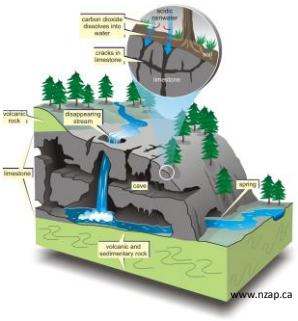
Today's Lecture

1. Assignment 2 Due – Pick up Assignment 1 if you don't have it
2. Review Questions
3. Continue with Karst landforms…Last lecture
4. What are mass movements (mass wasting)?
5. Driving forces for mass movements: Slope→ Angle of reprose, driving forces, resisting forces.
6. Types of mass movements; conditions of occurrence
7. External factors that affect slope stability
8. Human-induced mass movements
9. The Frank & Mt Steele Slides: Using new technology to examine landslides

Review of Previous Topics

Karst Features

Sinkholes



Karst Features

Caves




Friday: Assignment 2 Due
→ Mass movement processes, landslides pg 332 - 340

What are Mass Movements?

Also known as 'mass wasting'

Movement of rock due to pull of gravity
→ Often a result of weathering – weakens the material

All shapes and forms:


Dry landslide: Rock material at Frank Slide


Wet mudflow in Brazil

What are Mass Movements?

All shapes and forms:


Slow Landslide


Fast Landslide

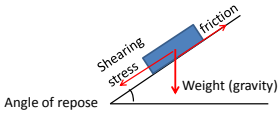

Small Landslide


Big Landslide

Slope and Angle of Repose

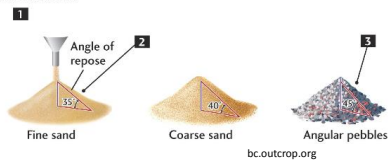
Influence of Slope → Mass movements occur on slopes

Everything runs down hill: driving force (gravity) + resisting force (friction)



Similar to rocks or sand sliding off a dump truck

Angle of Repose:



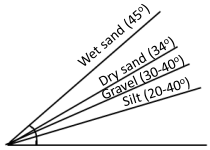
Driving and Resisting Forces

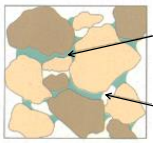
Driving Forces Dependent on:

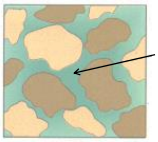
→ Weight, size and shape of material

→ If slope exceeds angle of repose (*over-steepened*)

→ Moisture availability







Driving and Resisting Forces

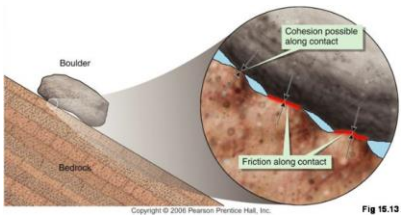
Resisting Forces Dependent on:

→ Cohesiveness of material, friction (*shear strength*)

→ *Shearing stress* the opposite of shear strength = gravity > friction

→ Loose sand, gravel = little cohesion: loss of contact

→ Moist clay = high cohesion (water also highly cohesive…) BUT will flow when saturated (viscous fluid).



Types of Mass Movements

At Failure, material can:

Fall → Rockfall, debris avalanches, snow avalanche: Material falls through the air

Translational slide

Slide → Rapid movement of non-saturated material: Landslide, translational slide along plane, rotational slide along concave surface

Rotational slide

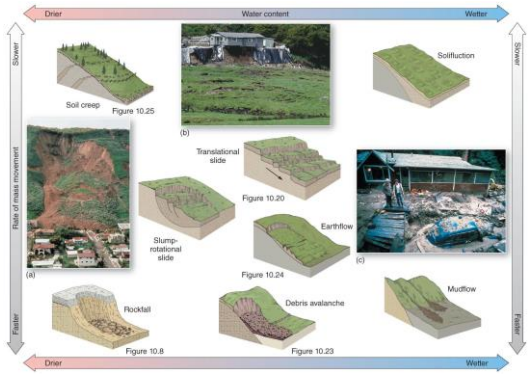
Types of Mass Movements

At Failure, material can:

Flow → Movement of saturated material: Earthflow, mudflow, lahar. Often related to rain/snow

Creep → persistent, gradual movement: wet/dry and freeze thaw cycles lift soil.

Types of Mass Movements



What external factors affect slope stability?

1. Vegetation →

2. Climate →

Human-induced mass movements

Main Causes:

1. Deforestation → loss of vegetation, root structures
2. Building on steep gradients → destabilisation of surface
3. Road construction → destabilization
4. Undercutting, mining → steeper slopes, underground mine shafts

→ Frank Slide

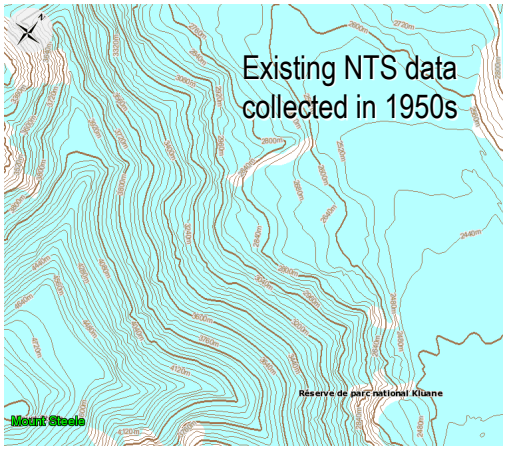
Mount Steele Landslide/Avalanche

→ Mt Steele: 5th highest mountain in Canada (5100 m asl in Kluane National Park)

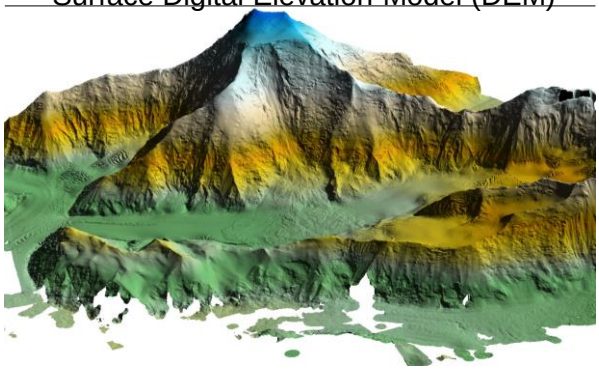
→ July 2007, 3 small and 1 massive rock/ice avalanche on NE face

> 2000 m vertical
> 4000 m horizontal

We were working with Geological Survey in Whitehorse at the time…



Surface Digital Elevation Model (DEM)



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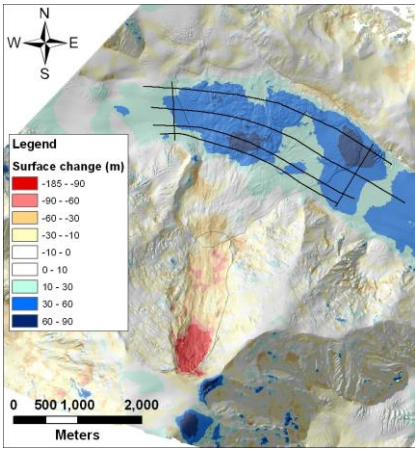
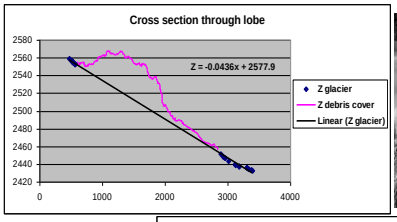
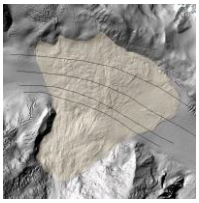
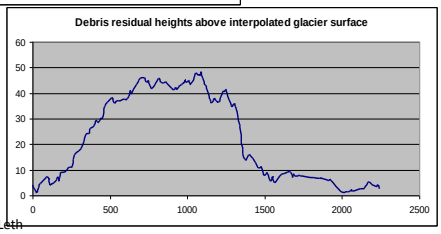






Cross section residual analysis

Regression performed on known glacier points to interpolate sub lobe surface



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Volume Assessment

Scar volume by surface subtraction =

~ 80 x 10^6 m^3

- → Slightly larger than seismic based prediction from NOAA
- → BUT – maximum due to NTS photos collected in 1950s!
- → Cannot assess lobe volume by subtraction due to glacial dynamics.
- → Improved by doing cross sections…

Estimated volume of lobe using cross sections and wedge model

~ 82 x 10^6 m^3

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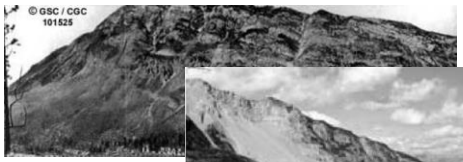
Frank Slide

- → Turtle Mountain used to be called: "The mountain that moves" (Blackfoot, Kutenai)
- → Coal seam exposed after Pleistocene glacial erosion: 1900 to 1903 ¼ million tonnes of coal removed
- → Village of Frank had ~600 inhabitants

April 29, 1903 at 4:10 am, massive landslide.



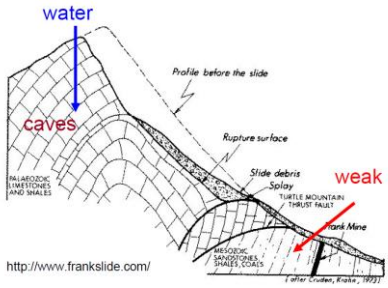
1903

1964

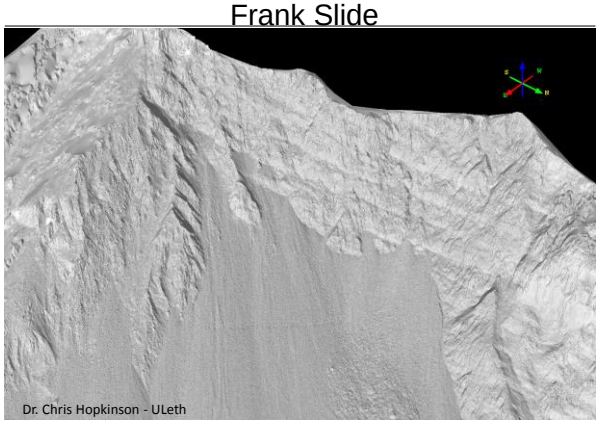
Frank Slide: Mechanics of the Slide

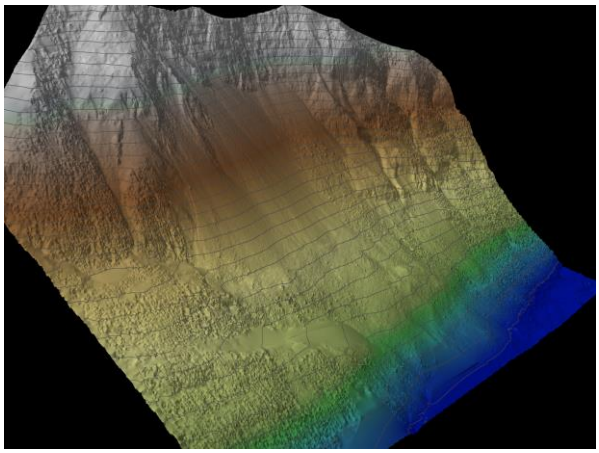
→ 90 million tons of rock slid down the eastern slope
→ Travelled very fast on pockets of air and pulverised stone

→ Rocks travelled as far as 2 kms from crest



Frank Slide





Next week: Reading week. No assignments, no readings.

Midterm is Wednesday Feb 26, in this room during normal class period.

Monday: Review for the exam, answer any questions, etc.

After midterm: Fluvial geomorphology, Coastal geomorphology, biogeography…

Have a nice break!