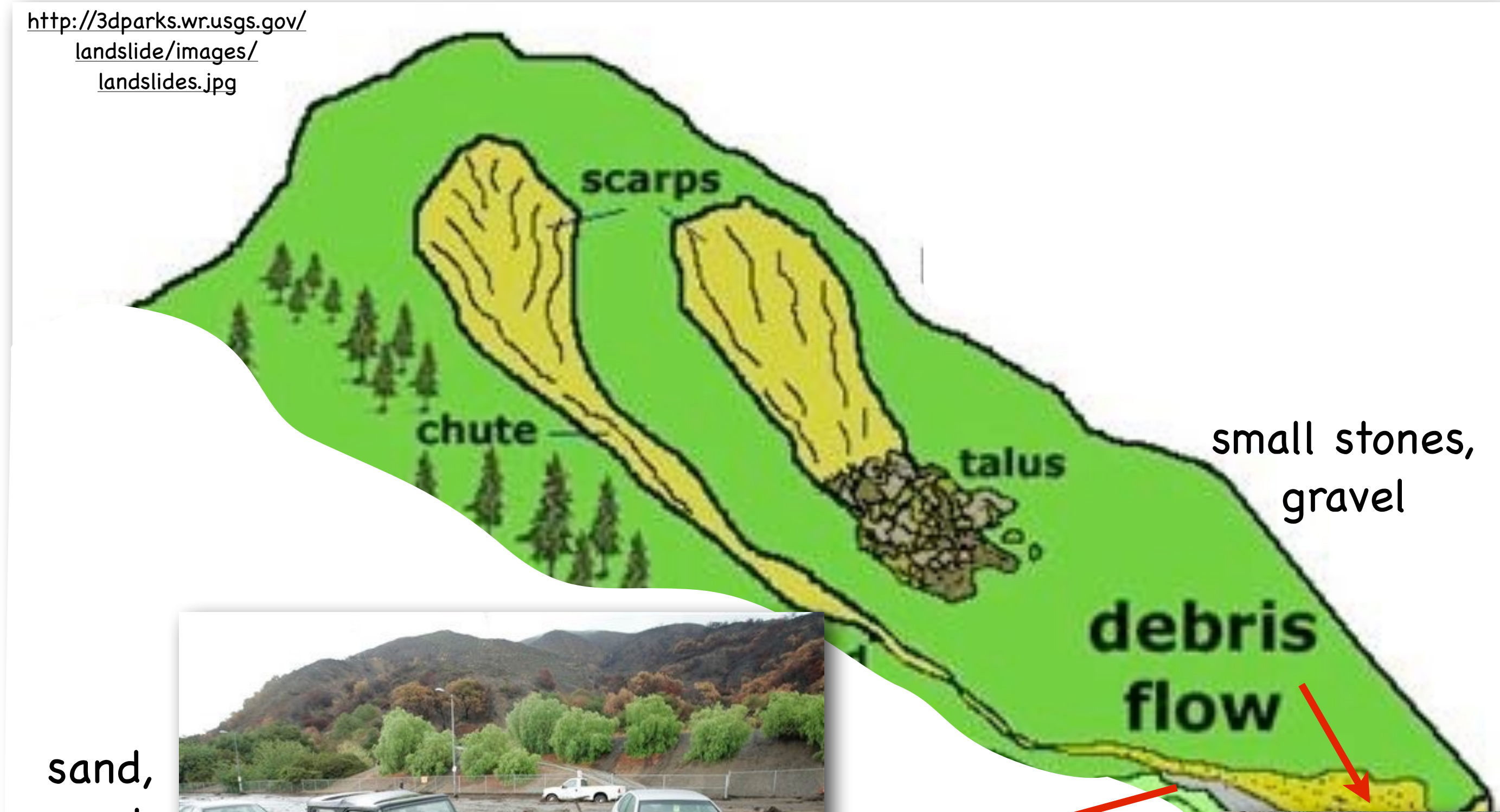
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Debris flows

Debris flows - also known as lahars, mudflows - travel fast! Occur after heavy rain with little warning, unless related to volcanic eruption or earthquake



Yellowstone, 2004

sand, mud



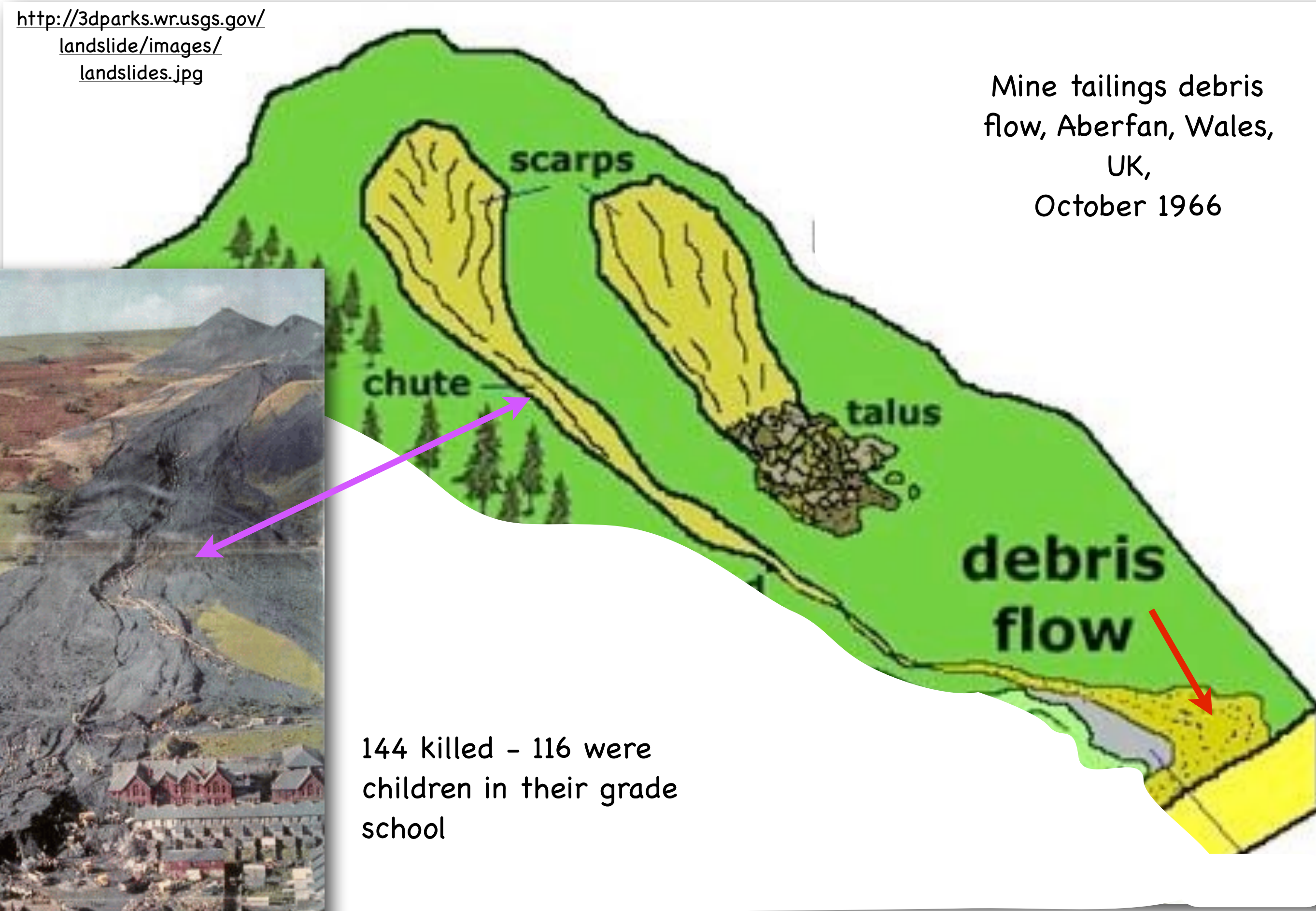
<http://www.topnews.in/files/mudslide.jpg>



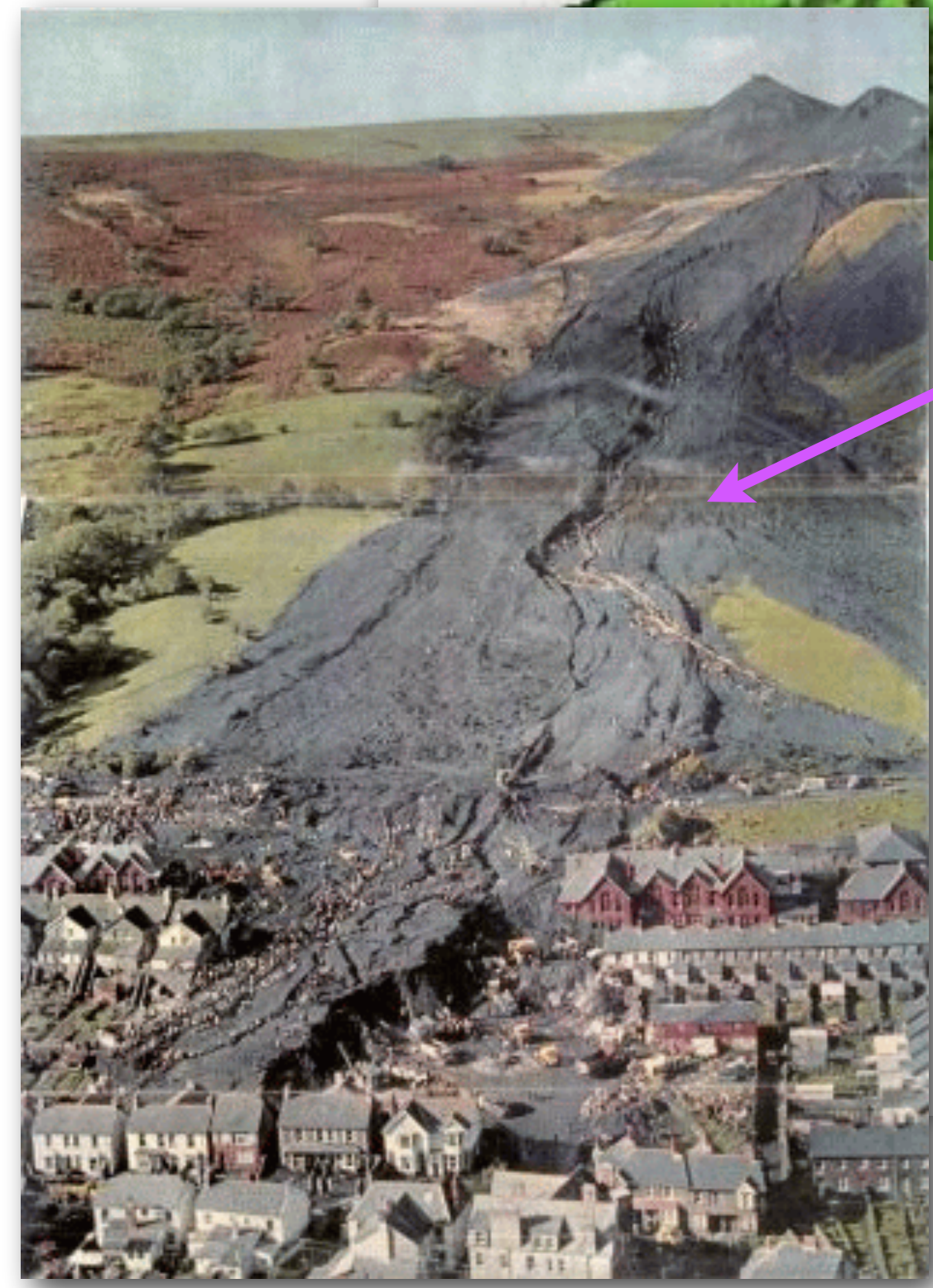
<http://www.nps.gov/archive/yell/tours/thismonth/july2004/images/mudslide.jpg>

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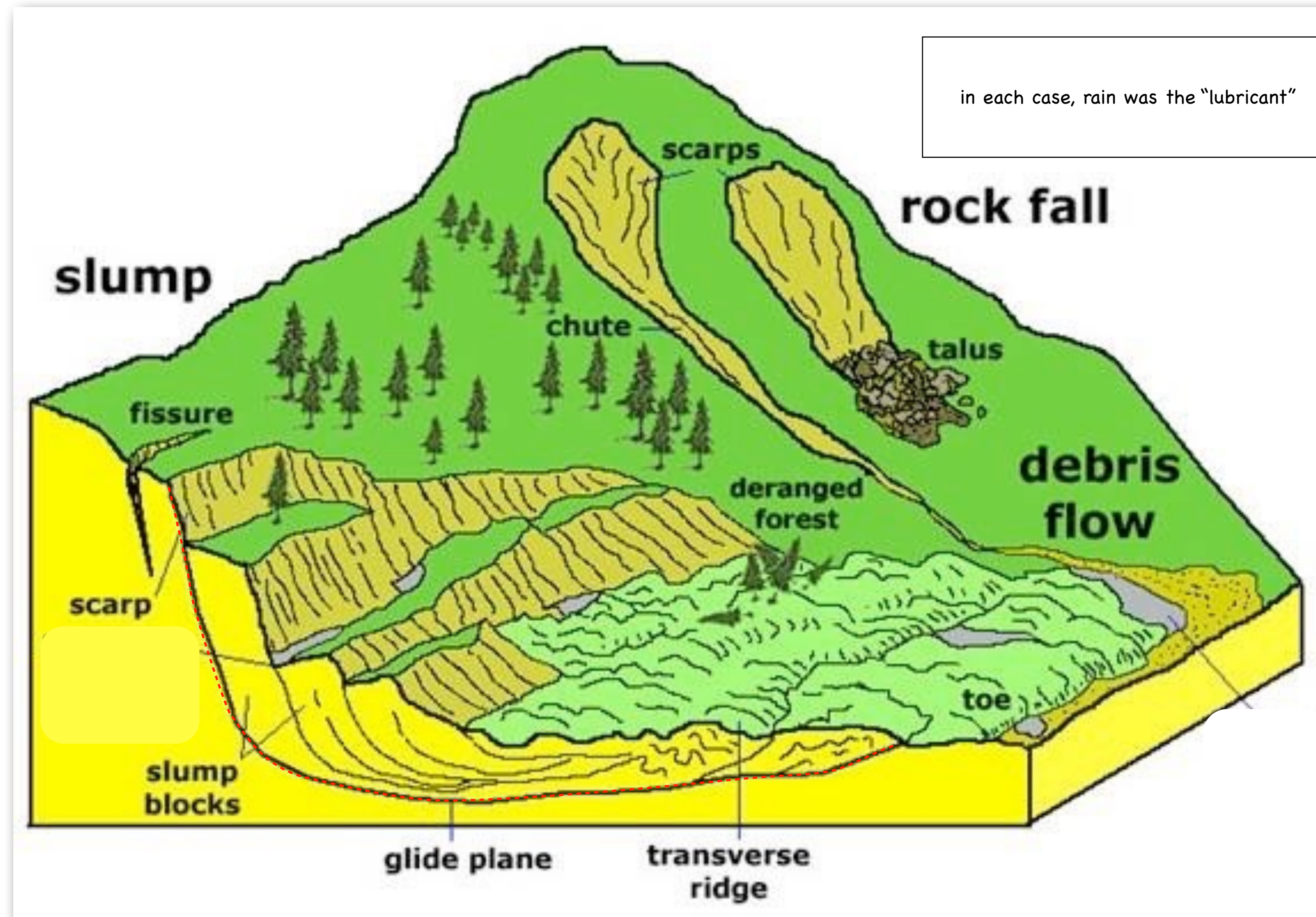
Mine tailings debris flow, Aberfan, Wales, UK, October 1966



144 killed - 116 were children in their grade school

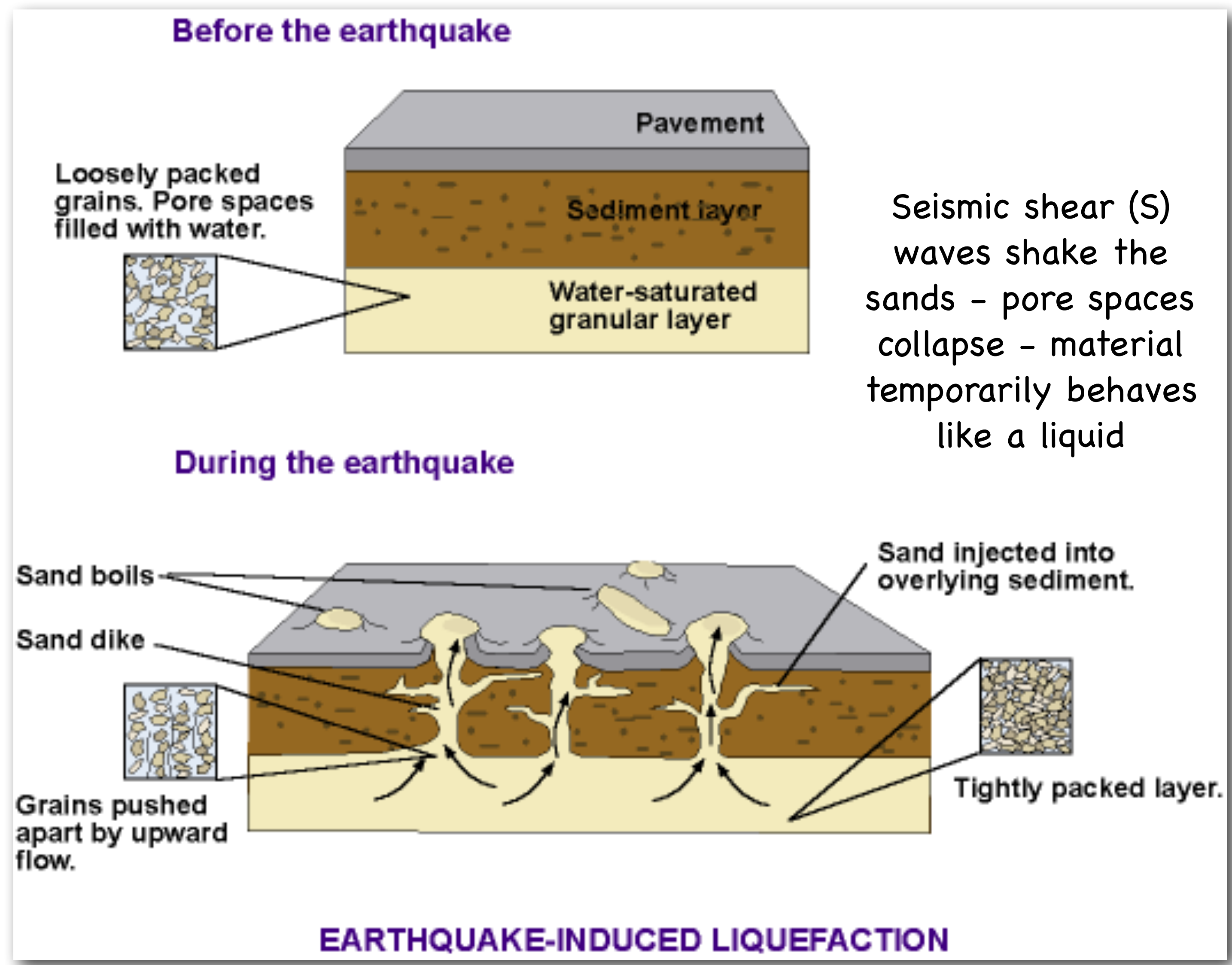
http://www.hiraeth.org.uk/aberfan/images/colour_aberfan.gif

Summary



The role of vibrations

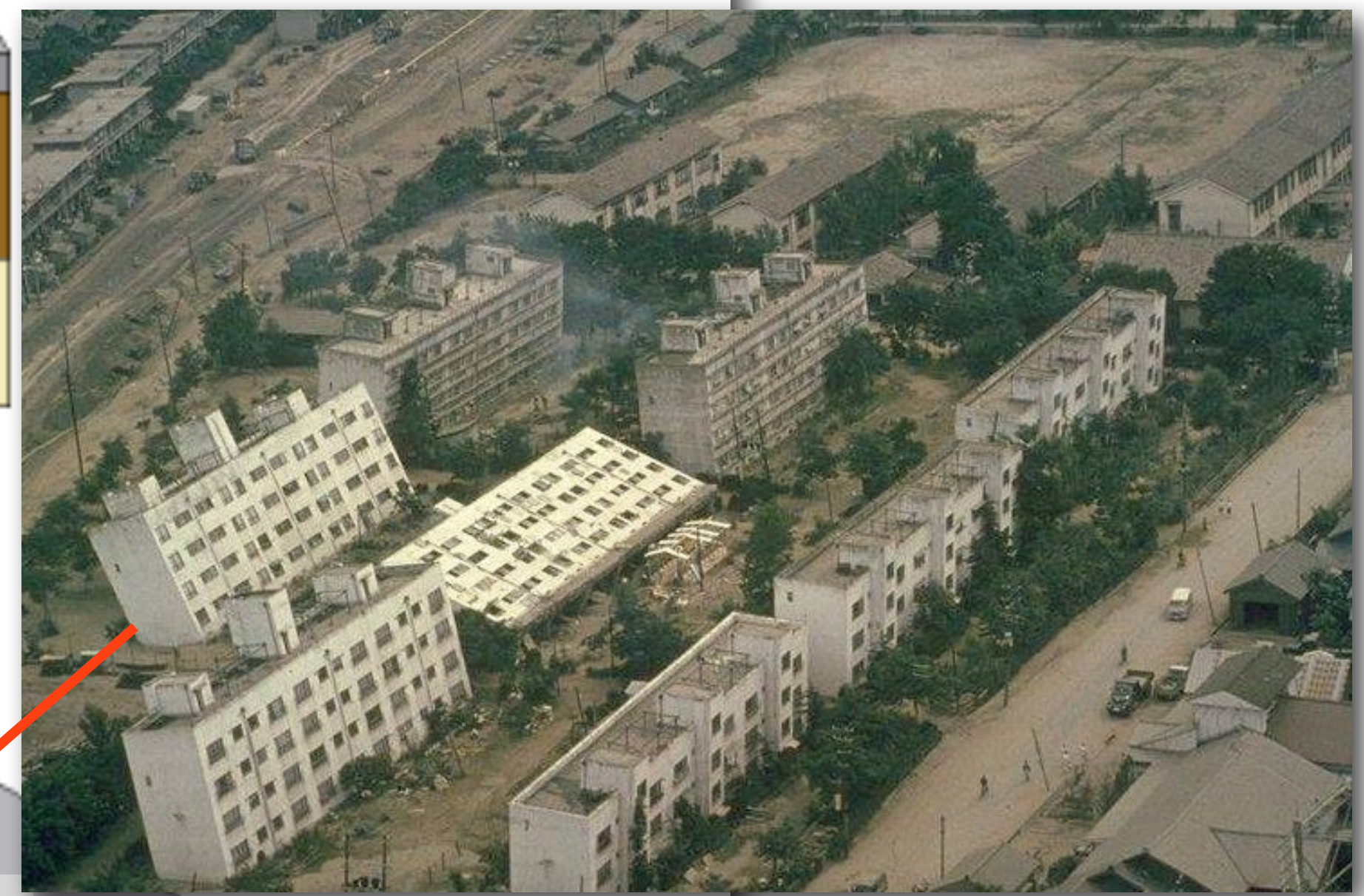
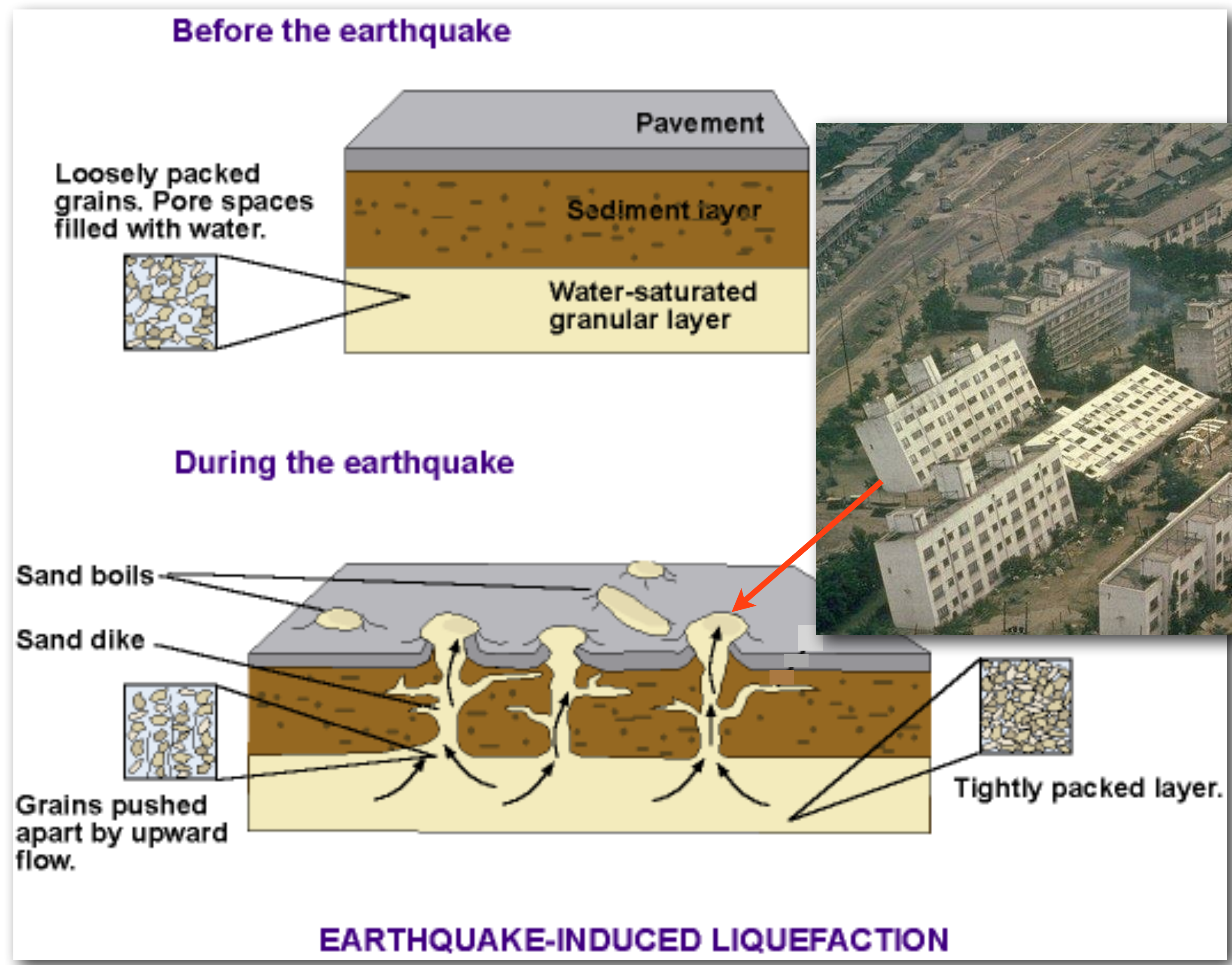
Wet sands, including reclaimed land, can undergo liquefaction during an earthquake



Debris flows

The role of vibrations

Wet sands, including reclaimed land, can undergo liquefaction during an earthquake



<http://www.civil.usyd.edu.au/images/news/liquefaction.jpg>

http://wapi.isu.edu/EnvGeo/EG5_earthqs/images/liquefaction.gif

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On February 24–28, 2015, a total of 40 **avalanches** in **Panjshir Province, Afghanistan** killed at least 310 people, and another 129 were wounded.

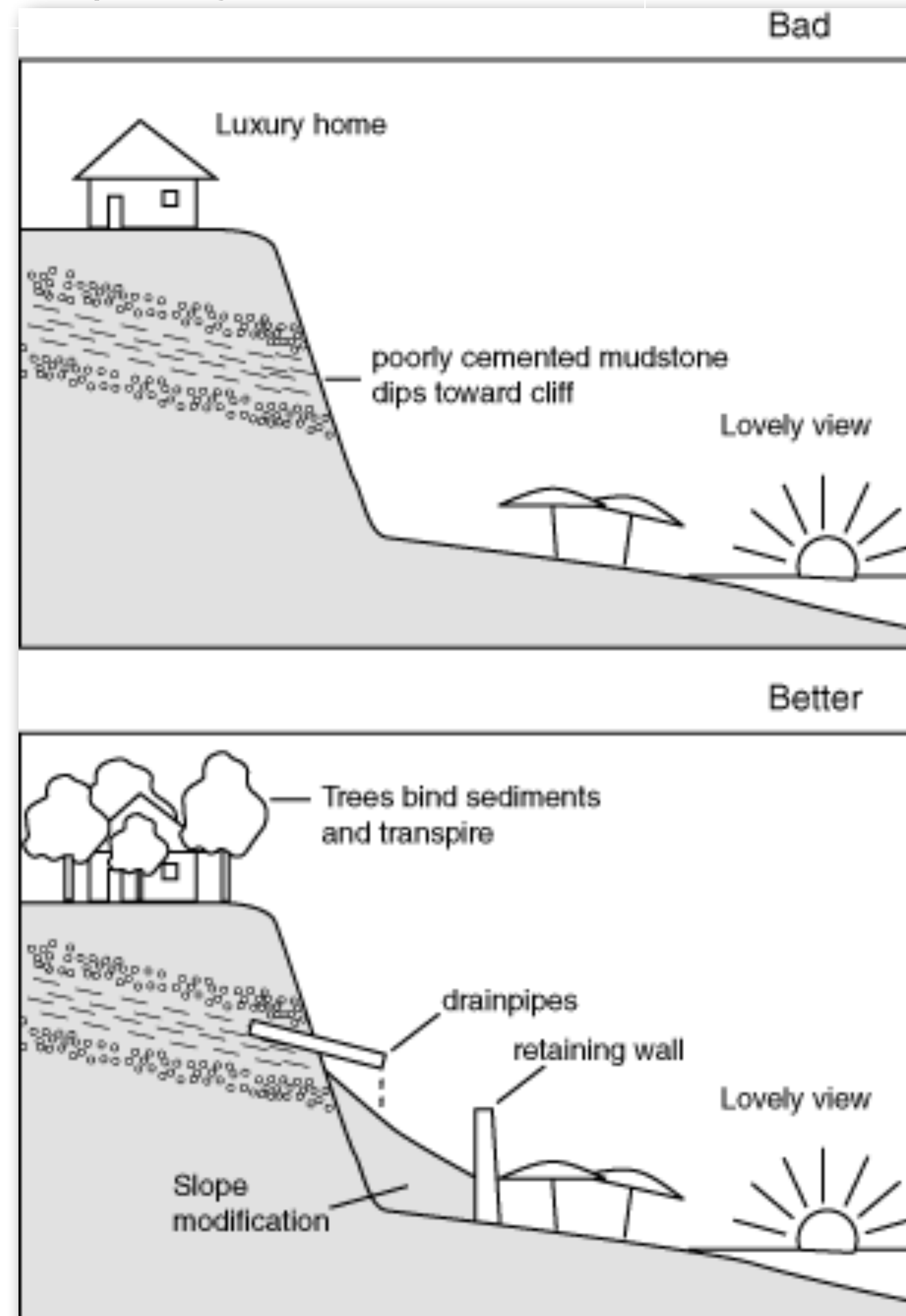


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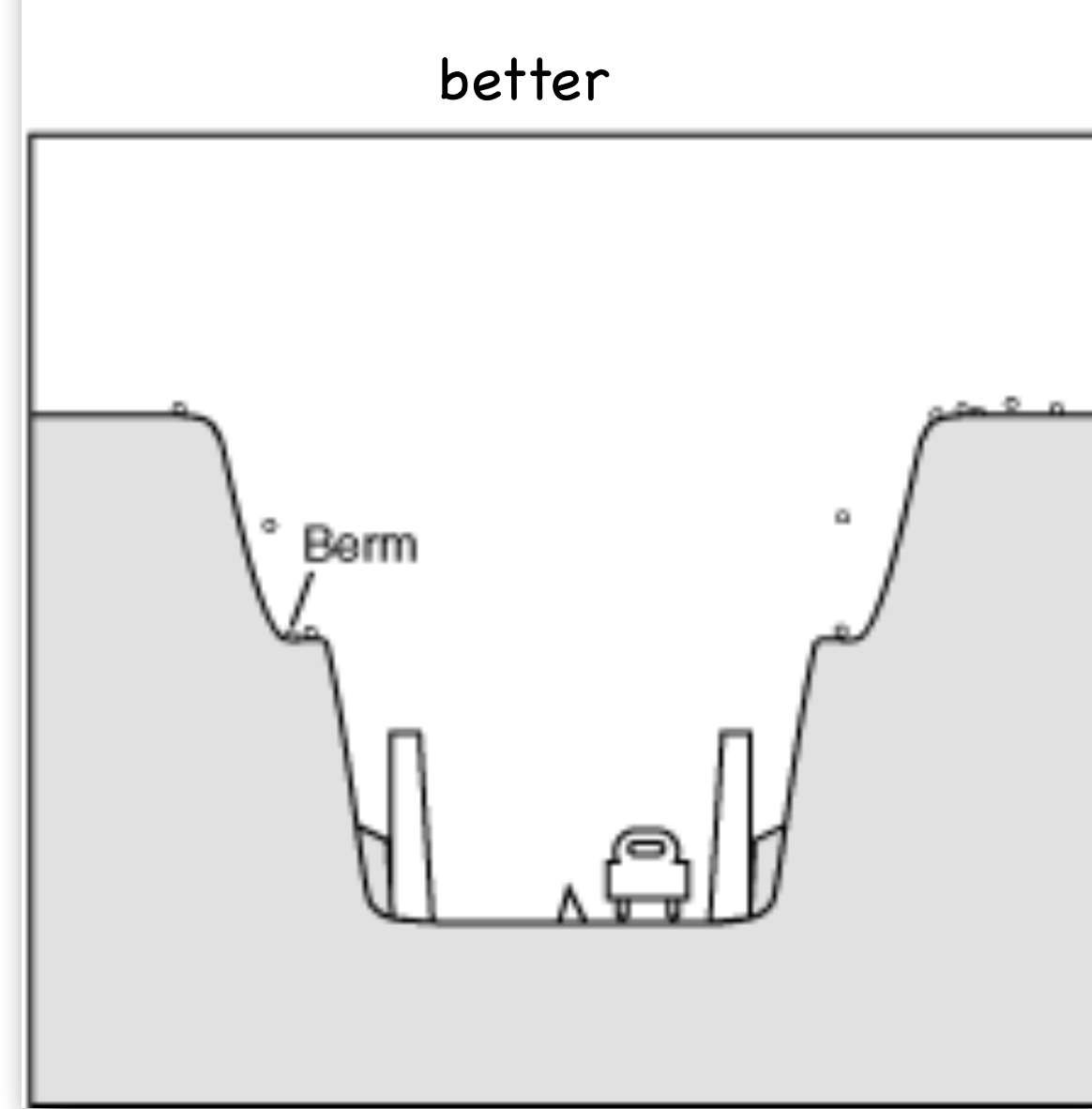
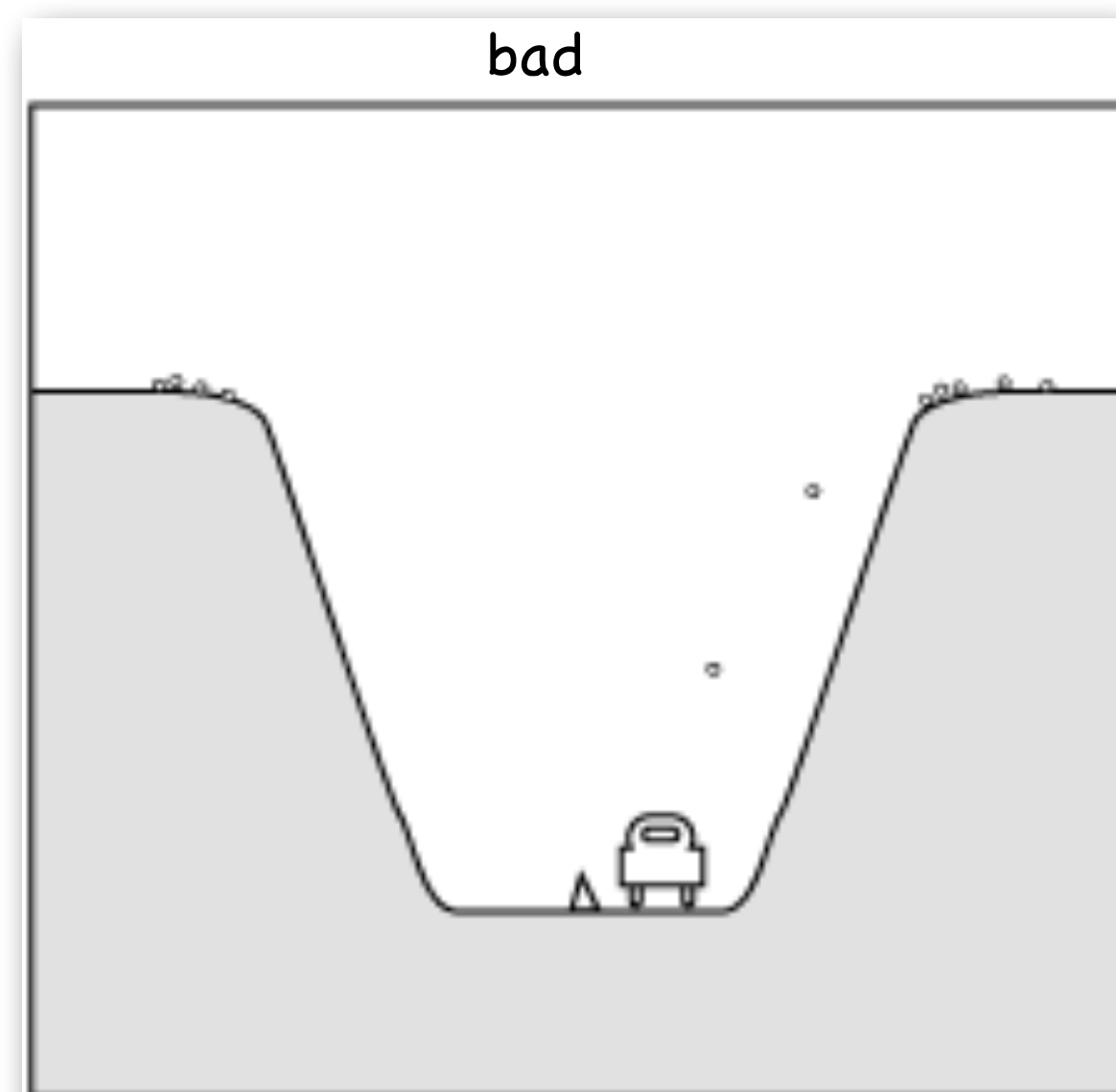
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Remediation - property



- Restore stable slope angle
- Move property back from cliff edge if possible
- Drain excess water
- Add vegetation to strengthen loose soils with their roots
- Add a retaining wall

Remediation - property



<http://www.yosemitefun.com/P1010024.jpg>

- Widen road cut to restore stable slope angle
- Add a berm or bench to catch falling rocks
- Add a retaining wall
- Build roof over highway if possible
- Divert highway to more stable route, if possible

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Precarious Rocks



Garden of Gods, Colorado



Chiricahua, Arizona



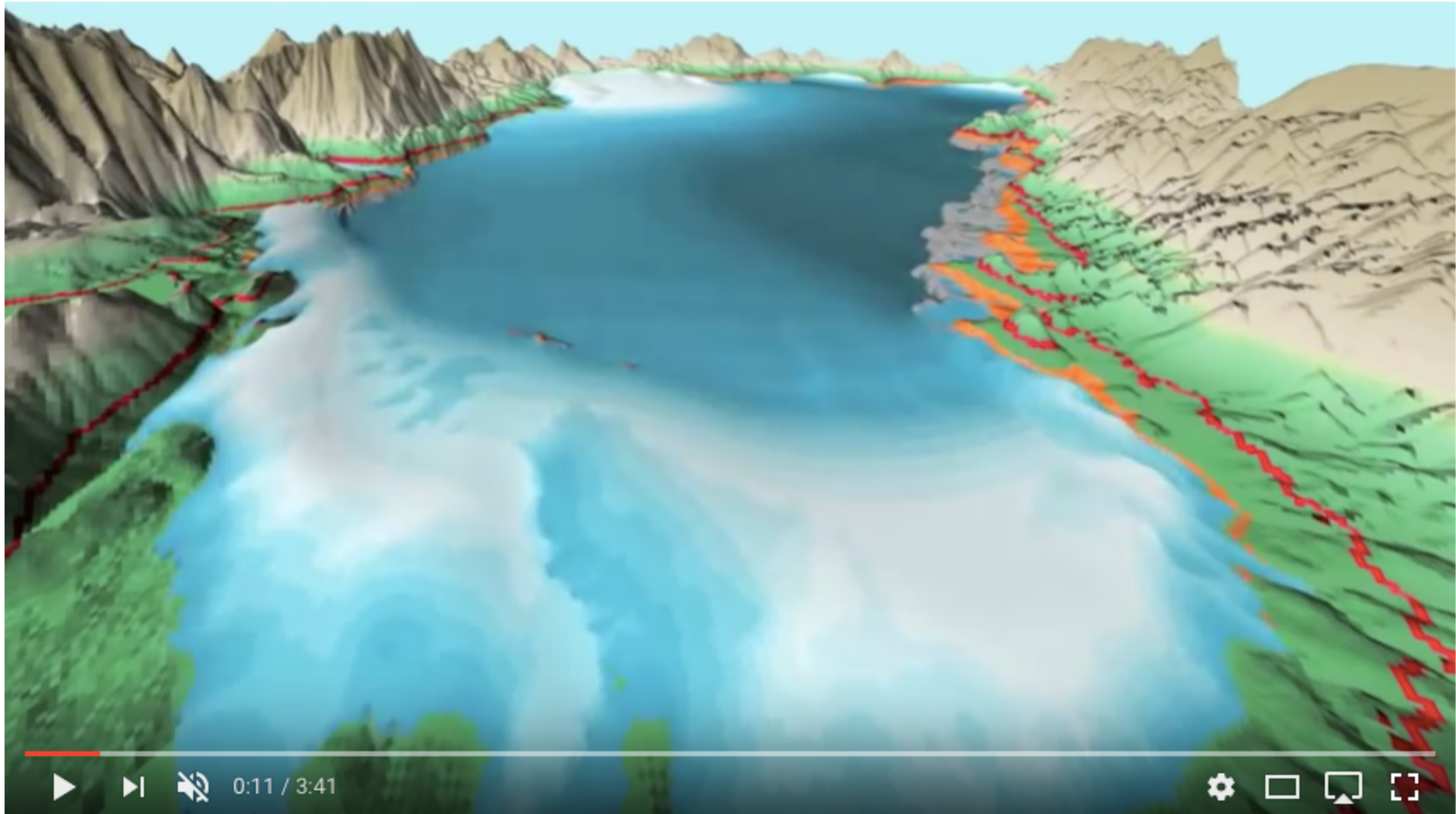
The Balancing Column near Digby, Long Island, Nova Scotia, Canada



Marble Canyon, Arizona



Big Bend, Texas



<https://www.youtube.com/watch?v=bxbVEnnmRGQ>

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Sinkholes



Sinkholes



A large sinkhole open in Guatemala City on February 23, 2007. At least three people have been confirmed missing.

A sinkhole in downtown of Guatemala City caused by torrential rains brought by the first tropical storm Agatha on Sunday, May 30, 2010

Sinkholes



In May 1981, during a period of record-low water levels in Florida's limestone aquifer, a massive sinkhole opened up underneath the city of Winter Park. The sinkhole is under the public swimming pool. In a single day, the hole widened to 98 m and a depth of 27 m, destroying several buildings, including a two-story house.

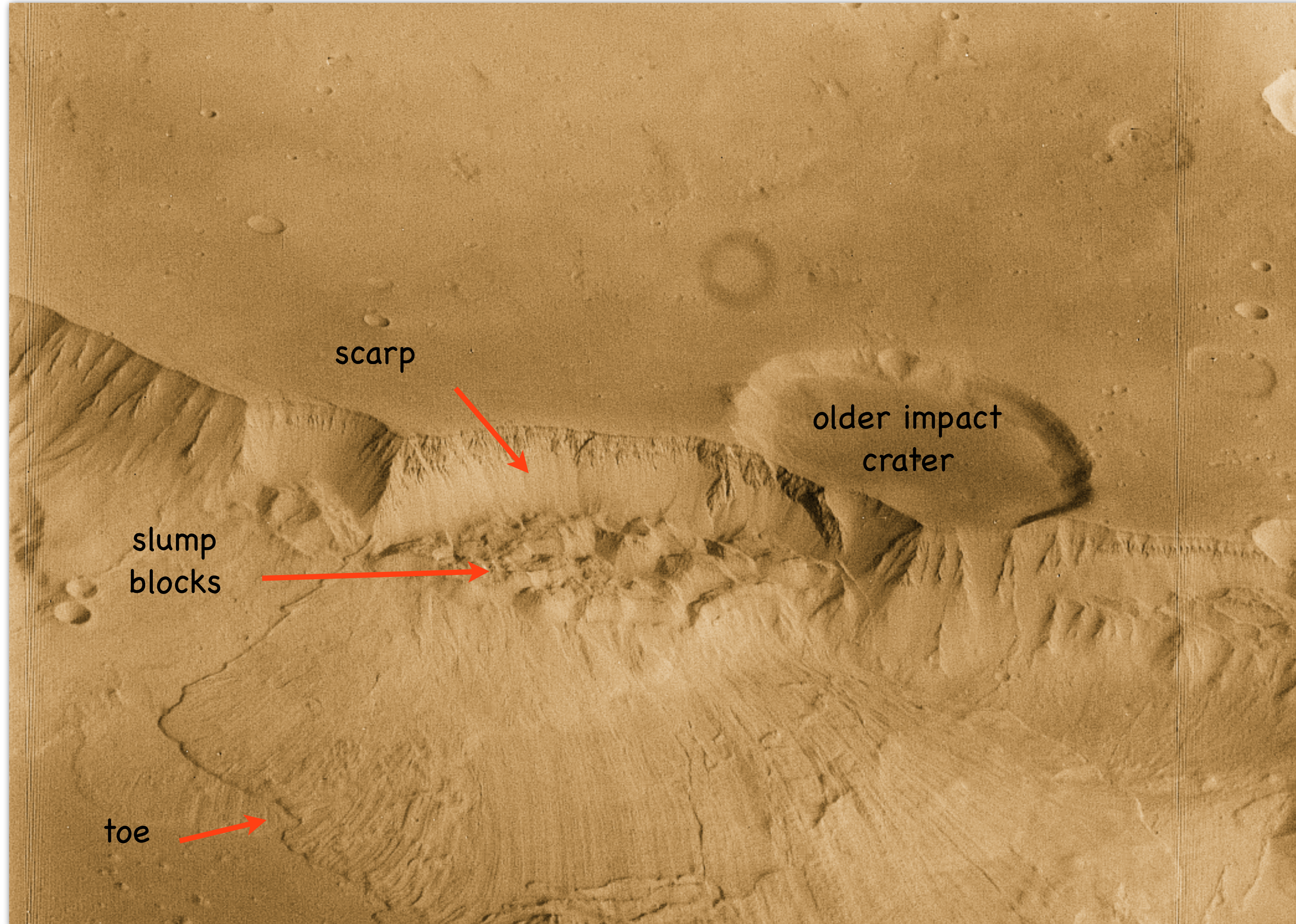


Close to Belize City, the “Blue Hole” is a circular hole that is part of the Lighthouse Reef system. The hole is 305 m wide and 123 m deep. During the Ice Age, it was an opening to a cave system. Today it is a magnet for extreme divers.

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landslides happen on other planets, too!

but there is no running water on Mars (at least, not now), so
what could have caused these landslides?

