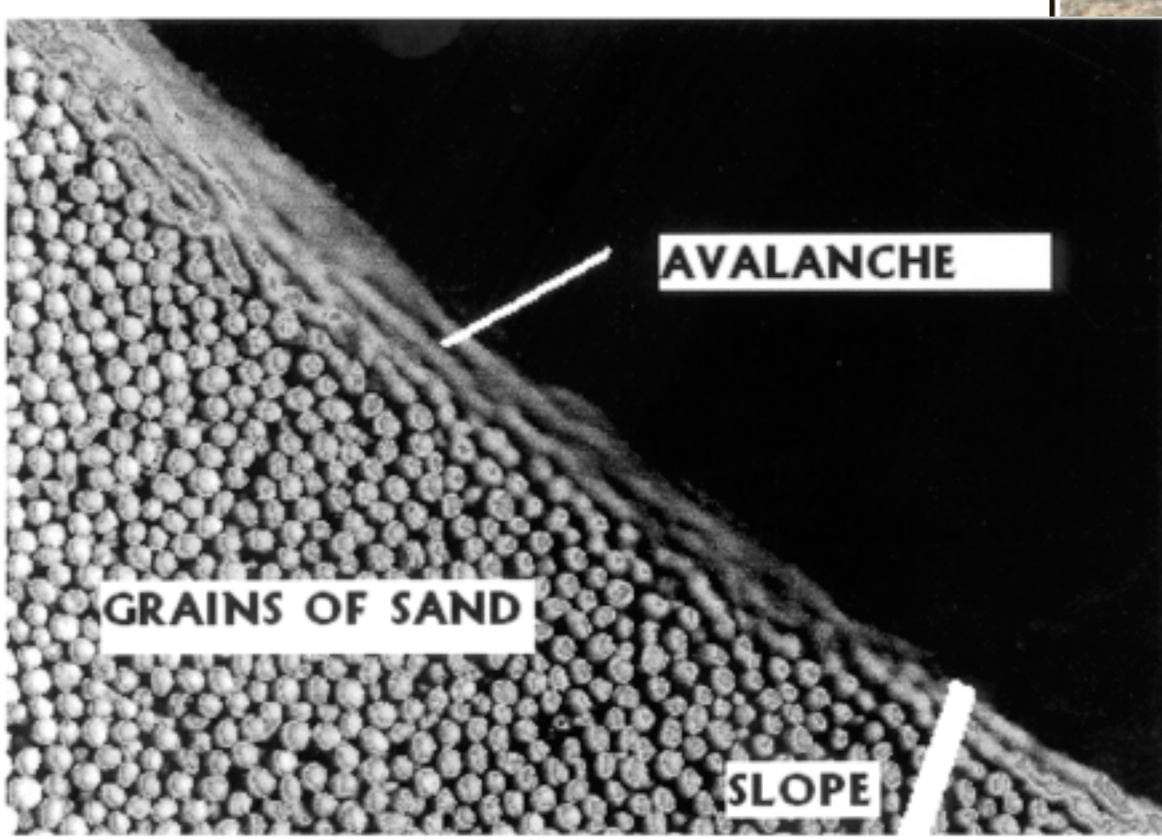
Angle of Repose

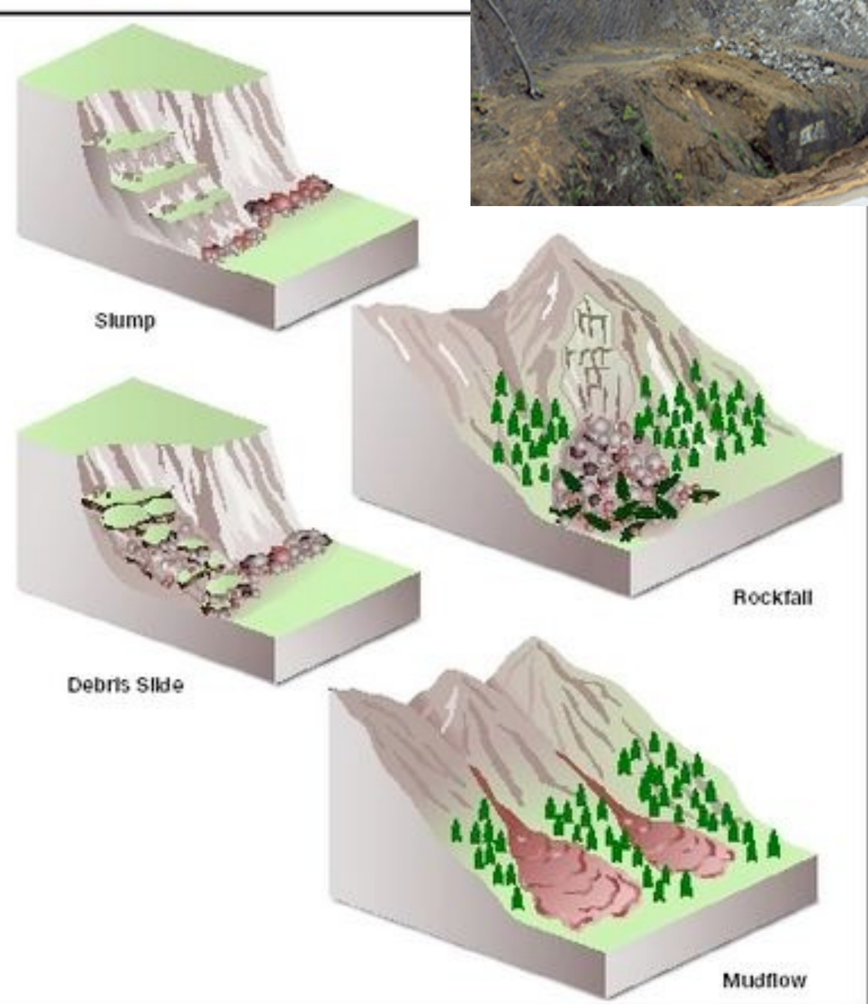
Applies to granular material



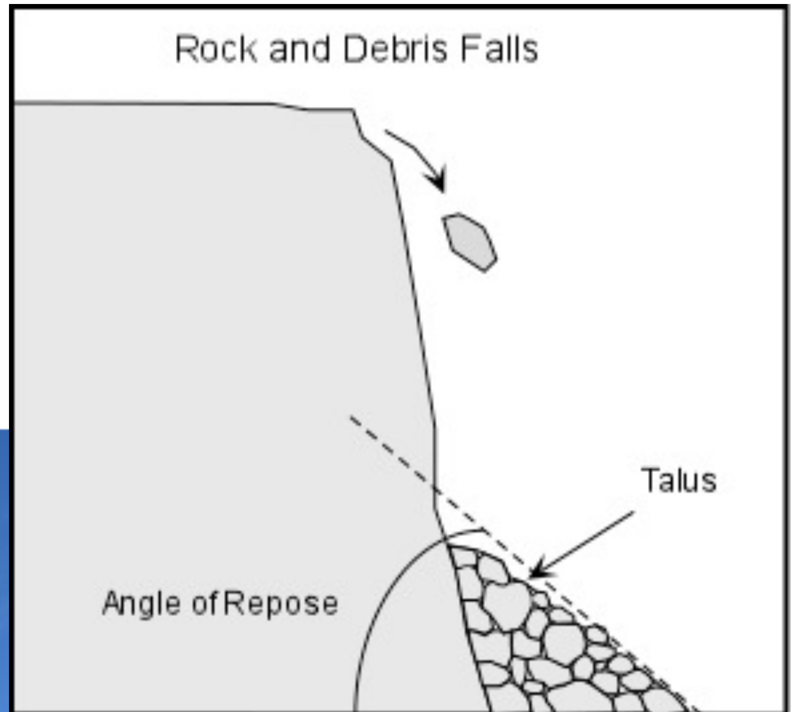
source: http://blogs.scientificamerican.com/cocktail-party-physics/2011/11/17/of-granular-material-and-singing-sands/

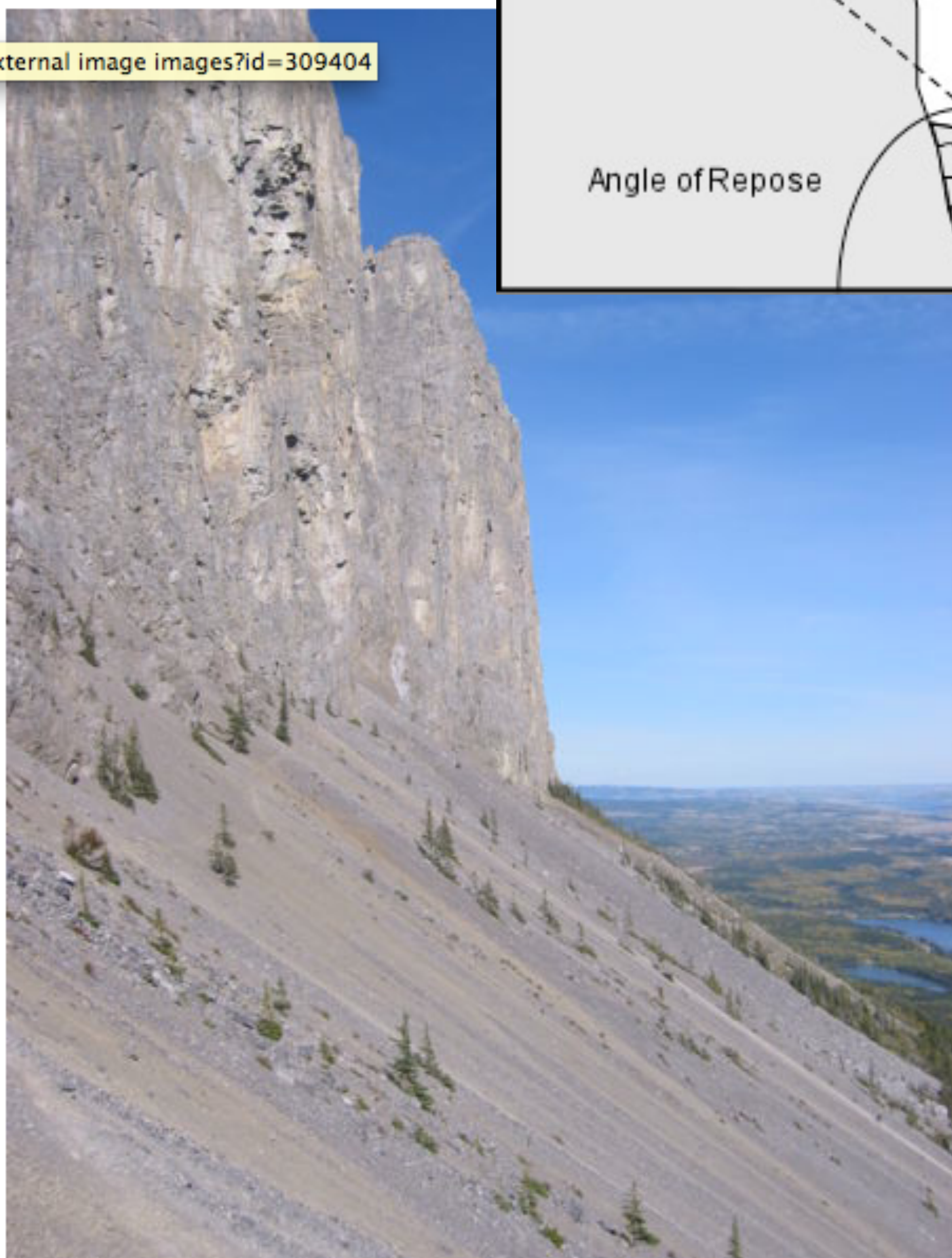
Volcanoes and Cinder Cones

Source http://www.guardian.co.uk/world/gallery/2010/sep/06/guatemala-landslides#/?picture=366454533&index=0

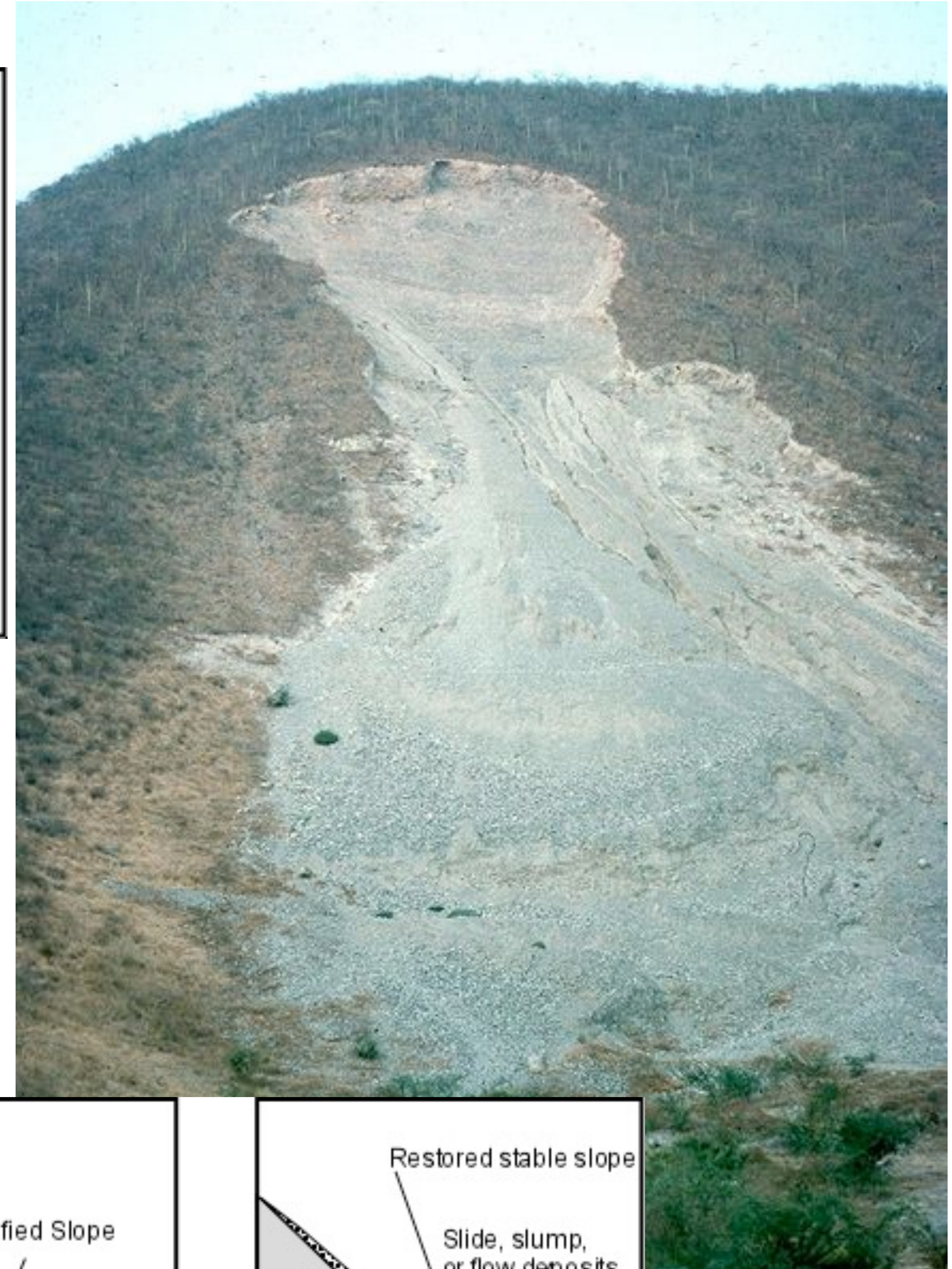


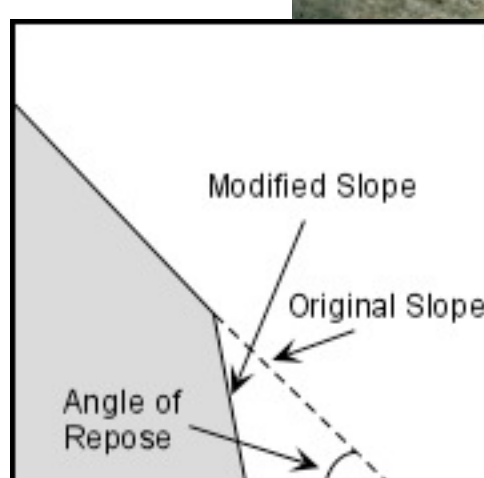
San Francisco and San Mateo County Coast. Large slide at Daly City. This is the largest slide encountered in San Mateo County. The base is about 152 meters (500 feet) across at its widest point, and it displaced approximately 36,700 cubic meters (48,000 cubic yards) of material.

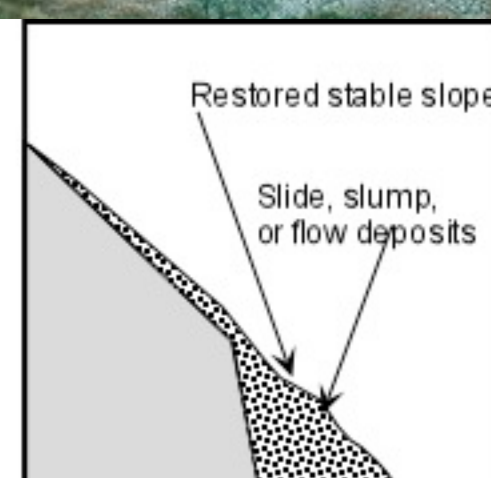


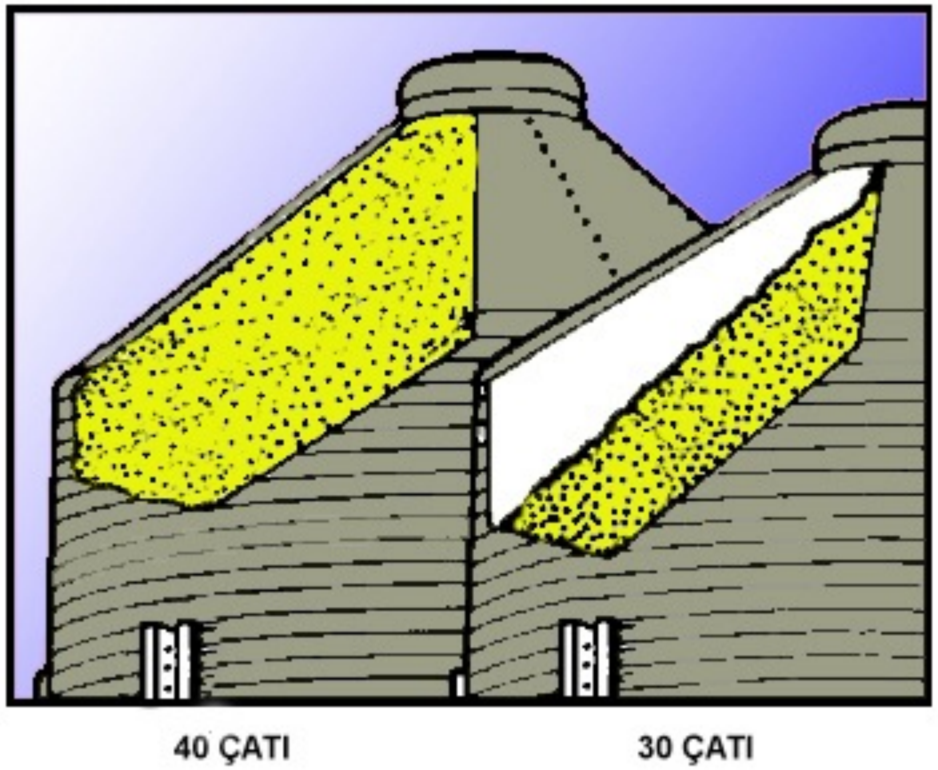


Pieces of rock regularly fall to the base of cliffs to form talus slopes.









The Professional Animal Scientist 22 (2006):120–125

Particle Size, Mill Type, and Added Fat Influence Angle of Repose of Ground Corn[1]

C. N. GROESBECK,*[2] R. D. GOODBAND,* PAS, M. D. TOKACH,* S. S. DRITZ,[†] J. L. NELSSEN,* and J. M. DEROUCHEY
*Department of Animal Sciences and Industry, Kansas State University, Manhattan, 66506-0201; a

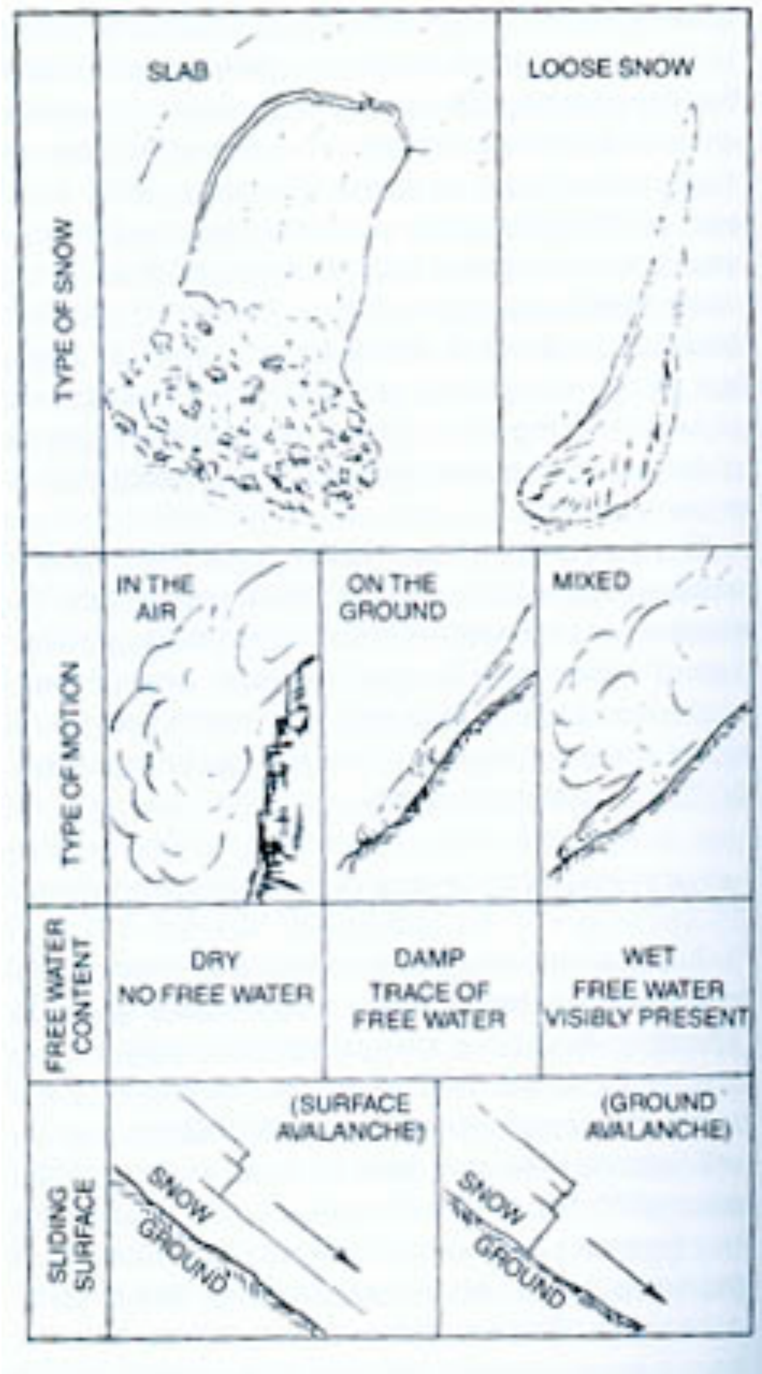
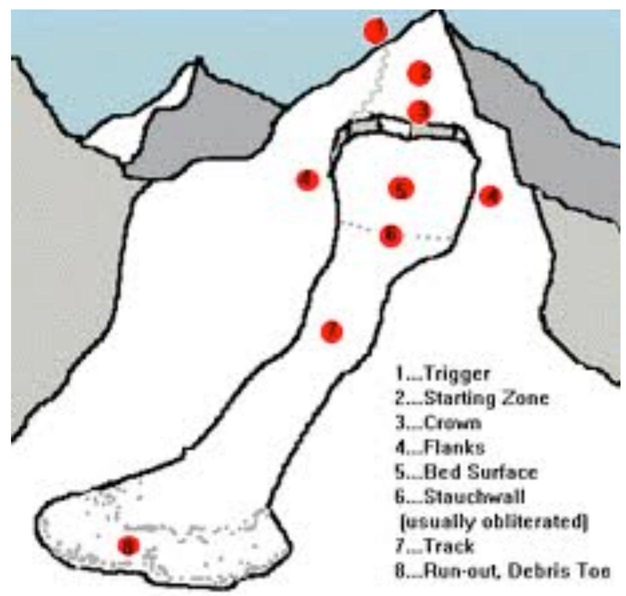



Fig. 2.—Avalanche classification

Loose Snow Avalanches

Loose snow avalanches involve individual snow crystals that can move separately from each other. This means the snow either does not stick together or only slightly sticky. There are two types of loose snow avalanches, dry and wet.

For either of these avalanches to form the snow must be on a surface that is steeper then the **angle of repose**. The angle of repose varies from as shallow as 15° for snow wet enough to classify as slush to as steep as 50° at which point snow will normally not accumulate. The most common angle at which avalanches occur is close to 30°.



source: http://ffden-2.phys.uaf.edu/212_fall2003.web.dir/Sarah_Schlichting/Slab.html

Slab Avalanches

Slab avalanches are usually more dangerous then loose snow avalanches, and are caused by the failing of a layer of snow under the **shear** force caused by the snow pack trying to move down hill and the ground or a layer of snow staying stationary or moving at a slower rate. This failure in a layer of snow allows the overlying snow (which can be one or more layers and can be the entire snow pack) to slide down the slope as a block. Similar to loose snow avalanches the angle of repose is normally around 30° but can be as high as 55°.

Snow Avalanche video

Ant Lions

Since the sides of the pit consist of loose sand at its angle of repose, they afford an insecure foothold to any small insects that inadvertently venture over the edge, such as ants. By throwing up loose sand from the bottom of the pit, the antlion undermines the sides of the pit, causing them to collapse and bring the prey with them.

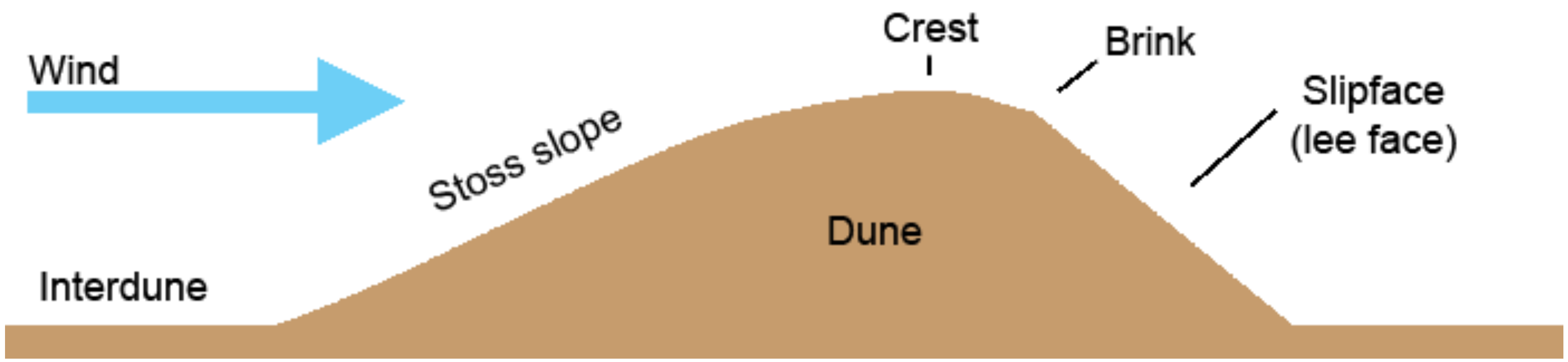
Source: http://en.wikipedia.org/wiki/Antlion

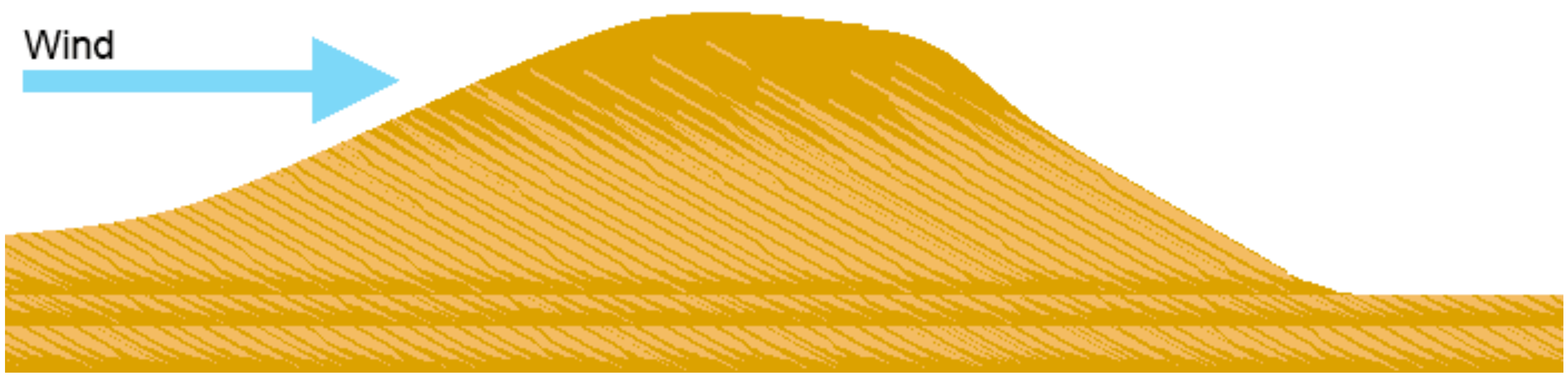
Antlion Video

Source: National Geographic

Sand Dunes

Aeolian (wind) Dunes





Source: http://web.ncf.ca/jim/sand/overview/index.html

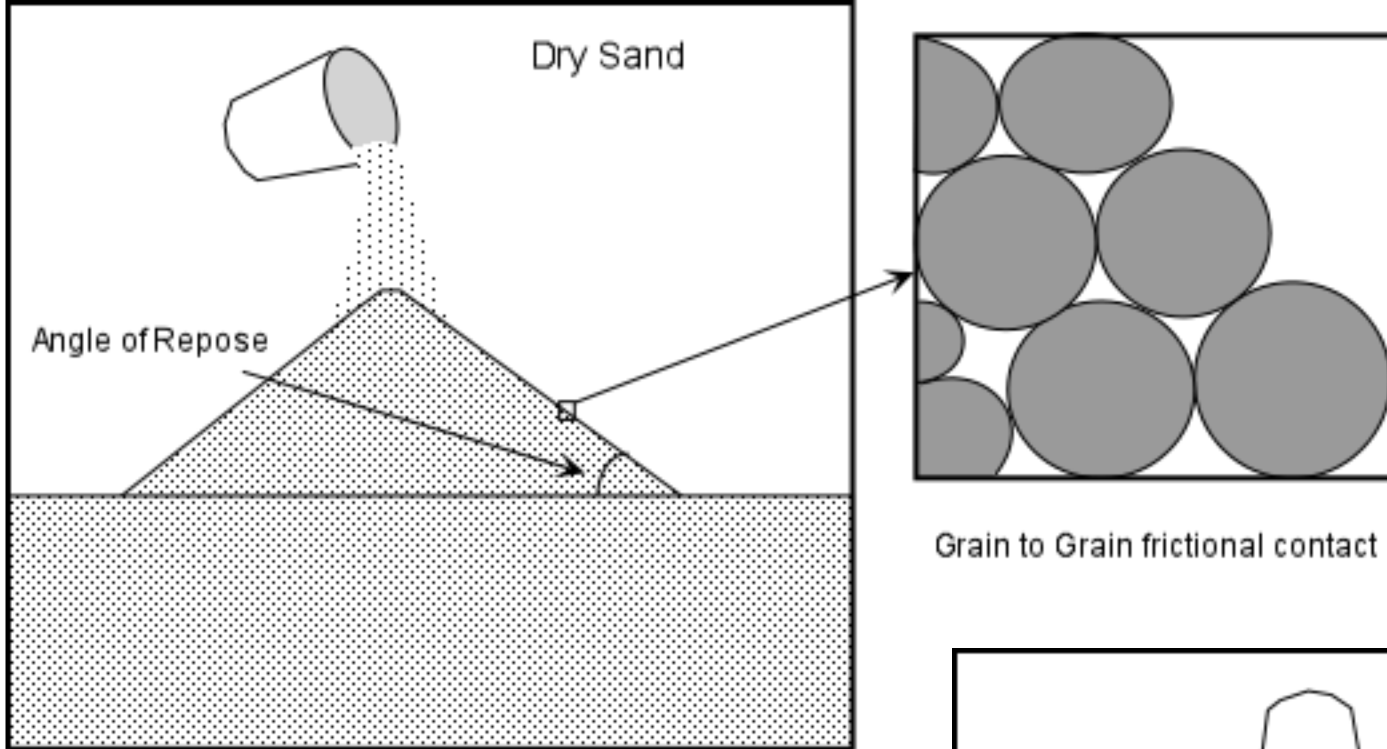
Video--Granular Materials

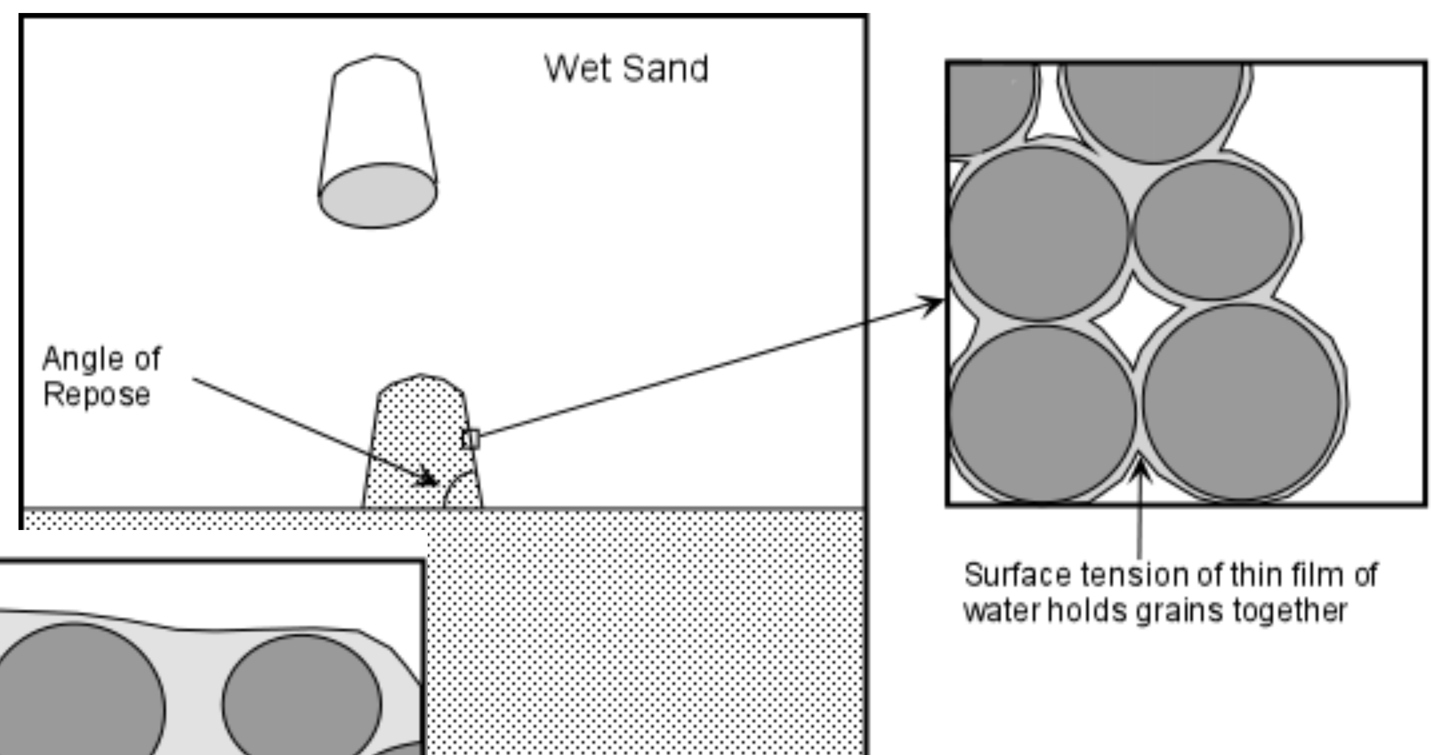
Video--Simulation

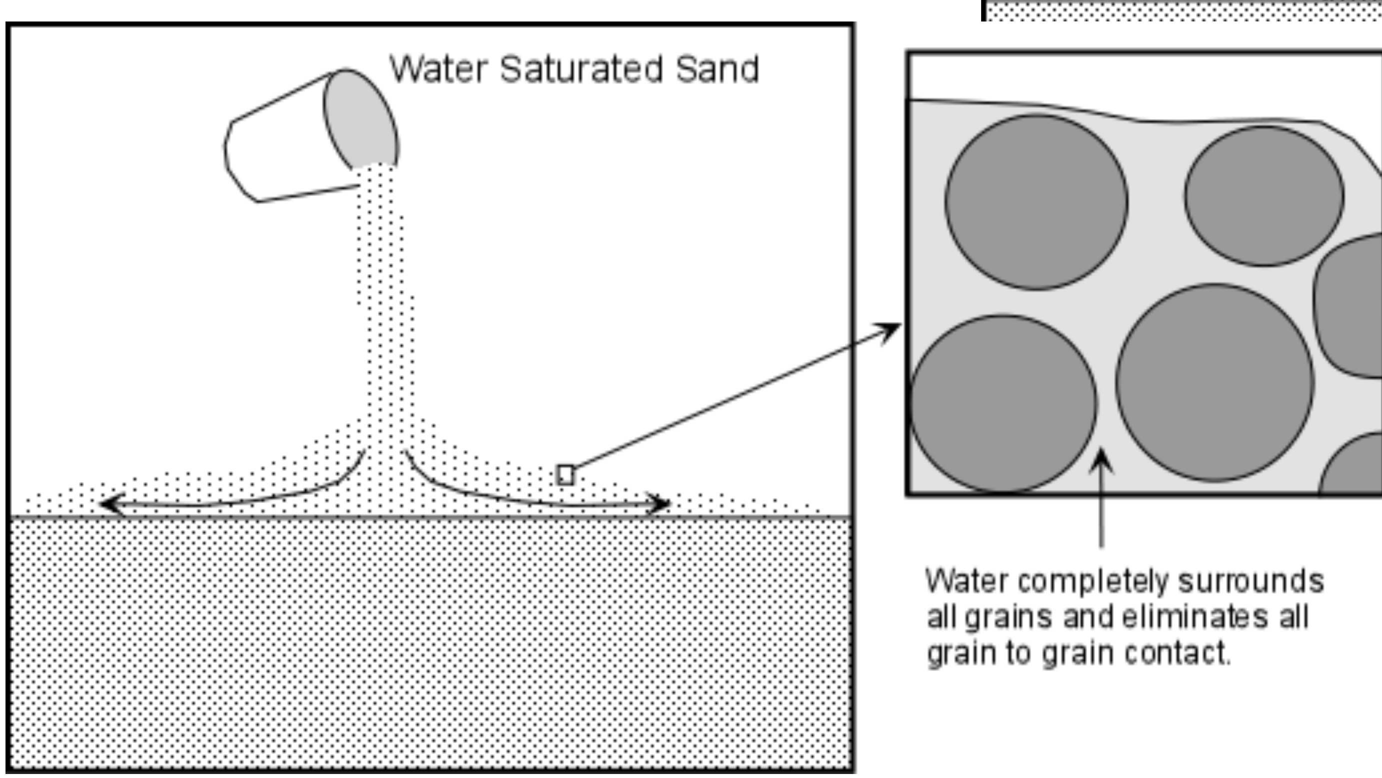
Notice how the grains move to the bottom before piling up

Note: There are two “angles of repose”:
a_c: the critical angle of repose is the maximum angle before an avalanche.
a_r: the rest angle of repose, the angle right after an avalanche.

For our investigation, we are interested in measuring a_r

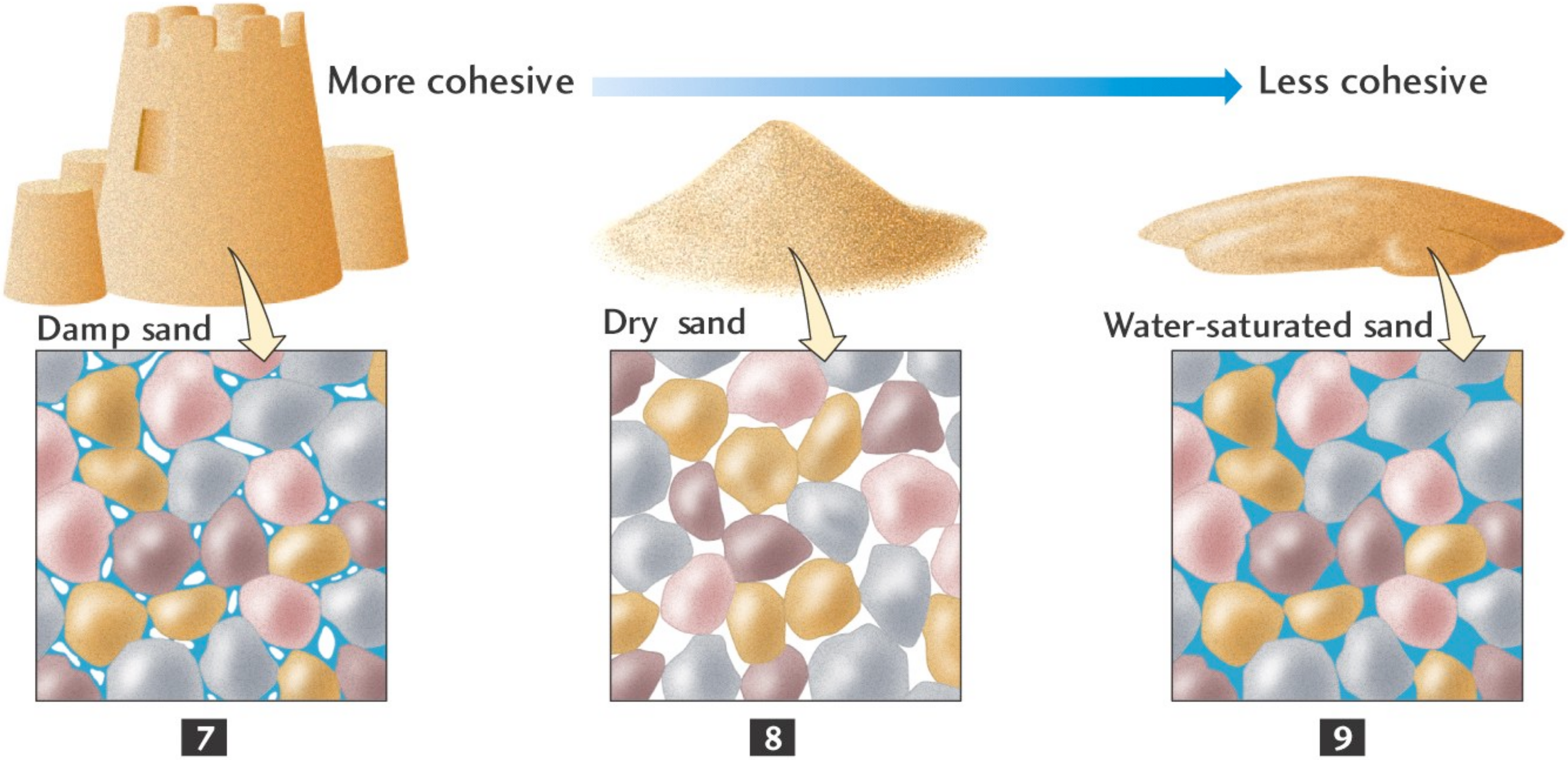






source:http://www.tulane.edu/~sanelson/geol204/slopestability.htm

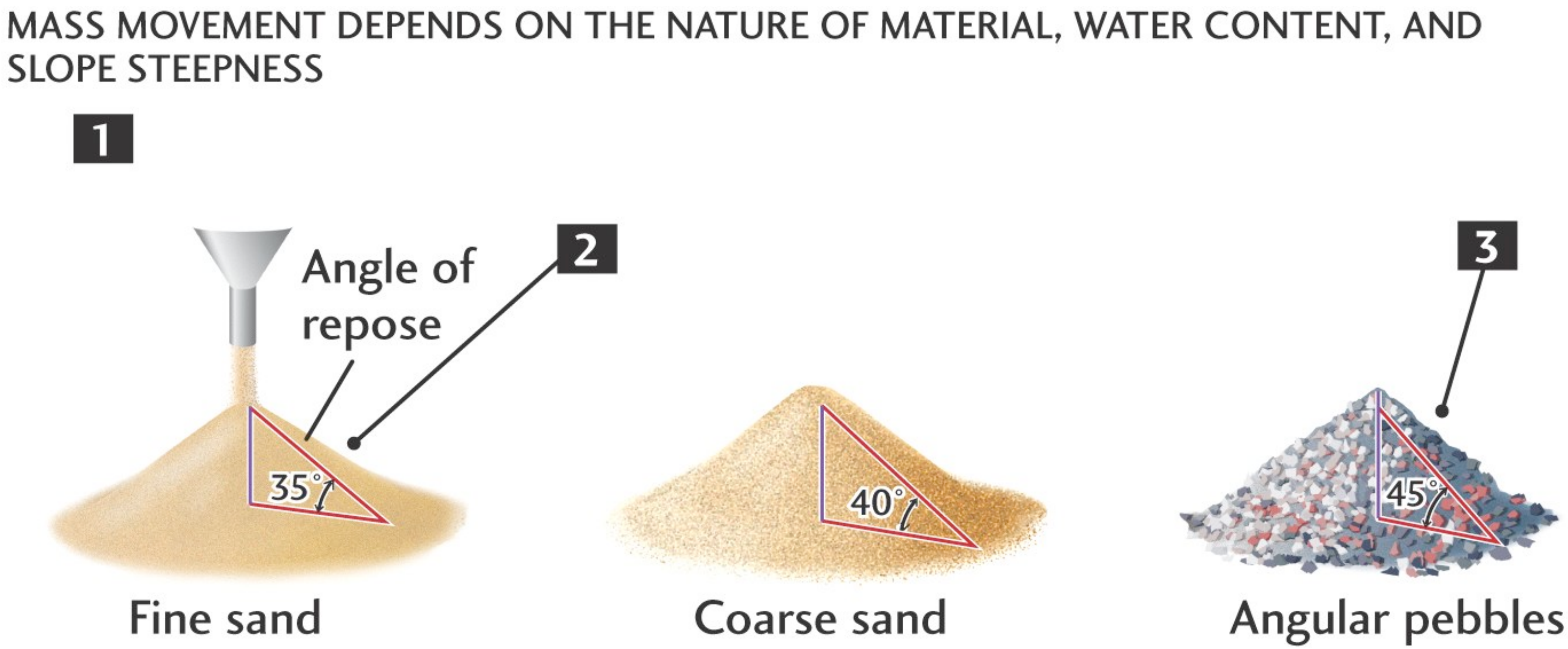
SAND



Source: http://hays.outcrop.org/images/mass_wasting/press4e/figure-12-01c.jpg

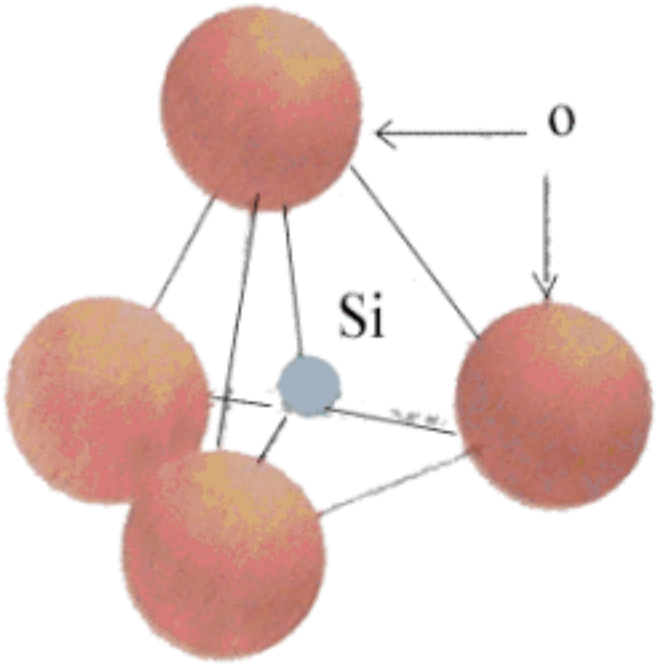

www.teamsandtastic.com

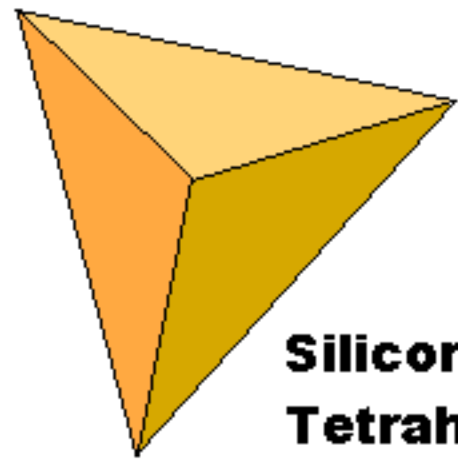
Angle of repose based on many variables

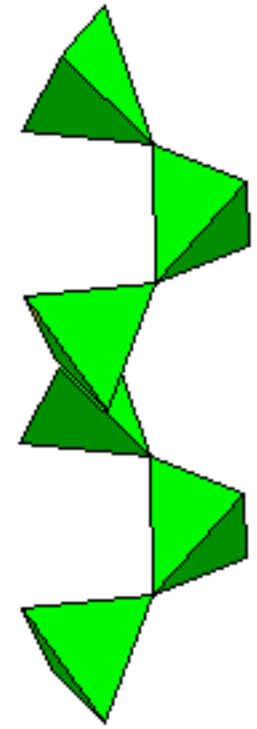


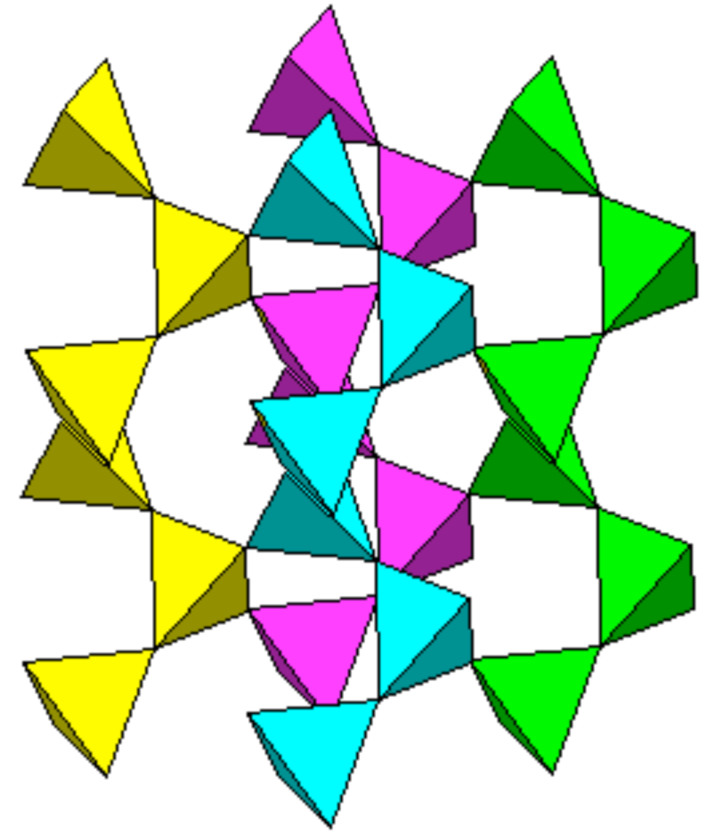
Source: http://hays.outcrop.org/GSCI100/lecture37s.html

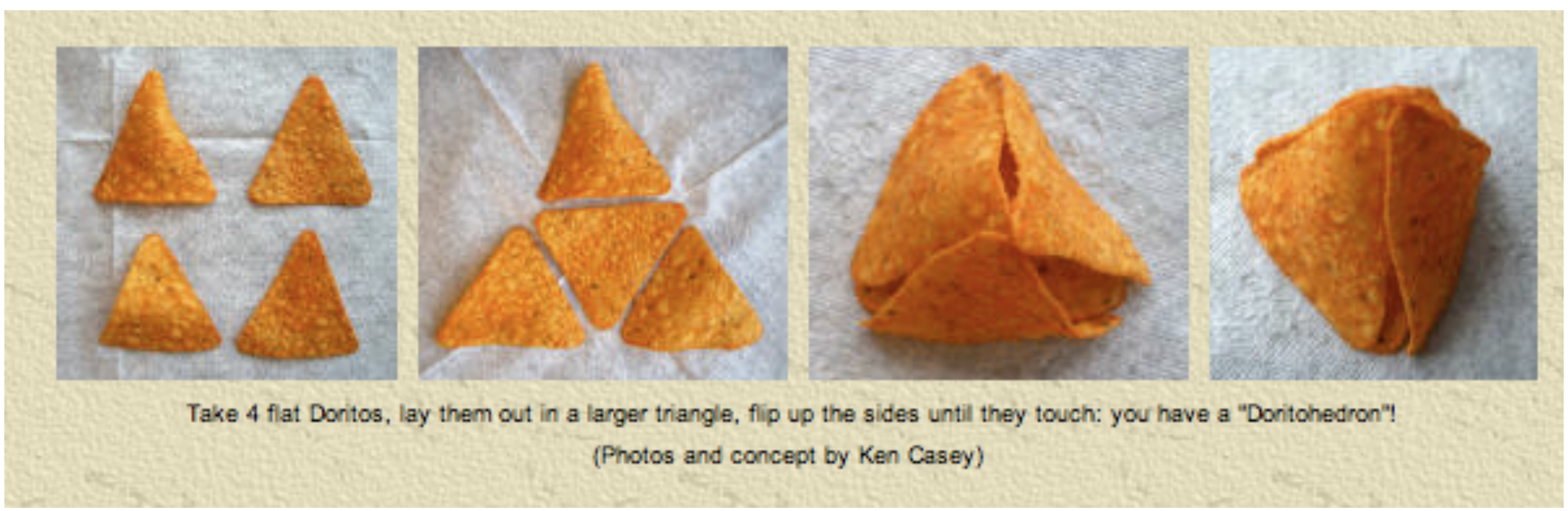
Sand: mostly SiO2 Silicon Dioxide (Quartz)



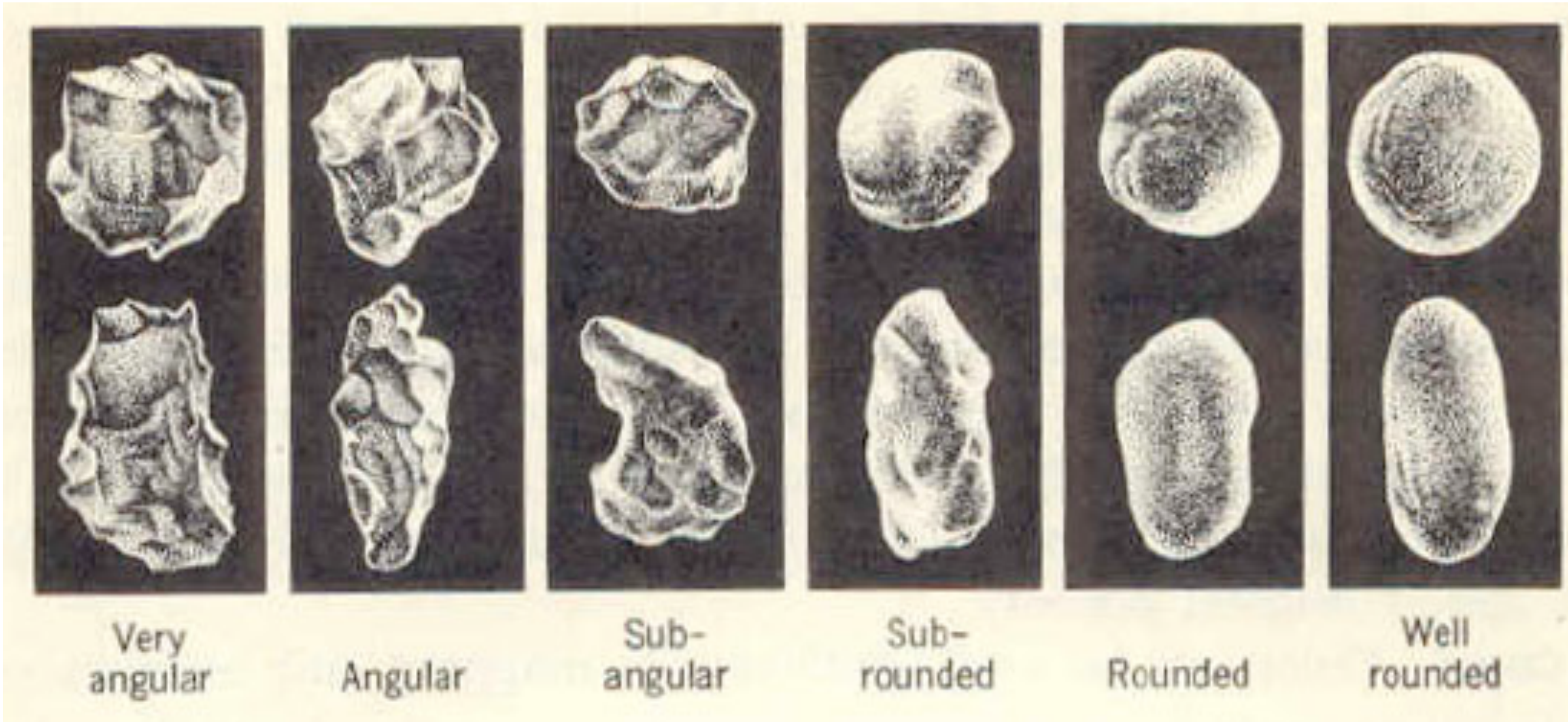








Source: http://www.delminsociety.net/motm/motm_oct2007.shtml



http://www.sand-atlas.com/en/shape-of-sand-grains/

Modeling Aeolian Dune and Dune Field Evolution

The angle of repose is affected by the force of gravity.

by

Serina Diniega

A Dissertation Submitted to the Faculty of the

GRADUATE INTERDISCIPLINARY PROGRAM IN APPLIED MATHEMATICS

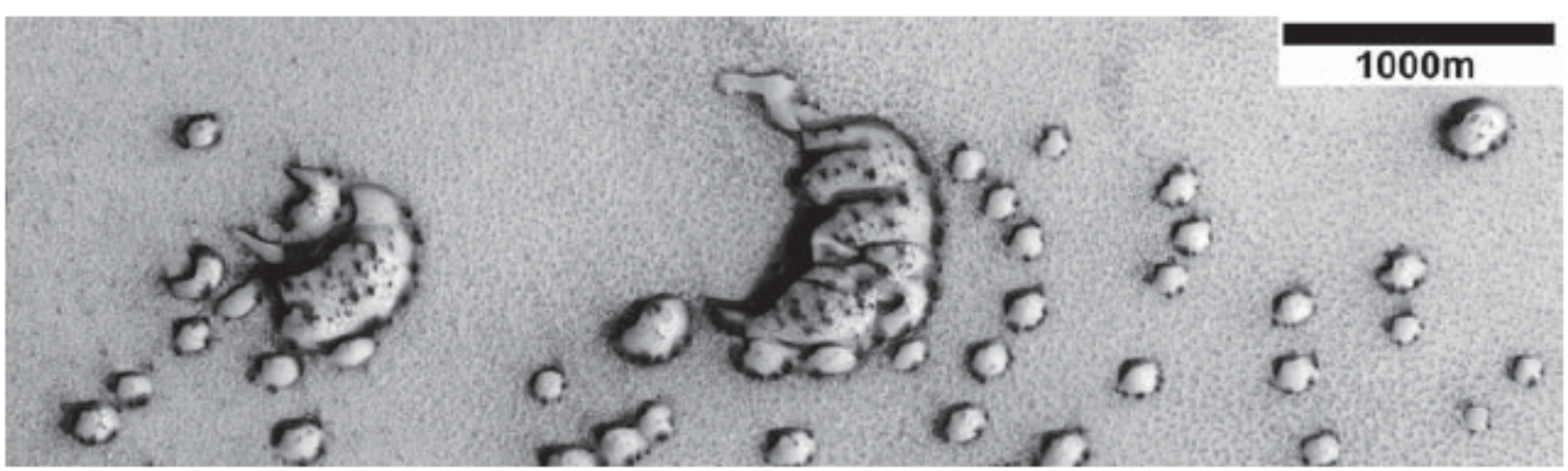


Figure 1.3. This image (HiRISE PSP_007172_2570) shows a martian dune field

ON THE ANGLE OF REPOSE OF WET SAND

By A. G. Webster

Ballistic Institute, Clark University, Worcester, Massachusetts*

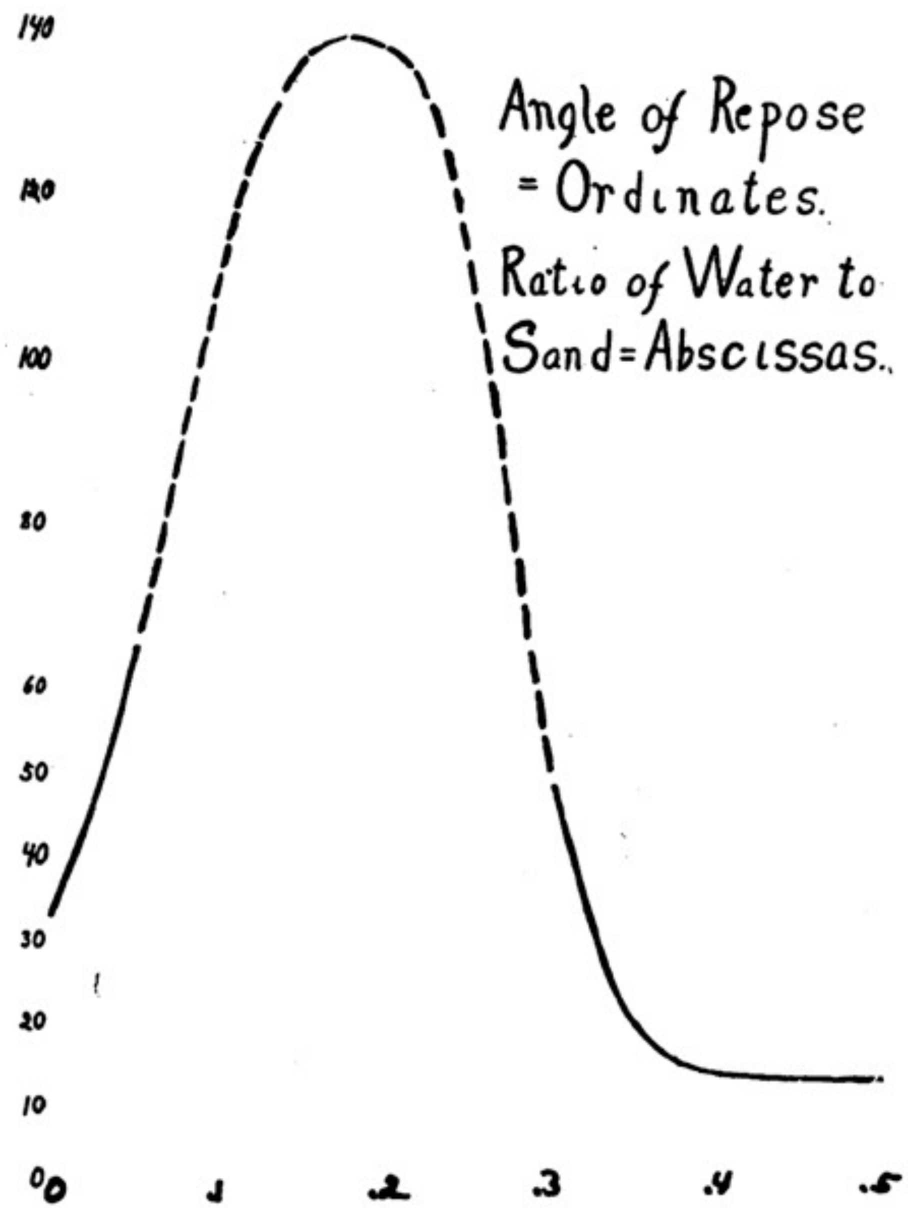
Read before the Academy, April 29, 1919

It is well known that sand, gravel, broken stones, grain, sugar or any pulverulent substance has a definite angle of limiting steepness which is called the angle of repose. In Dr. Breasted's lecture the pile of debris in front of the Temple of Thebes showed such a definite angle. In driving to Washington last week I passed along the Cape Cod Canal and noticed a very definite angle of repose for the sand alongside the Canal. Passing by the beach at Narragansett Pier I measured its slope and found it to be very uniform and about one in fourteen.

*Contribution from the Ballistic Institute, Clark University, No. 6.

A few years ago a committee of this Academy was sent to Panama to examine into the cause of the Culebra slides. My interest was excited at that time, and a year ago by my being consulted as an expert on the collapse of a house.

A few days ago it occurred to me, having a load of sand on the floor of my ballistic laboratory, to wet it and make an artificial beach. I found that on scraping it up with a board a very definite slope was obtained depending upon the wetness. I therefore requested my assistant Dr. E. A. Harrington to make a few quantitative experiments to determine the angle in terms of the wetness. This is shown in the figure.



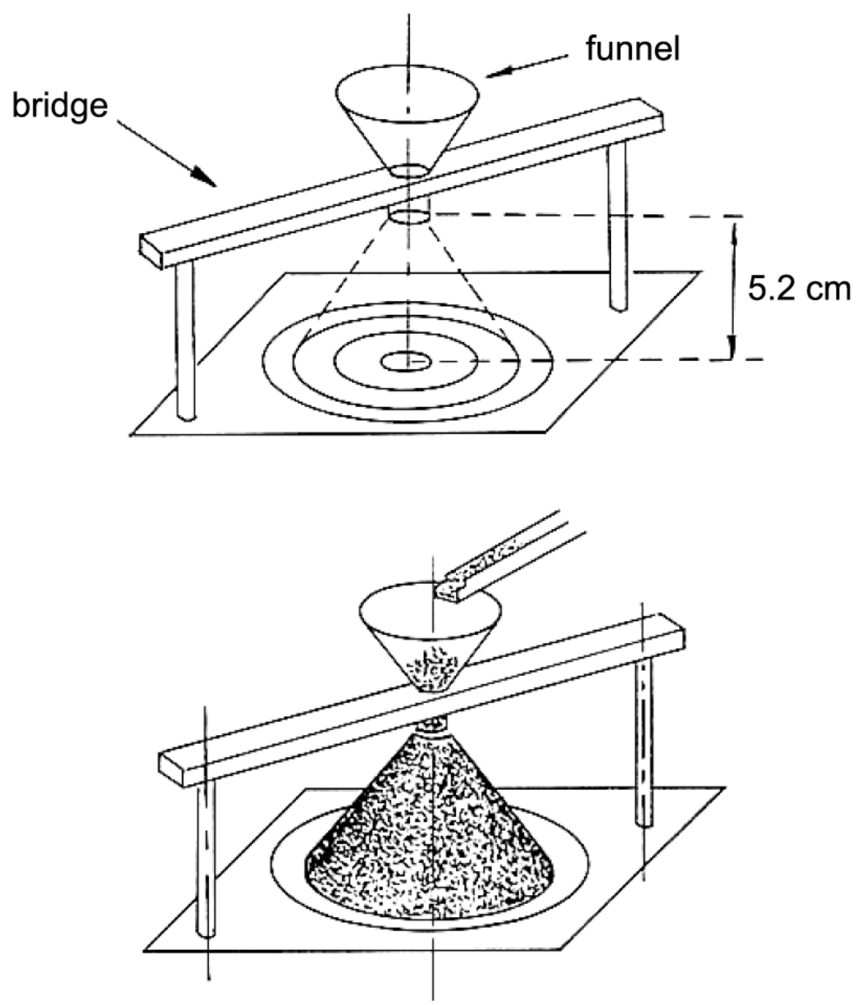
What is the "ordinate" axis? What is the "Abscissas"?

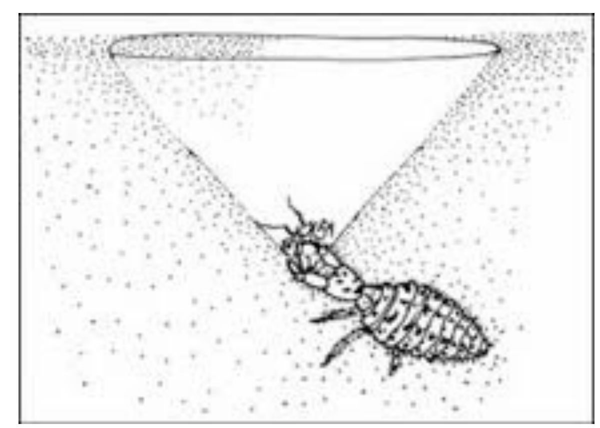
Beginning with absolutely dry sand which was weighed in a tray a certain amount of water was added and the whole weighed. At first the added water is quickly absorbed and on account of the work done by the surface tension and the cohesion of the water a certain positive amount of cohesion is obtained by the sand, and it will remain in equilibrium vertically and even overhang. Of course these experiments are not extremely accurate. When a certain degree of wetness is passed the sand then acts like a plastic substance, the degree of plasticity depending upon the relative amounts of water and sand.

SAND	WATER	ANGLE OF REPOSE	REMARKS
pounds	*pounds*		
10	0	33°	Dry
10	0.5	65°	Not hard
10	1.0	120°	Not accurate, but large obtuse angle, hard
10	1.5	120°–140°	Not accurate, but large obtuse angle, hard
10	2.0	120°–140°	Not accurate, but large obtuse angle, hard
10	2.5	120°	Not accurate, but large obtuse angle, hard
10	3.0	48°	Fairly hard
10	3.5	19°	All mixes
10	3.75	14.5°	Very slight excess of water
10	4.0	13°	Water not all absorbed
10	5.0	12°	Excess of water

Task: *Design an experiment to measure the angle of repose of dry and damp sand?*

How will you create the pile to measure the angle of repose ?





Examples of methods to create avalanched pile

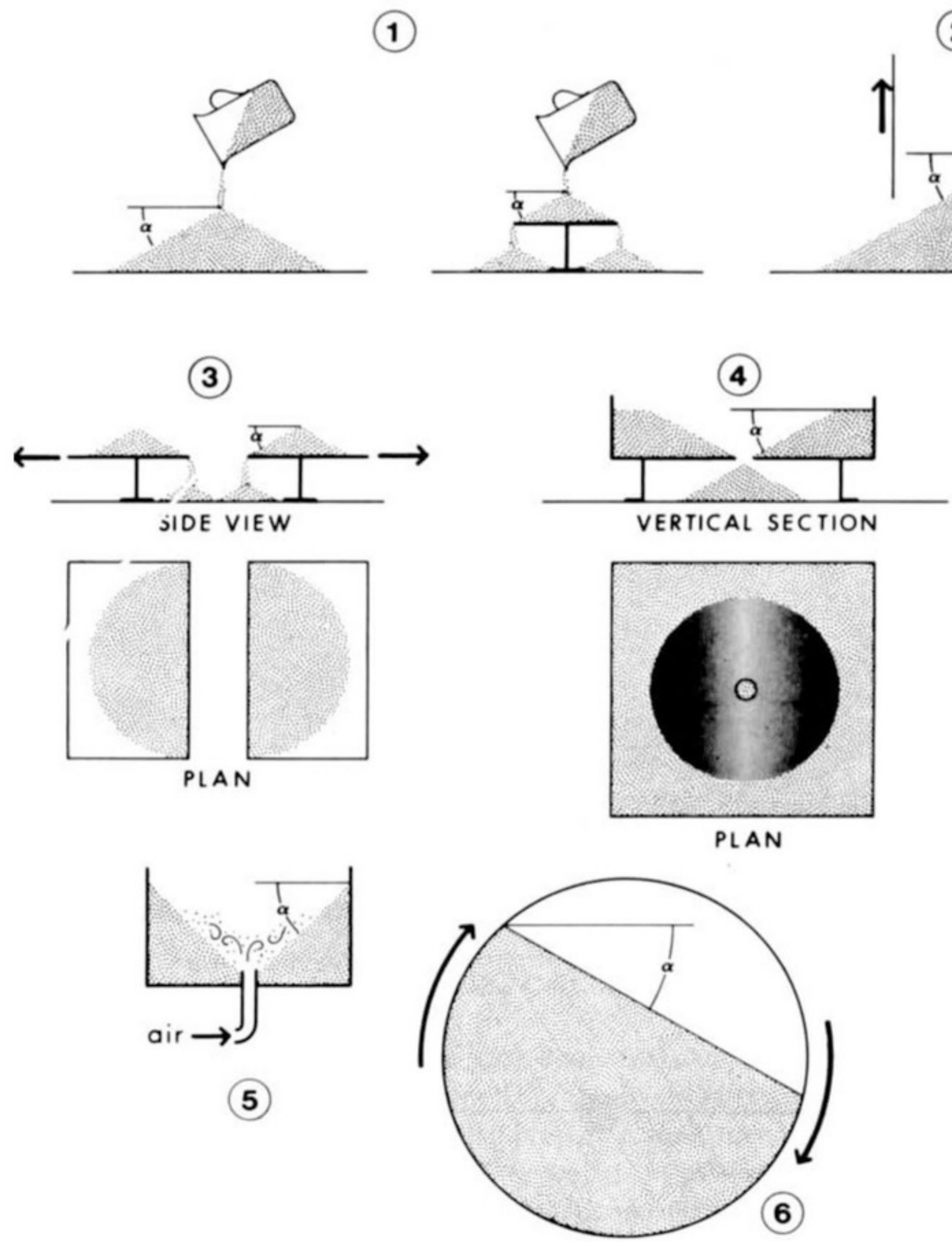


Fig.1. Methods of producing angles of repose in granular materials: *1.* by carefully pourin loose particles onto a cone-shaped pile; *2.* by filling a container, removing one side, and letting th particles flow out; *3.* by pulling apart the base beneath a poured cone and letting the exce material spill over the edge until movement stops; *4.* by removing a plug from below a layer of loose granules and letting the particles flow through the hole until movement ceases; *5.* by blowing a jet of air through loose granular material until a crater is excavated; *6.* by measuring the rotation of a trough of granular material until movement begins.

There are two angles of repose for most granular materials: a critical angle (a_C), beyond which the material cannot be piled; and an angle of rest (a_R), the inclination of the slope after avalanching has ceased.

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EXPERIMENTS ON THE ANGLES OF REPOSE OF GRANULAR MATERIALS[1]

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Research Council of Alberta, Edmonton, Alta. (Canada)

(Received January 26, 1970)

How will you measure it?
(create at least two methods of measurement)

Measurement and Trig review