Indian Institute of Technology, Kanpur
Department of Earth Sciences

ESO213A: Fundamentals of Earth Sciences

Lecture 39. Weathering & Erosion - II

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IITK Experimental Rock Deformation Laboratory

Aims of this lecture

Soil formation and characteristics

Erosion and mass Movement

Readings:
Grotinger & Jordan's Book: Chapter 16

SOIL

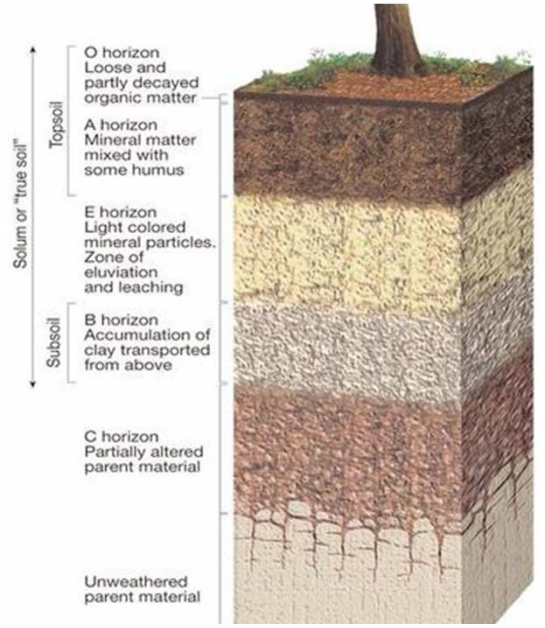
What is Soil?

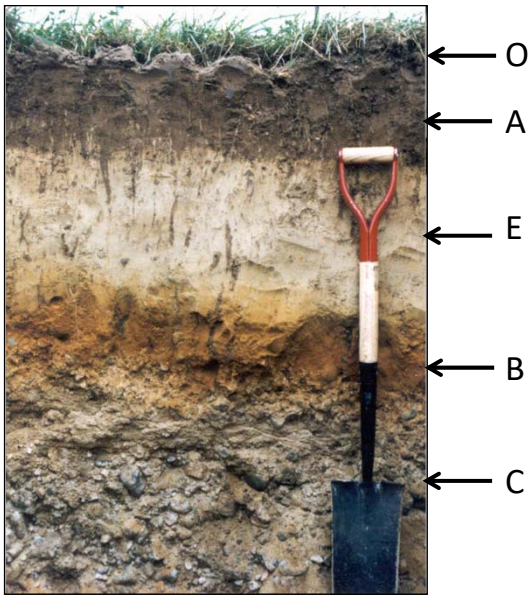
Weathering is a key part of the process of soil formation.

Soil is a complex mixture of minerals (~45%), organic matter (~5%), and empty space (~50%, filled to varying degrees with air and water). The mineral content of soil varies, but is dominated by clay minerals and quartz, along with minor amounts of feldspar and small fragments of rock.

The types of weathering that take place within a region have a major influence on soil composition and texture.

Soil Profile





Soil Profile

Fresh Vegetation

Dead Leaf-Litter (L)

Fermenting Litter (F)

Humus (H)

Eluvial Horizon (E)

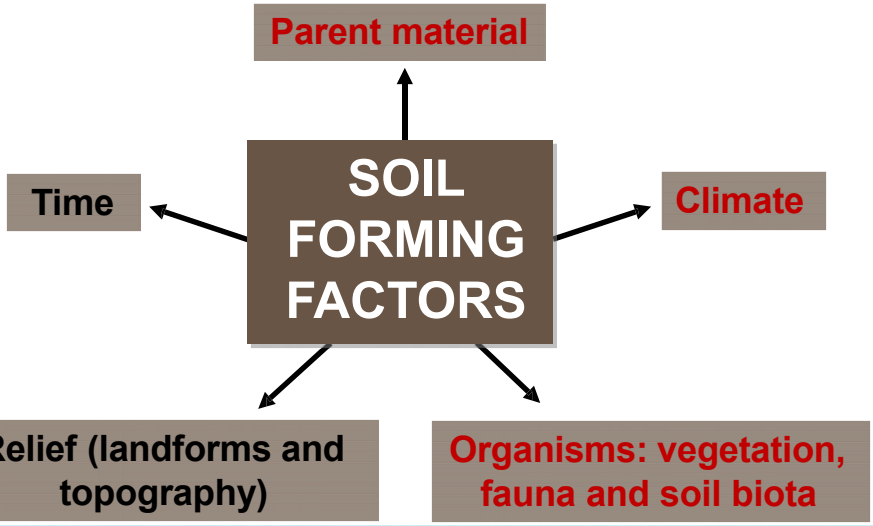
The A horizon is further sub-divided into four horizons:

- (L) leaf litter
- (F) fermenting leaf litter
- (H) humus
- (E) eluvial

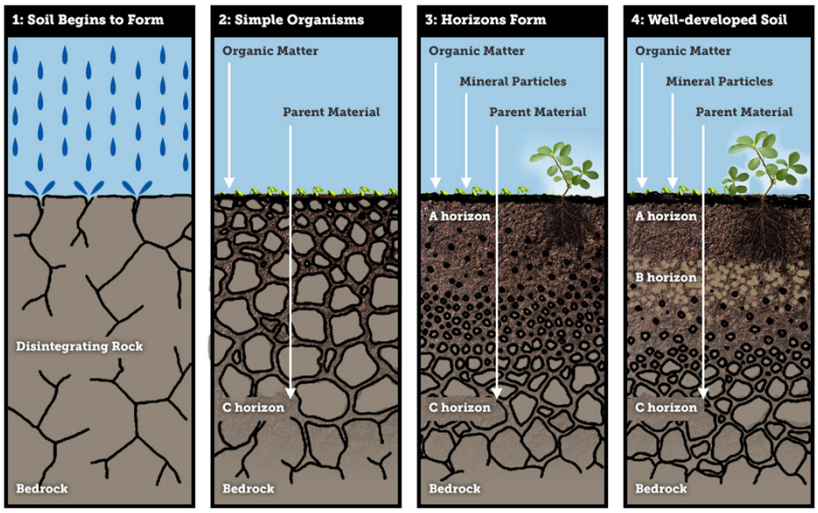
These lie above the B horizon.

Formation of Soil

Soils develop as a result of the interplay of 5 factors; Parent material, climate, organisms, relief and time.



Formation of Soil



TOPSOIL, upper or A horizon

SUBSOIL, middle or B horizon

PARENT MATERIAL, lower or C horizon

Parent Materials

This is the material from which the soil develops and can vary from solid rock to deposits like alluvium and boulder clay.

The parent material can influence the soil in a number of ways:

- colour
- texture
- structure
- mineral composition
- permeability/drainage

This soil has developed on Old Red Sandstone and so has derived its distinctive colour from its parent material.

Climate

Contrasting soils can be produced from the same parent material under different climates.

Climate has two major components: moisture (precipitation) and temperature,

Soil forms most readily under temperate to tropical conditions, and moderate precipitation.

When precipitation exceeds evaporation, leaching of the soil will occur.

Temperature determines the rate of reactions; chemical and biological decay and so has an influence on weathering and humification.

Organic Matter

Organisms influencing soil development range form microscopic bacteria to large animals including human. Micro organisms such as bacteria and fungi assist in the decomposition of plant litter. This litter is mixed into the soil by macro organisms (soil animals) such as worms and beetles.

Soil horizons are less distinct when there is much soil organism activity.

Higher plants influence the soil in many ways. The nature of the soil humus is determined by the vegetation cover and resultant litter inputs. Roots contribute dead roots to the soil, bind soil particles together and can redistribute and compress soil.

Organic Matter

Rate of degradation, $\frac{dC}{dt} = A - rC$

A – annual addition of organic matter
C – amount of organic matter already in soil
r – decomposition constant

r – direct measure of CO_2 production in soil; important to determine the rate of chemical weathering

If soil is in equilibrium, $\frac{dC}{dt} = 0$; and $A = rC_e$

where C_e is the equilibrium concentration of carbon

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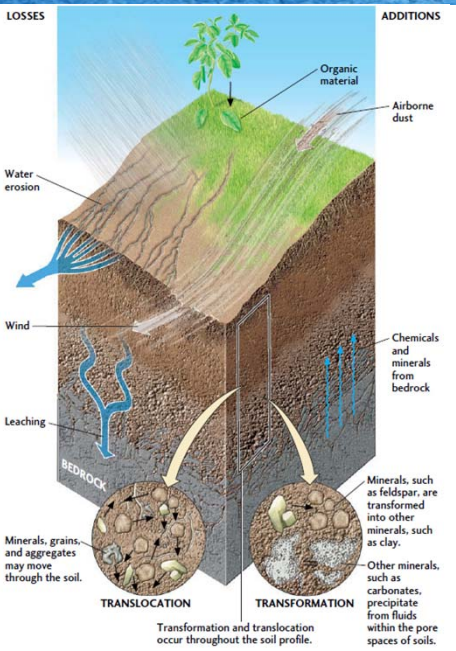


As soil ages and matures, the materials added to or removed from it cause it to undergo a set of *transformations*. (Addition of humus; chemical and mechanical weathering etc.)

Translocations are lateral and vertical movements of materials within the developing soil. Water is the main agent of translocation, usually transporting dissolved salts and other minerals and nutrients (Leaching).

See Table 16-3 of the text book for different soil types (page 448)

Erosion & Mass Movement

Erosion

Erosion is defined as removal of rocks and soil by wind, water, ice and gravity.

Wind*, water*, ice* and gravity are also known as the agents of erosion.

Remember: Weathering breaks-down rocks and Erosion transports the fragments (sediments)

*we already learnt

Gravity induced Erosion: Mass Movement

Gravity Erosion is better known as Mass Movement and is defined as the transfer of rock and soil down slope by direct action of gravity without a flowing medium (such as water or ice).

Some of the best examples of Mass Movement are:

Creep; Rock fall; Slump; Landslides; Avalanches

When the right combination of materials, moisture, and steepness makes a slope unstable, a mass movement is inevitable. All that is needed is a trigger.

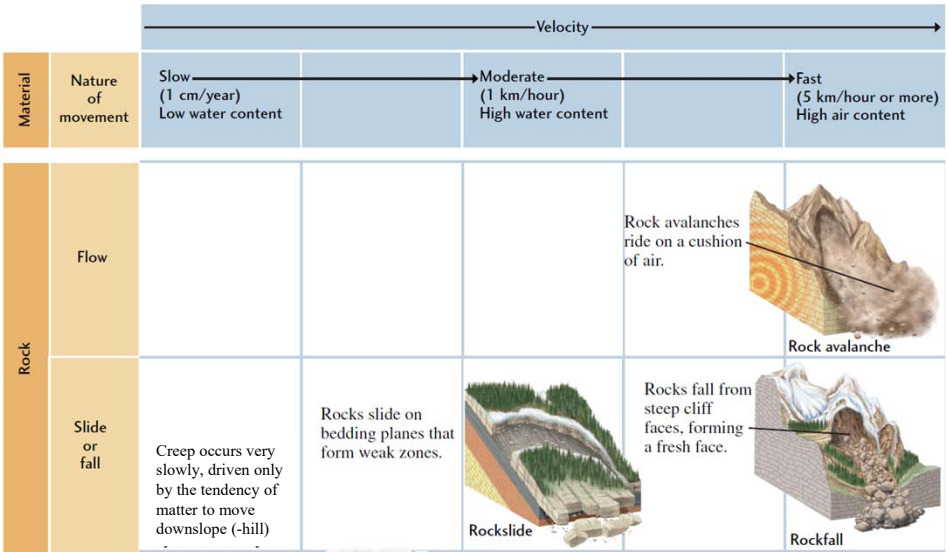
Mass Movement: Classification

The nature of the moving material (for example, whether it is rock or unconsolidated material)

The velocity of the movement (from a few centimeters per year to many kilometers per hour)

The nature of the movement: whether it is sliding (the bulk of the material moves more or less as a unit) or flowing (the material moves as if it were a fluid)

Mass Movement: Classification



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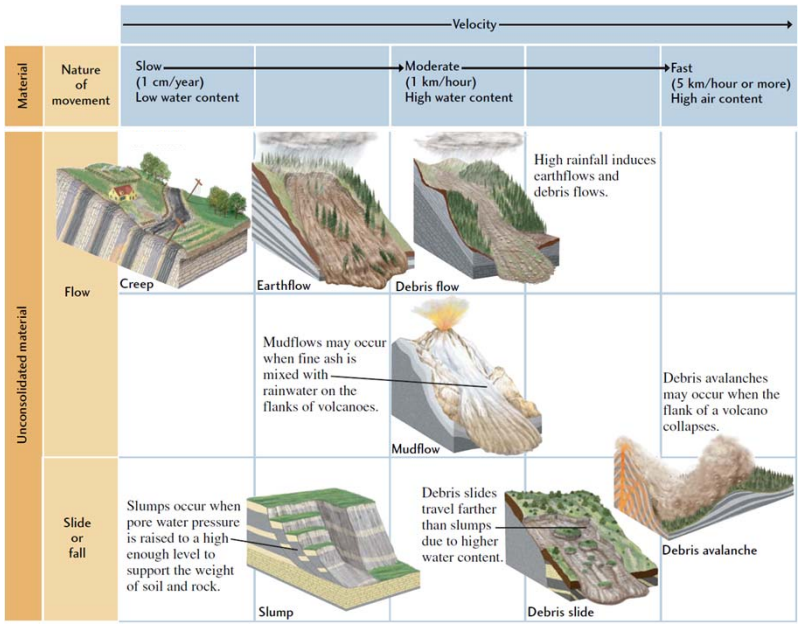

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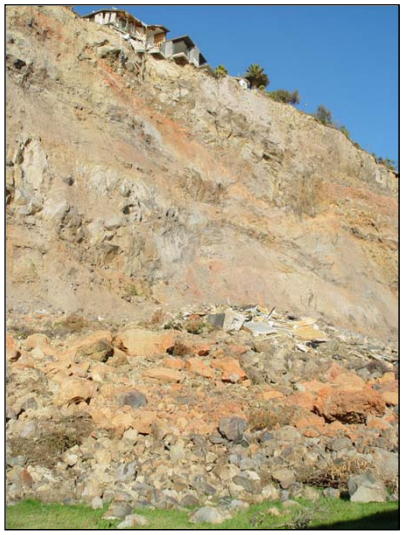
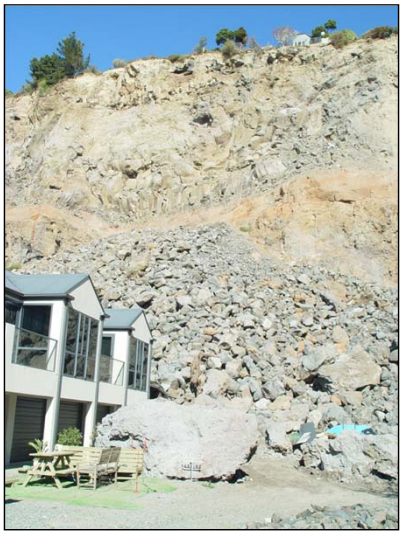

Mass Movement: Classification


Next Lecture

Resources of the Earth