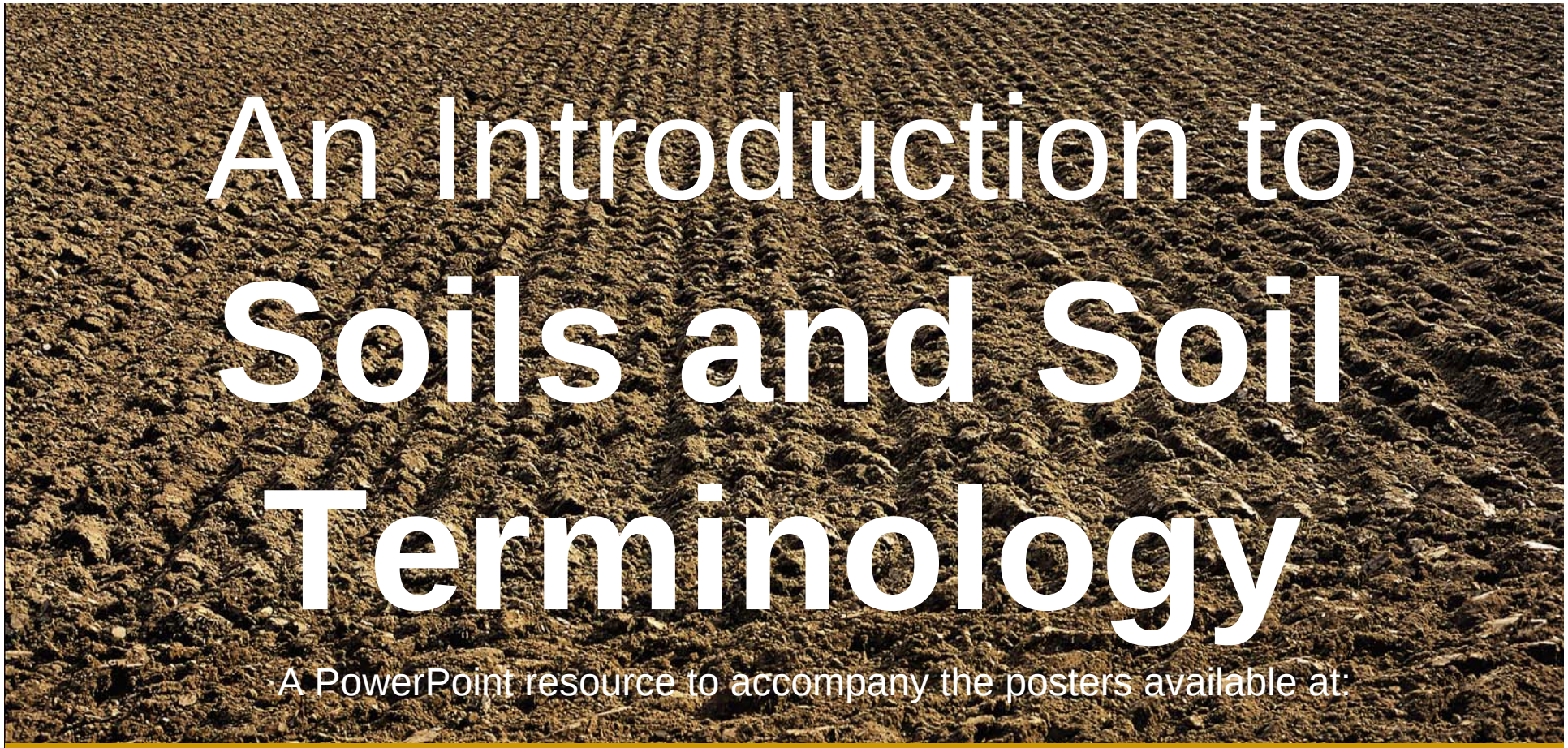


An Introduction to Soils and Soil Terminology

A PowerPoint resource to accompany the posters available at:

http://www.macaulay.ac.uk/soilposters/1.pdf
http://www.macaulay.ac.uk/soilposters/5.pdf

THE MACAULAY INSTITUTE

Learning +Teaching Scotland

Soil: some definitions

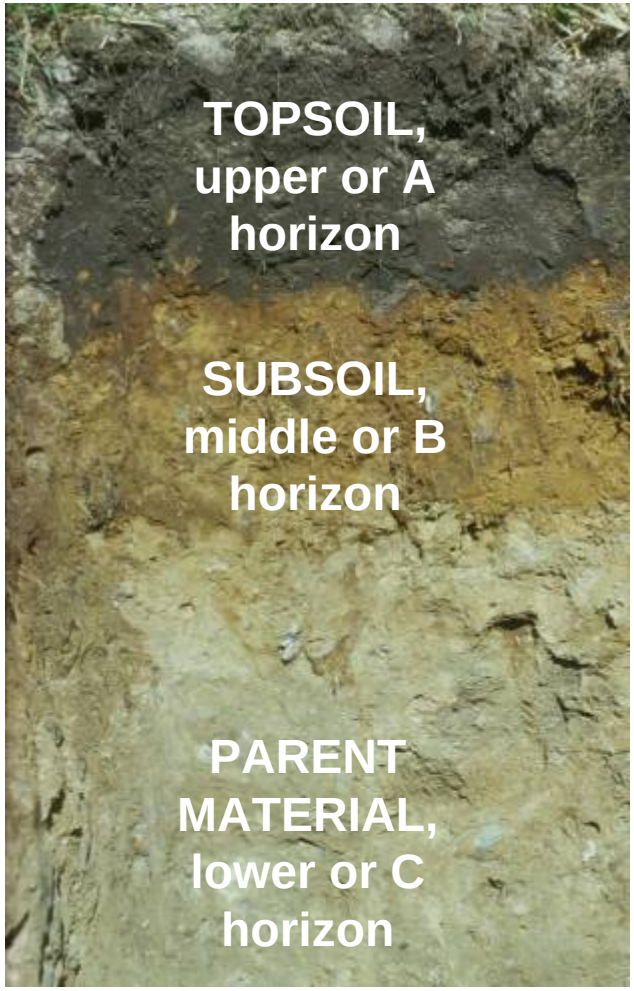
Soil can be defined as the solid material on the Earth's surface that results from the interaction of weathering and biological activity on the parent material or underlying hard rock.

The study of soils as naturally occurring phenomena is called pedology (from the Greek word *pedon*, meaning soil or earth).

Pedology takes into account:

- factors and processes of soil formation
- soil characteristics
- distribution of soil types

The basic unit of study: Soil Profiles



This diagram shows simplified soil horizons

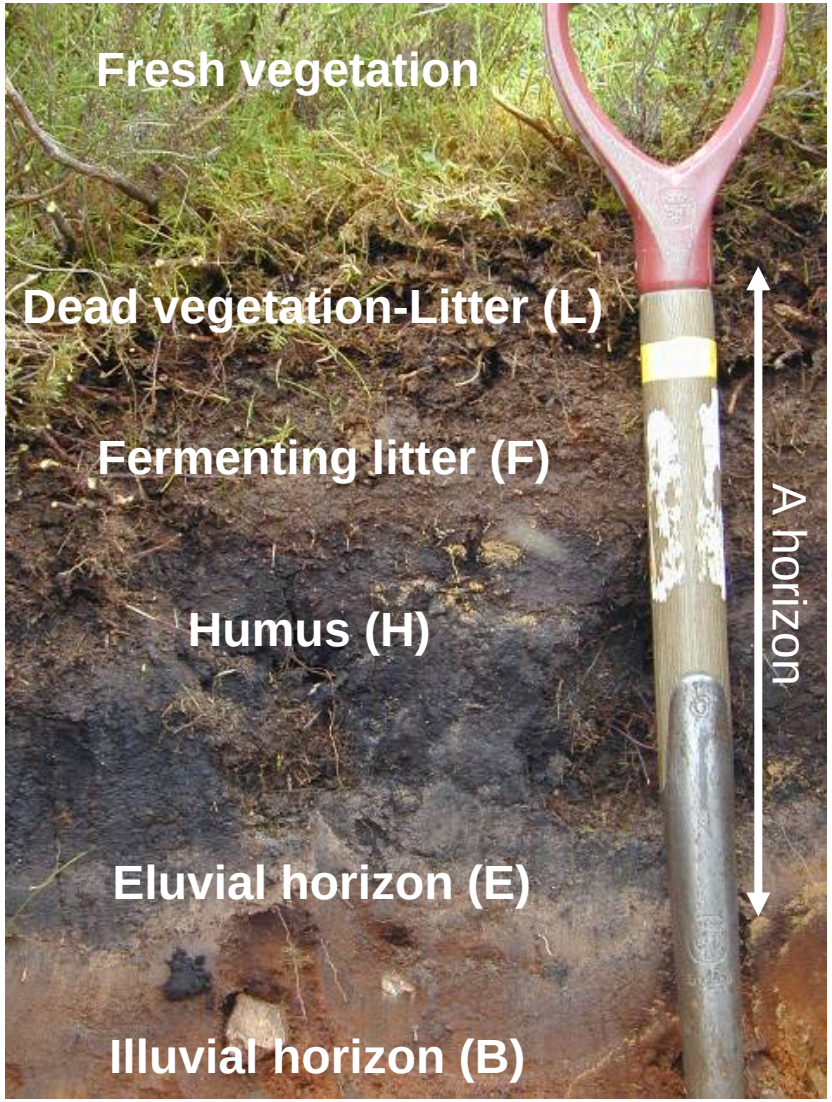
A soil profile is a vertical cross-section of a soil. It is divided into a number of distinct layers, referred to as horizons.

The horizons are normally designated by symbols and letters.

The presence or absence of particular horizons allows pedologists (soil scientists) to classify the soil.

In addition, the organic or O horizon can form above the mineral soil- commonly in forested areas, resulting from the dead plant and animal remains.

Soil Horizons



The horizons may be further subdivided.

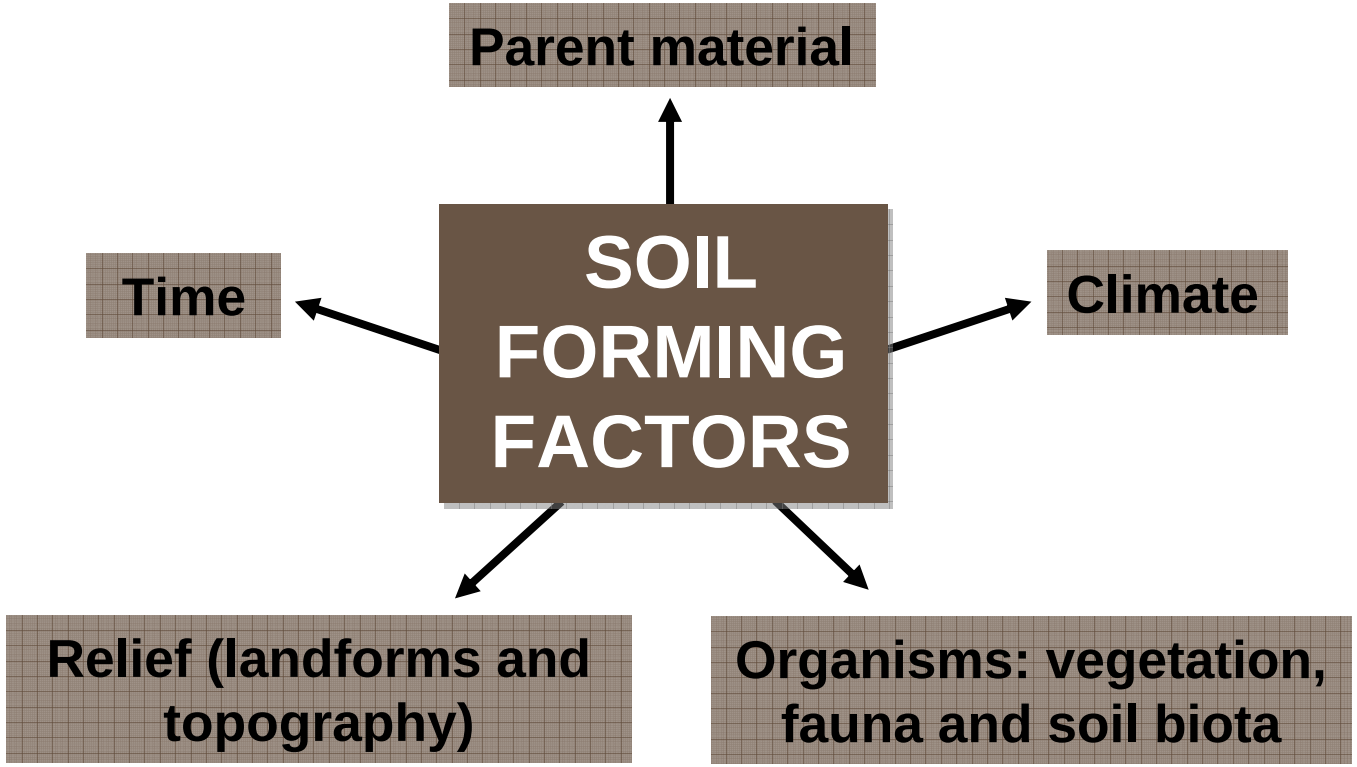
For example, in this soil profile the A horizon has been divided into 4 further pedological horizons:

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

These lie above the (B) or illuvial horizon.

Soil Forming Factors

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



Click over factors for further explanation. Use back button to return to this slide

Advance to slides on soil processes by clicking here

Parent Material

This is the material from which the soil has developed and can vary from solid rock to deposits like alluvium and boulder clay. It has been defined as ‘the initial state of the soil system’.

Jenny H (1941) Factors of soil formation. McGraw-Hill Book Co Inc pp281.

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.

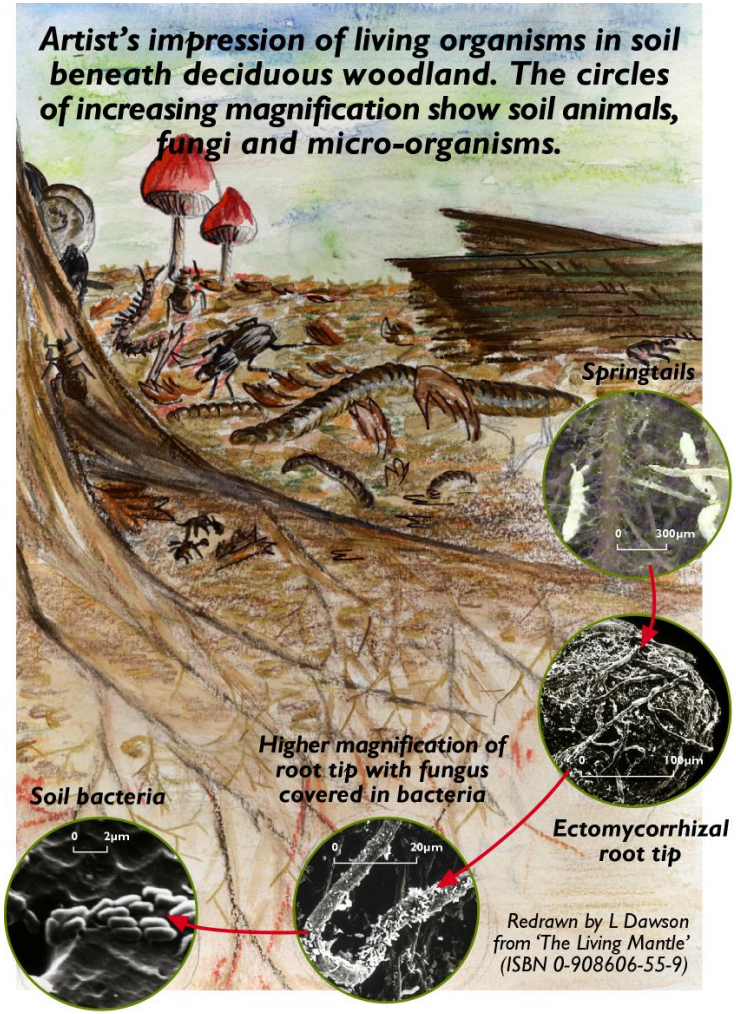
Climate

This is probably the most important factor (soils produced from the same parent material under different climates contrast). Climate governs the rate and type of soil formation and is also the main determinant of vegetation distribution.

Soil climate has two major components; moisture (precipitation) and temperature, influencing evaporation. 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.

Organisms : vegetation, fauna and soil microbes



Organisms influencing soil development range form microscopic bacteria to large animals including man. 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.

Relief (landforms and topography)

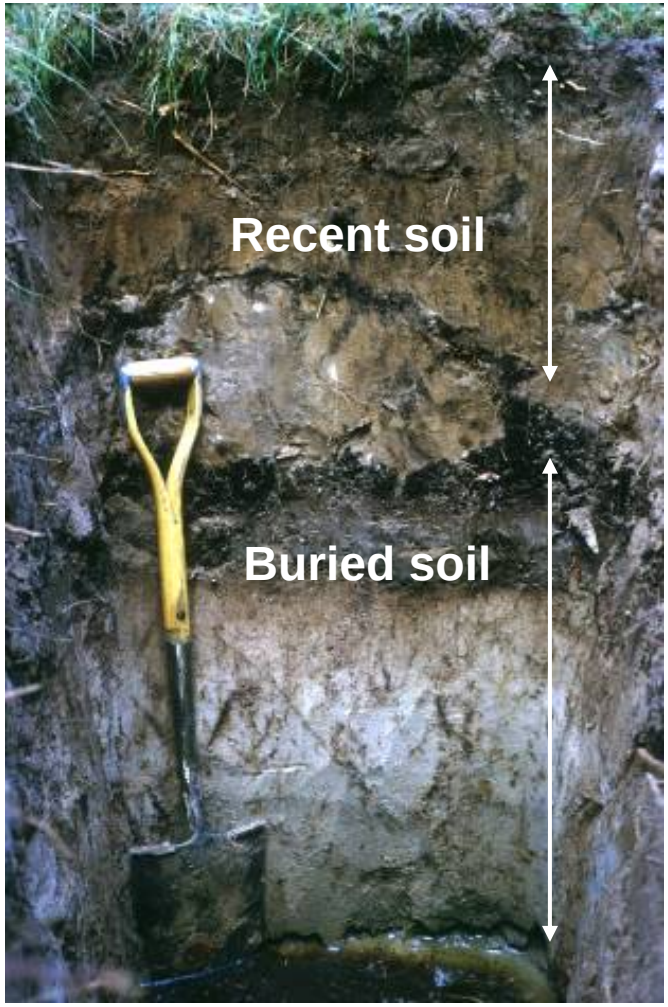
Relief is not static; it is a dynamic system (its study is called geomorphology).

Relief influences soil formation in several ways:

- It influences soil profile thickness i.e. as angle of slope increases so does the erosion hazard
- it has an effect on climate which is also a soil forming factor
- gradient affects run-off, percolation and mass movement
- it influences aspect which creates microclimatic conditions

In this photograph soils are thin on the glacially eroded rock outcrops but are much deeper on the raised beach deposits in the foreground.

Time



This soil profile shows a recent soil in Culbin Forest which has formed on sand overlying an ancient buried profile

Soils develop very slowly. In Britain it takes about 400 years for 10mm of soil to develop.

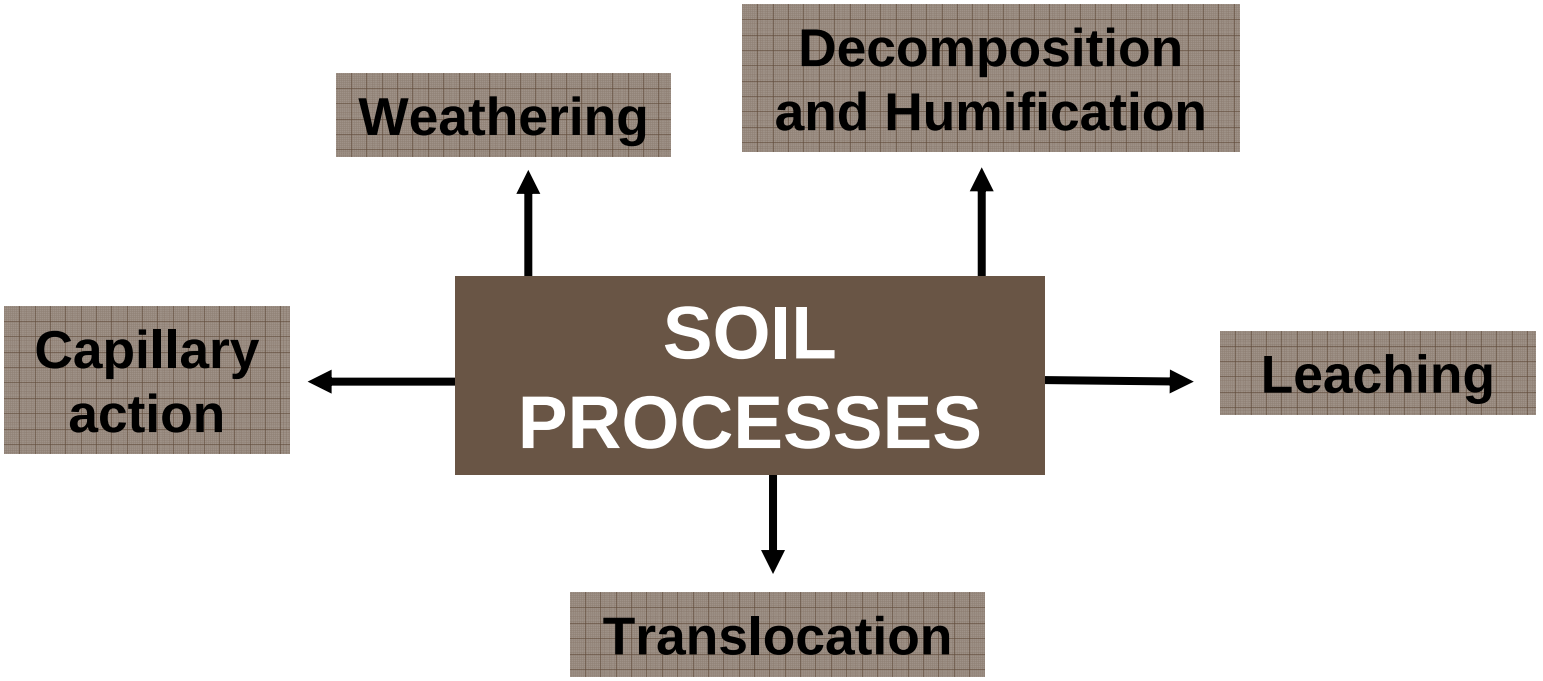
Young soils retain many of the characteristics of the parent material. Over time they acquire other features resulting from the addition of organic matter and the activity of organisms.

The soils of Britain are relatively young because they are largely post-glacial.

An important feature of soils is that they pass through a number of stages as they develop, resulting in a deep profile with many well differentiated horizons.

Soil Forming Factors

Soils are complex and dynamic systems, in which many processes are taking place.



Click over factors for further explanation. Use back button to return to this slide

Advance to slides on other soil features by clicking here

You can go from this slide to the revision materials by using this button

Weathering

This refers to the breakdown and decomposition of rocks and minerals by factors including air, water, sun and frost.

Physical weathering involves continual breakdown or rocks into smaller and smaller particles.

Chemical weathering involves alteration of the chemical composition of rock minerals.

Decomposition and Humification

Decomposition is the breakdown of plant derived material into its simpler organic constituents. This is accomplished by enzymes, earthworms, mites and other organisms.

Humification is the breakdown of plant remains- leading to the formation of different types of humus. It is probably the most important biological process taking place in soils.

MULL humus develops under deciduous woodland, where base-rich plant remains are actively broken down by a prolific soil biota.

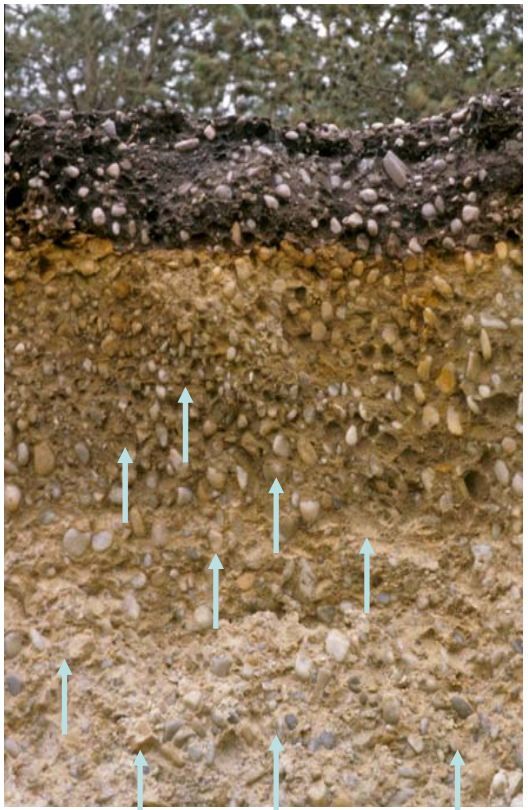
MODER humus is intermediate between mor and mull.

MOR humus usually develops beneath coniferous woodland or heather moorland, under cool, wet climatic conditions. Breakdown is slow due to the absence of soil biota.

Capillary action

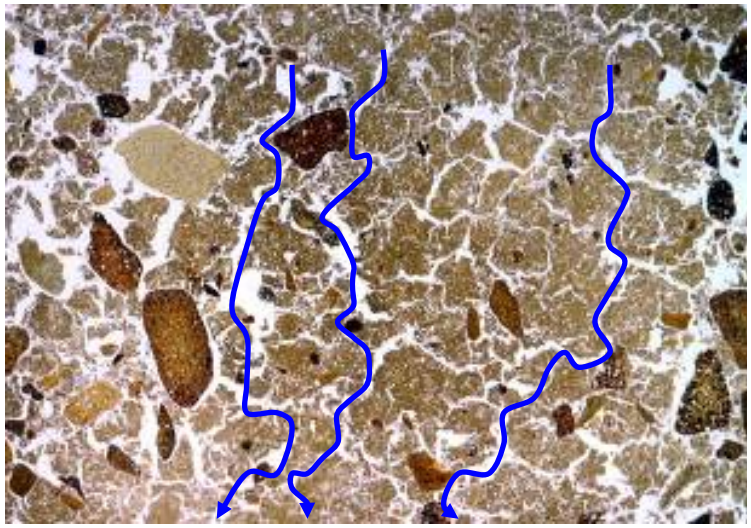
Where evaporation exceeds precipitation, moisture moves upwards within the soil profile by capillary action. It is therefore in the reverse direction to leaching.

In Britain precipitation generally exceeds evaporation. As a result capillary action in British soils rarely occurs, apart from in very sandy soils.



Leaching

Wherever rainfall exceeds evaporation and there is free downward movement of water through the soil pore system, soluble minerals are leached or removed from the soil profile.



A soil with small soil peds or crumbs and high porosity leading to free drainage and active leaching

Continual leaching tends to impoverish the upper mineral horizons by removal of basic cations (cations are ions having a a positive electrical charge e.g. Ca^{2+}).

Leaching is most active in sandy soils with high porosity and is least in fine-textured soils such as clays which have restricted pore spaces.

Translocation

The movement of material in solution or suspension from one horizon to another is referred to as translocation.

The upper mineral horizon losing the material is the ELUVIAL or E horizon. This is where maximum leaching or eluviation takes place. The E horizon near the surface of a podzol is a good example of an eluvial horizon.

The lower horizon gaining the material is the ILLUVIAL horizon (often a subsoil or B horizon). This is the zone of maximum accumulation.

Soil colour

Generally soil colour is determined by the amount of organic matter and the state of the iron. Soil colour is also related to soil drainage, with free draining, well AERATED soils (with pore space dominated by oxygen) having rich brown colours.

In contrast, poorly draining soils, often referred to as gleys, develop under ANAEROBIC conditions (the pore space dominated by water) and have grey or blue-grey colours.

Soils with periodic waterlogging are imperfectly drained and are often highly mottled with blotches of contrasting colour. MOTTLES are often rusty in colour and are due to iron concentration.

Such colours are the result of oxidation-reduction; iron is the main substance affected by these processes. If the iron is released in an anaerobic environment, then it stays in the reduced state giving it the grey blue colour of waterlogged soils.

Soil texture

Soil texture is a term used to describe the distribution of the different sizes of mineral particles in a soil.

Soil high in silt and clay with compact subsoil lacking in pore spaces

Textures range from clay, sand, and silt at the extremes, to a loam which has all three sized fractions present. The main influence of texture is on permeability which generally decreases with decreasing particle size.

Soil clod on right (above) is dense with a poor texture and leads to a poor structure if badly managed. Due to continual compaction it is blue-grey in colour due to low oxygen conditions. It is a poor environment for root development. Soil clod on left has been well managed and is relatively loose with ample pore space for good, healthy root development.

“A Question of Soil Formation”

The nine number question board which follows is adapted from a template made available by :

www.sln.org.uk/geography

Click on a number to link to a question

Click the back button to link back to the question board

“A Question of Soil Formation”

Use ‘end show’ command to exit presentation

1

What factors might contribute to the visible differences between these two soils?

2

What type of humus is most likely to develop in this environment?

3

How do soil biota such as the earthworm above assist in the formation of soils?

4

What indicates that the lower part of this soil is poorly drained and lacks aeration?

5

What process is producing this layer in this soil?

6

What is a vertical cross section through a soil called?

What name is given to the layers in a soil cross section?

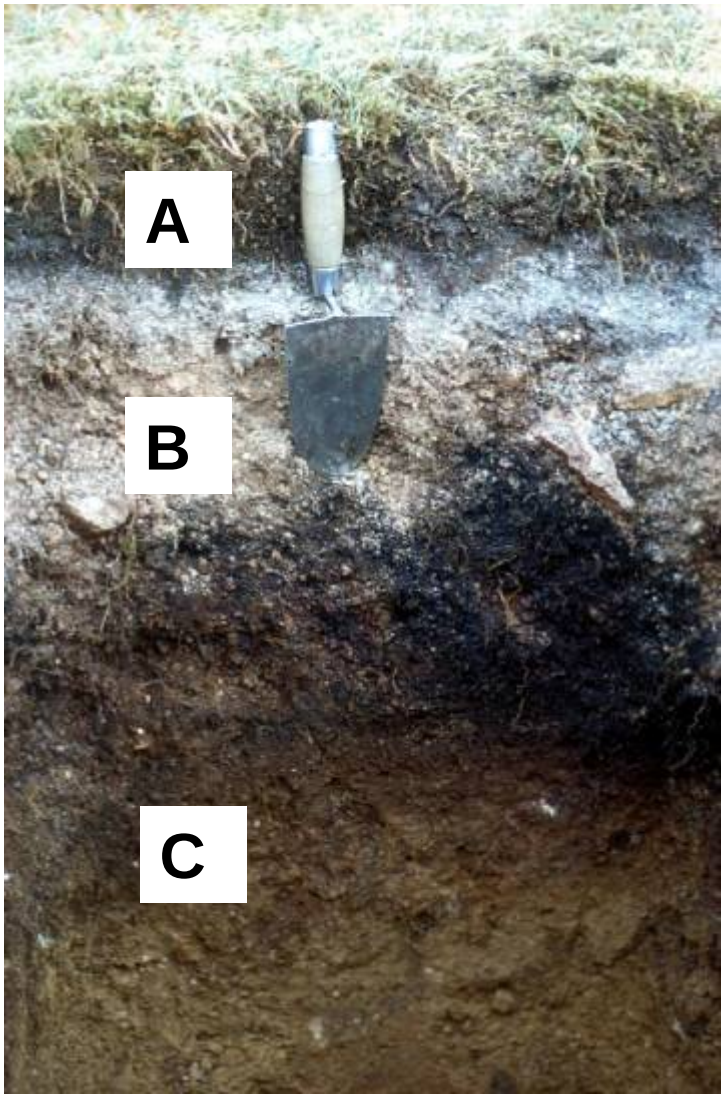
7

Explain how the relief shown in this photograph may affect soil formation.

8

Why is leaching of the soil likely to be occurring in this part of north west Scotland?

9



Which layer in this soil is eluviated?

Which layer in this soil is illuviated?