Mass Wasting

Mass wasting:Mass wasting is a term used to describe the movement of geological material (rocks, soils, sediments) under the effects of gravity but frequently affected by water and water content as in submarine environments and mud slides. Types of mass wasting include **creep**, **slides**, **flow**, **topples**, **falls**,and **sinkhole** each with its own characteristic features, and taking place over timescales from seconds to years.It proceeds at variablerates of speed and is largelydependent on the **water saturation levels**and the **steepness** of the terrain. A destructive, rapid mass-wastingevent is called a **landslide**; if the movement is slow enough that itcannot be seen in motion, it is called **creep**.

Three kinds of movement are generally recognized: **flow**, **slip**, and **fall**. A mass-wasting event is called a **flow** if the mass movesdownslope like a viscous fluid. If the mass moves as a solid unit alonga surface or plane, it is called a **slip**. A **slip** that moves along a surfaceparallel to the slope is called a **slide**. If the movement occursalong a curved surface where the downward movement of the upperpart of the mass leaves a steep scarp (cliff) and the bottom part ispushed outward along a more horizontal plane, it is called a **slump**. Earth material that free-falls from a steep face or cliff is termed a **fall**.

Mass-Wasting Controls

Varieties of conditions affect the development of mass wasting in aparticular area. 1-Steep slopes, 2- widely varying altitude ranges (relief), 3- the thickness of the loose earth material, 4-planes of weakness parallelto the slopes, 5- frequent freezing and thawing, 6- high water content inthe earth material, 7- dry conditions with occasional heavy rainfall, 8- andsparse vegetation are the factors that contribute to the unstable conditionsthat result in mass wasting. Movements can be triggered by the motion of earth quakes or too much weight added to the upper partof a slope, such as snowpack.

FACTORS THAT CONTROLMASS WASTING

1- Steepness of the slope

Obviously, the steepness of a slope is a factor in mass wasting. If frost wedging dislodges a rock from a steep cliff, the rock tumbles to the valley below. However, a similar rock is less likely to roll down a gentle hill side.

2-Type of rock and orientation of rock layers

If sedimentary rock layers dip in the same direction as aslope, the upper layers may slide over the lower ones. Imagine a hill underlain by shale, sandstone, and limestone oriented so that their bedding lies parallel to the slope, as shown in Figure 6–1a. If the base of the hillis undercut (Fig. 6–1b), the upper layers may slide overthe weak shale. In contrast, if the rock layers dip at an angle to the hill side, the slope may be stable even if it is undercut (Figs. 6–1c and 6–1d).

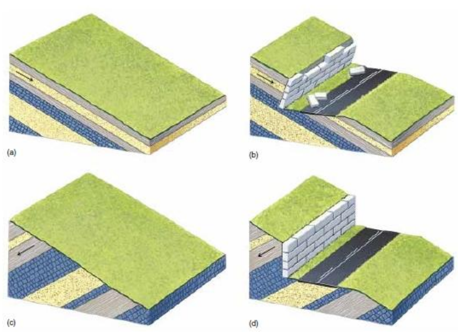


Figure 6–1 (a) Sedimentary rock layers dip parallel to this slope. (b) If a road cut undermines the slope, the dipping rock provides a good sliding surface, and the slope may fail. (c) Sedimentary rock layers dip at an angle to this slope. (d) The slope may remain stable even if it is undermined.

Several processes can undercut a slope. A stream orocean waves can erode its base. Road cuts and othertypes of excavation can also destabilize it. Therefore, ageologist or engineer must consider not only a slope’sstability before construction, but how the project mightalter its stability.

3- Angle of repose: The angle of repose is the steepest angle at which loose material will remain in place. It is largely dependent on the size, shape, and roughness of the particles. The angle varies from about 25 degrees to about

40 degrees. If the angle is exceeded by additional sedimentation or tilting, a slide or disturbance will result.

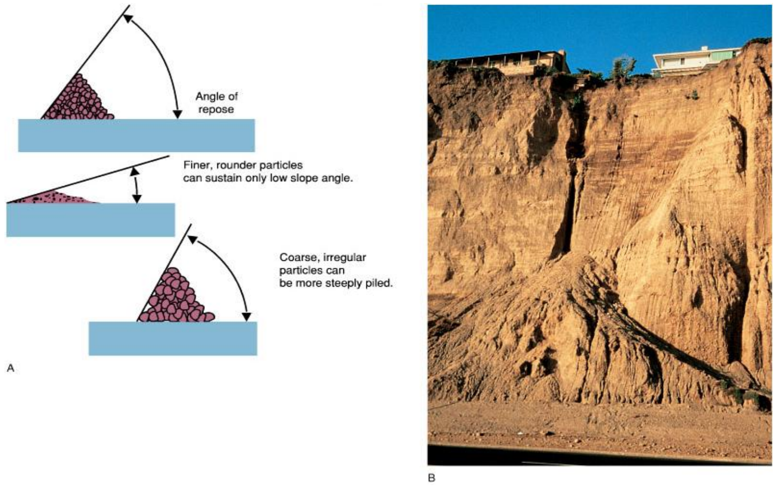


Figure 6–2 (A), shows the variation of the angle of repose due the size , shape, and roughness, B, photo of angle of repose.

4-**Water and vegetation**

To understand how **water** affects slope stability, think of a sand castle. Even a novice sand-castle builder knowsthat the sand must be moistened to build steep walls andtowers (Fig. 6–3). But too much water causes the wallsto collapse. Small amounts of water bind sand grains together because the electrical charges of water molecules attract the grains. However, excess water lubricates thesand and adds weight to a slope. When some soils becomewater saturated, they flow downslope, just as thesand castle collapses. In addition, if water collects on impermeable clay or shale, it may provide a weak, slippery layer so that overlying rock or soil can move easily.

Figure 6–3The angle of repose depends on both the type of material and its water content. Dry sand forms low mounds, but if you moisten the sand, you can build steep, delicate towers with it.

Roots hold soil together and plants absorb water; therefore, a highly vegetated slope is more stable than asimilar bare one. Many forested slopes that were stablefor centuries slide when the trees were removed during logging, agriculture, or construction.

Vegetation is sparse because of summer drought and wildfires. When winter rains fall, bare hillsides often becomesaturated and slide. Mass wasting occurs for similar reasons during infrequent but intense storms indeserts.

5-Earthquakes and volcanoes

An earthquake may cause mass wasting by shaking an unstable slope, causing it to slide. A volcanic eruptionmay melt snow and ice near the top of a volcano. Thewater then soaks into the slope to release a landslide.

TYPES OF MASS WASTING

Mass wasting can occur slowly or rapidly. In some cases, rocks fall freely down the face of a steep mountain. In other instances, rock or soil creeps downslope so slowlythat the movement may be unnoticed by a casual observer.

1-FLOW

Types of flow include **creep**, **debris flow**, **earthflow**, **mudflow**, and **solifluction**.

Creep

As the name implies, creep is the slow, downhill movement of rock or soil under the influence of gravity. Individual particles move independently of one another, and the slope does not move as a consolidated mass. A creeping slope typically moves at a rate of about 1 centimeterper year, although wet soil can creep morerapidly. During creep, the shallow soil layers move more rapidly than deeper material (Fig. 6–4). As a result, anything with roots or a foundation tilts downhill. Over theyears, soil creep has tipped the older monuments, but thenewer ones have not yet had time to tilt.Trees have a natural tendency to grow straight upward. As a result, when soil creep tilts a growing tree, the tree develops a J-shaped curve in its trunk called pistolbutt (Fig. 6-4a). If you ever contemplate buying hillsideland for a home site, examine the trees. If they have pistol-butt bases, the slope is probably creeping, and creeping soil may tear a building apart.

Creep interpretation

Creep can also result from freeze–thaw cycles in the spring and fall in temperate regions. Recall that waterexpands when it freezes. When damp soil freezes, expansion pushes it outward at a right angle to the slope. However, when the Sun melts the frost, the particles fall vertically downward, as shown in Figure 6-4. This movement creates a net downslope displacement. The displacement in a single cycle is small, but the soil may freeze and thaw once a day for a few months, leading toa total movement of a centimeter or more every year.

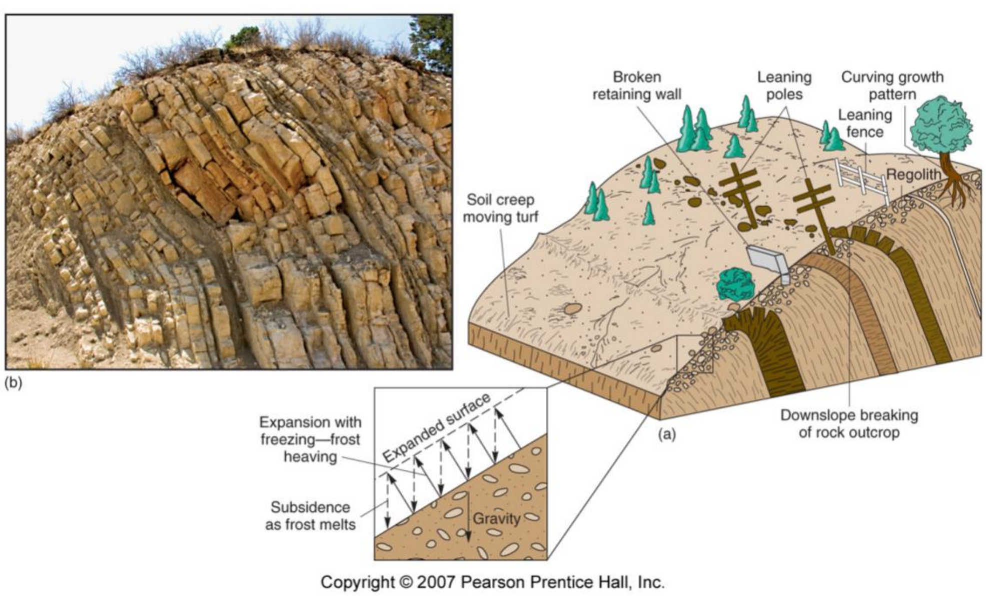


Figure 6–4, sketch of inclination of many objects like trees, poles, fences, retaining walls and layers due to creep, in lower part the interpretation of creep. b, Photo shows bending of layers.

Debris Flows, Mudflows, and Earthflows

Different types of flows are characterized by the**sizes** of the solid particles. A **debris flow** consists of amixture of **clay**, **silt**, **sand**, and **rock fragments** in whichmore than **half** of the particles are larger than sand(Fig. 6–5). Incontrast, mudflows and earthflows are predominantly sand and mud. Some **mudflows** have the consistency ofwet concrete, and others are more fluid. Because of itshigh water content, a mudflow may race down a streamchannel at speeds up to 100 kilometers per hour. An **earthflow** contains less water than a mudflow and istherefore less fluid (Figure 6–6).

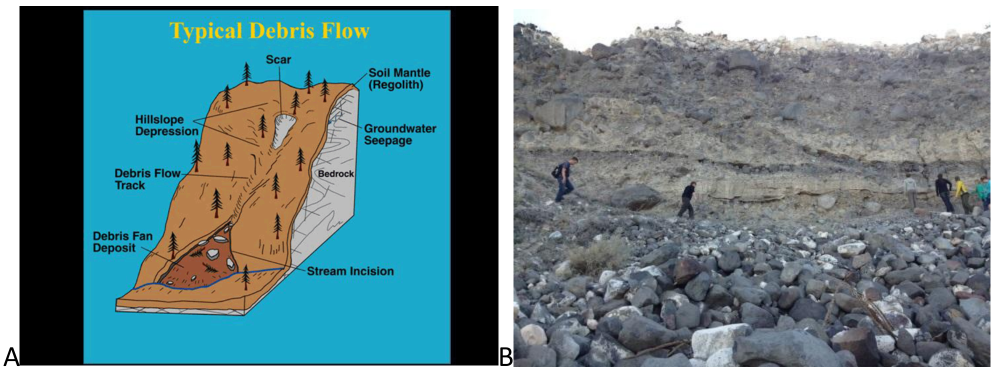


Figure 6–5,A shows skech of debris flow, B shows an areaaffected by debris flow.

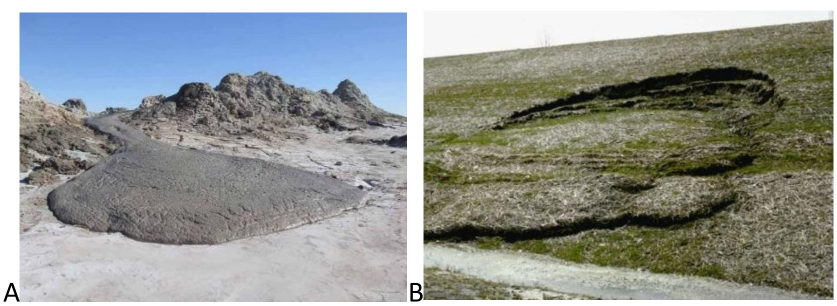
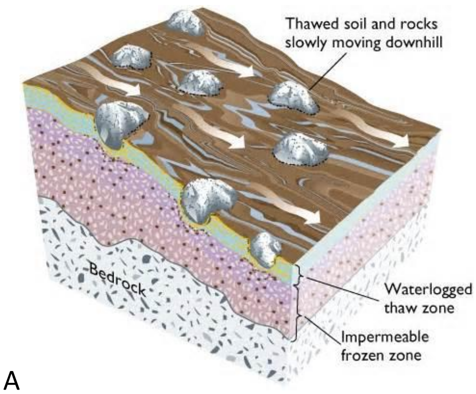


Figure 6–6, shows photo of A, mudflow, B, Earthflow.

Solifluction is a type of mass wasting that occurs when water-saturated soil flows downslope. It is most common in permafrost regions, where the permanent icelayer causes overlying soil to become waterlogged, althoughit can also occur in the absence of permafrost (Fig. 6–7). Solifluction can occur on a very gentleslope, and the soil typically flows at a rate of 0.5 to 5centimeters per year.



A

B

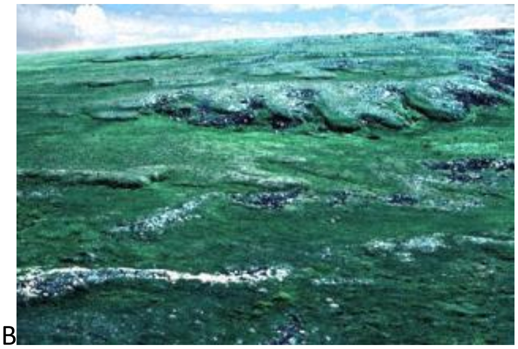
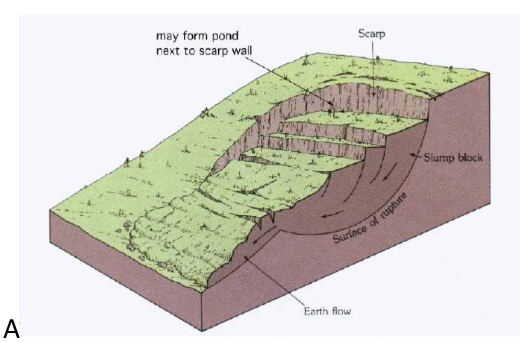


Figure 6–7, shows, A skech of solifluction, B , photo of solifluction.

1- SLIDE

In some cases, a large block of rock or soil, or sometimes an entire mountain side, breaks away and slides down slope as a coherent mass or as a few intact blocks. Two types of slides occur: **slump** and **rockslide**.

A **slump** occurs when blocks of material slide downhill over a gently curved fracture in rock or regolith (Fig.6-8). Trees remain rooted in the moving blocks.However, because the blocks rotate on the concave fracture, trees on the slumping blocks are tilted **backward**.Thus, you can distinguish slump from creep because slump tilts trees **uphill**, whereas creep tilts them **downhill**. At the lower end of a large slump, the blocksoften pile up to form a broken, jumbled, hummocky topography. It is useful to identify slump because it often recursin the same place or on nearby slopes. Thus, a slope that shows evidence of past slump is not a good place to builda house.

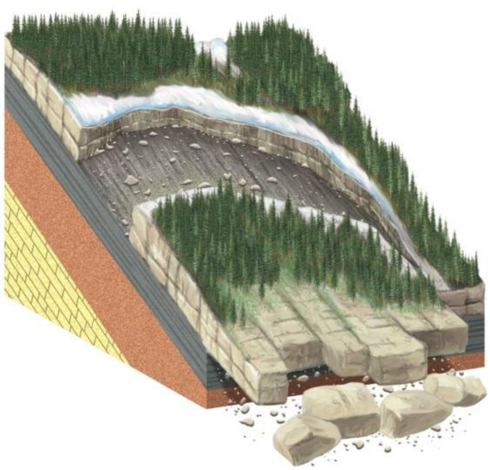


A

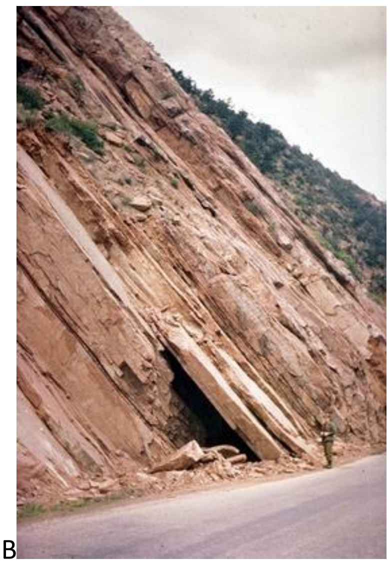
B

Figure 6–8,shows skech of slump, B, photo of sluped area.

During a **rockslide**, or **rock avalanche**, bedrock slides downslope over a fracture plane. Characteristically, the rock breaks up as it moves and a turbulent mass ofrubble tumbles down the hillside (Fig 6-9). In a large **avalanche**, the falling debris traps and compresses air beneath andwithin the tumbling blocks. The compressed air reduces friction and allows some avalanches to attain speeds of 500 kilometers per hour. The same mechanism allows asnow or ice avalanche to cover a great distance at a highspeed(Fig 6-10).



A



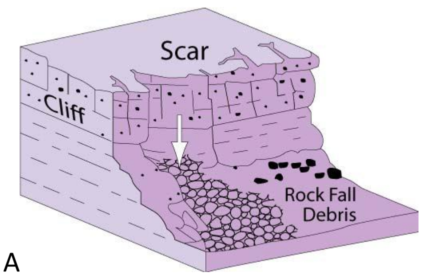
B

Fig 6-9, shows sketch of rock slide, B, photo of rockslide.

Fig 6-10, shows photo of rock avalanche.

FALL

If a rock dislodges from a steep cliff, it falls rapidly under the influence of gravity. Several processes commonly detach rocks from cliffs, that when water freezes and thaws, the alternate expansion and contraction can dislodgerocks from cliffs and the growth of roots trees and cause rockfall. Rockfall also occurs when a cliff is undercut. For example, if ocean waves ora stream undercuts a cliff, rock above the waterline maytumble (Fig. 6–11).

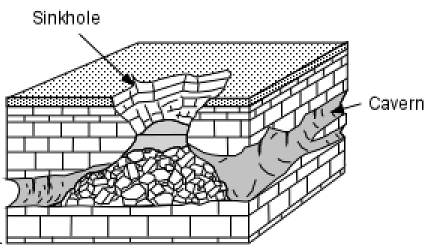


A

B

Fig 6-11, shows sketch of rockfall, B, photo of rockfalls.

Subsidence or sinkhole, is a depression or hole in the ground caused by some form of collapse of the surface layer**,** frequently causes major problems in karst terrains, where dissolution of limestone by fluid flow in the subsurface causes the creation of voids (i.e. caves). If the roof of these voids becomes too weak, it can collapse and the overlying rock and earth will fall into the space, causing subsidence at the surface. This type of subsidence can result in sinkholes which can be many hundreds of meters deep(Fig. 6–12).



A

B

Fig. 6–12, A. shows sketch of sinkhole, B shows photo of sinkholein Guatemala.