

DEBRIS FLOWS AND DEBRIS AVALANCHES (23)

I Main Topics

A Hazard recognition

C Nevado del Ruiz, Colombia

D Mount St. Helens, Washington

B Mount Shasta, California

E Hawaii

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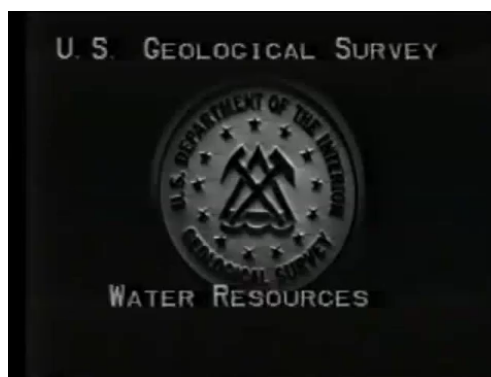
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II Hazard recognition for debris flows

- A One of the most widespread types of mass wasting
- B Slurries resembling flows of wet concrete
- C Common where episodic pulses of water encounter concentrations of loose rocky debris, such as stream channels in semi-arid regions and on volcanoes
- D Alluvial fans are built largely by debris flows
- E Debris avalanches commonly yield debris flows in Hawaii
- F Iverson (1997) describes debris flows physics

Debris flow dynamics, from USGS



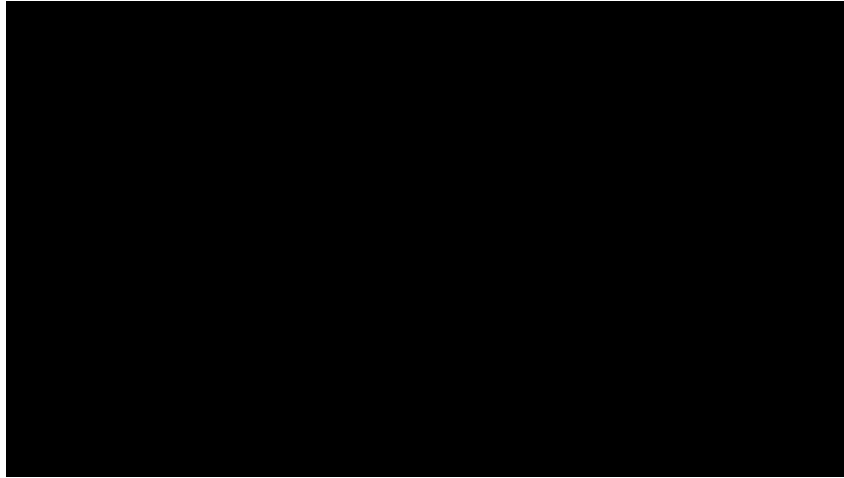
<https://www.youtube.com/watch?v=zpGP1uoChr4>

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II Hazard recognition for debris flows Johnsons Landing in British Columbia



<https://www.youtube.com/watch?v=n1cCs-S5EKc>

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II Indoneisan lahar Volcan Semeru, Java



<https://www.youtube.com/watch?v=WEAfXO7q8Xs>

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IV Nevado del Ruiz, Colombia November 13, 1985

- A Casualty toll of ~23,000 people: largest toll from a mass wasting event in the last 3/4 of a century
- B Substantial damage at a run-out distance of 100 km
- C Debris flow originated on a stratovolcano – Nevado del Ruiz



http://en.wikipedia.org/wiki/Nevado_del_Ruiz

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Nevado del Ruiz volcano 5389m



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Explosive Eruption at Summit Crater November 13, 1985, 9:08



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Pyroclastic Flows Melt Snow and Ice



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Lahars Merge at Base of Volcano



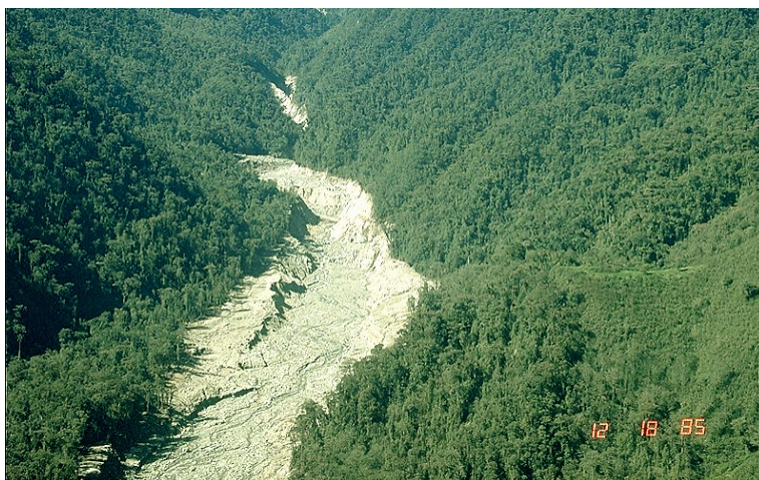
<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Lahars Grow in Size Through Erosion



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High Ground Means Safety



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Towns in River Valley Destroyed



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Armero Destroyed 74 km from Nevado del Ruiz



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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Armero Destroyed ~25,000 fatalities



<http://volcanoes.usgs.gov/hazards/lahar/ruiz.php>

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V Mount St. Helens, Washington

A Largest documented landslide in recorded history, May 18, 1980

B Estimated volume: $\sim 1 \text{ km}^3$

B Debris avalanche generated devastating debris flows

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15

V Mount St. Helens, Washington



<https://www.youtube.com/watch?v=UK--hvgP2uY>

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III Mount Shasta, California 4322m



http://volcanoes.usgs.gov/volcanoes/mount_shasta/mount_shasta_hazard_24.html

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III Mount Shasta, California Comparison with Mt. St. Helens

Mt. St. Helens



Mt. Shasta



Estimated volume of Mt. Shasta avalanche deposit (Crandell et al. 1984): 1 km^3
Estimated volume of Mt. Shasta avalanche deposit (Crandell et al. 1984): 26 km^3

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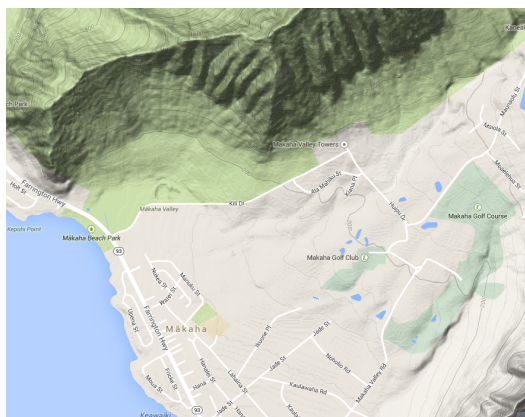
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VI Debris flows and debris avalanches in Hawaii

A Makaha Valley,
11/14/1996

- 1 Debris flow
- 2 Time: ~2 AM
- 3 21" of rain in November preceded the debris flow
- 4 No casualties



Map from google.com

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1996 Makaha Valley Debris Flow Views to NE



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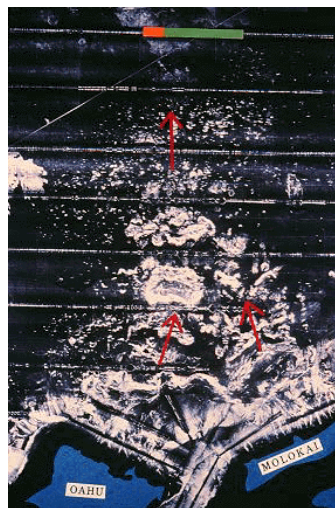
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VI Hawaii

B Nuuanu debris avalanche

- 1 Among the largest known mass wasting events in the solar system
- 2 Volume: ~5,000 cubic km
- 3 Length: 235 km
- 4 Run-up height at distal end: 300m+
- 5 Minimum speed at base Hawaiian Deep: $v = [2gh]^{1/2}$
 $= [2(9.8)(300)]^{1/2}$ m/sec
 $= 80$ m/sec = 280 km/hr



<http://www.uhh.hawaii.edu/~kenhon/geol205/Landslides2/default.htm>

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References

- Iverson, R.M., 1997, The physics of debris flows: Reviews of Geophysics, v. 35, p. 245-296.
- <http://starbulletin.com/96/11/14/news/story1.html>
- <https://www.youtube.com/watch?v=2FFRNA7VK7U>
- Moore, J.G., Clague, D.A., Holcomb, R.T., Lipman, P.W., Normark, W.R., and Torresan, M.E., 1989, Prodigious submarine landslides on the Hawaiian Ridge, Journal of Geophysical Research, v. 94, p. 17,465-17,484.

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