Soil – Soil Formation

Where does soil come from?

- All soil comes from rocks weathering and breaking down into tiny particles
- Weathering: the breaking down of parent material (rock).
- There are 3 types of weathering:
  - Physical,
  - Chemical
  - Biological

Physical Weathering

- **E.g. Freeze Thaw Action**
- Rocks absorb the heat of the sun during the day and expand
- At night, the rocks cool and contract
- This constant expansion and contraction causes cracks to appear in the rock

Physical Weathering

- Rain water collects in these small cracks over night.
- The water freezes and expands and cools and contracts which causes the rock to shatter
- The fragments of the rock are now known as Solum

Chemical Weathering

- **E.g. Acid rain**
- Carbon Dioxide is released from the burning of fossil fuels.
- It mixes with the rain in the rain clouds to from a very weak acid called Carbonic Acid.

$$CO_2 + H_2O \rightarrow H_2CO_3 \text{ Carbonic acid}$$

Chemical Weathering

- Sulphur dioxide is also produced when fossil fuels are burned
- When Sulphur dioxide mixes with rain it produces a weak acid called Sulphuric Acid

$$SO_2 + H_2O \rightarrow H_2SO_4$$ Sulphuric acid

- These weak acids fall as acid rain

Chemical Weathering

- When acid rain falls onto rocks it dissolves the rock and erodes it over time.
- The Burren is a classic example of chemical weathering

Carbonation:

- In rocks with high levels of Calcium Carbonate e.g. Limestone Carbonation can occur
- Carbon dioxide combines with water to form a weak Carbonic Acid
- This acid seeps through the rock creating caves and sink holes.
- Limestone Pavement = clints and grikes in the Burren

Chemical Weathering

Chemical Weathering

Hydrolysis:

Minerals react with water to form hydroxides

Oxidation/Reduction:

Reactions that involve the addition (oxidation) or removal (reduction) of oxygen

Biological Weathering

- **E.g. Lichens**
- Lichens are very simple plants that grow on rocks
- They secrete an acidic liquid onto the rock which dissolves it over time
- When the lichens die they form a layer of humus on the rock

Biological Weathering

- Other plants like mosses start to grow on the rock and their roots grow through the rock breaking it up further

Lichens

Parent Rock

- Soil sits on top of rock. This rock is called the parent rock
- The parent rock will determine what type of soil will exist on top
- E.g. is the parent rock is acidic, the soil above will be acidic
- Granite parent rock is acidic whereas limestone parent rock is basic

Types of parent material

There are 3 types of parent material:

1. **Residual:**

- The parent rock doesn't move and weathers in it's environment.
- The soil forms on top of the rock

Types of parent rock

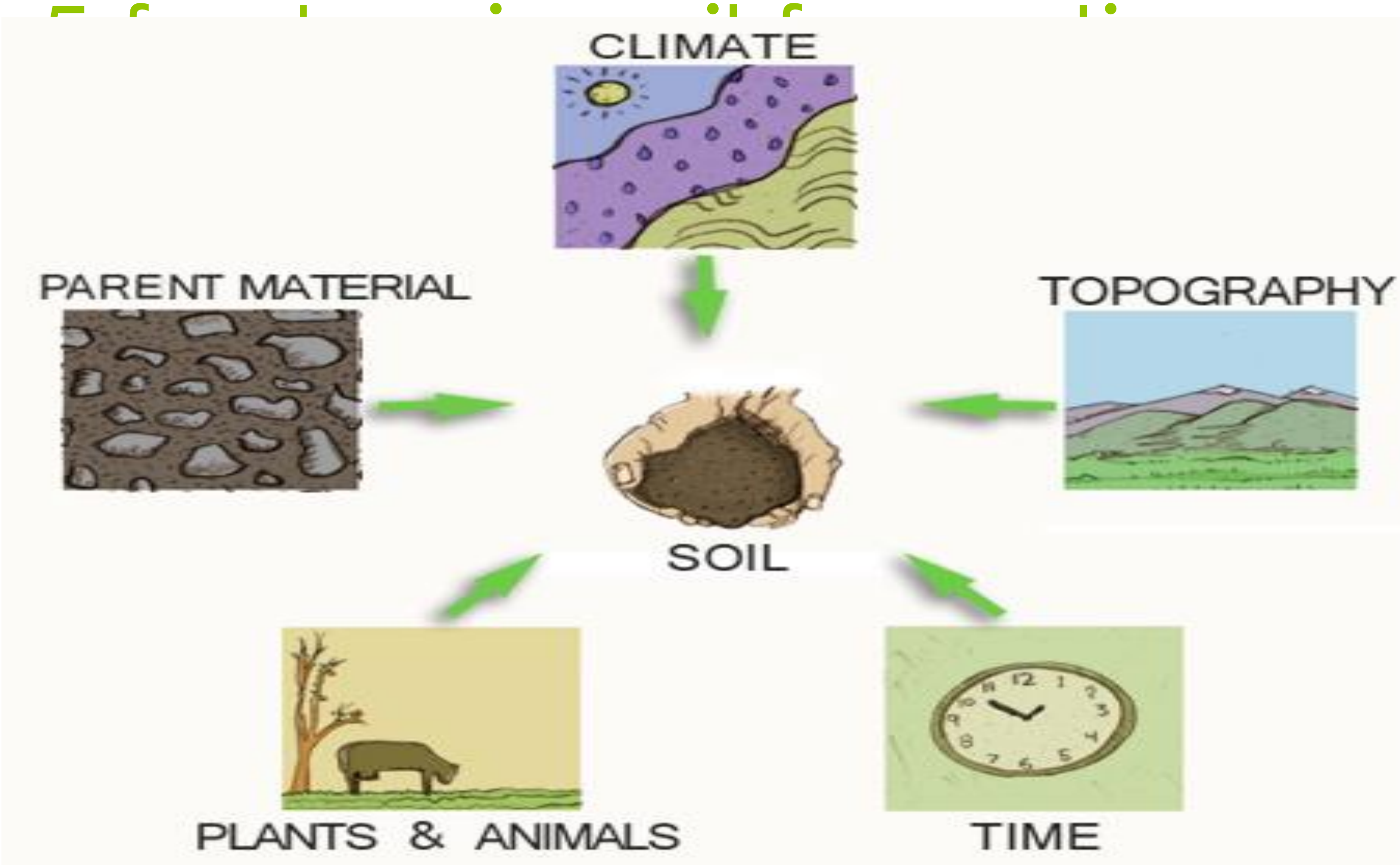
2. Transported:

- The parent rock and fragments of the rock has been transported from another location
- The Ice Age caused a lot of movement of parent rock in Ireland
- The parent rock weathers and a soil forms on top of it, called a derived soil

Types of parent rock

3. Cumulose:

- No parent rock here. Instead the remains of dead plants build up upon each other.
- This results in the formation of peat soils or bogs


CLIMATE
PARENT MATERIAL
TOPOGRAPHY
SOIL
PLANTS & ANIMALS
TIME

Irish soils are young soils

- In ideal conditions a soil can form in about 200 years, but it usually takes thousands of years
- Irish soils are regarded as young soils because they have been formed in the last 15,000 years
- Some soils can take up to 30,000 years to form

3 main types of Rock

The 3 main types of rock are:

- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

Igneous Rock

- The 3 minerals found in Igneous Rock are Mica, Feldspar and Quartz

Igneous Rock

- If the lava cooled quickly it formed the rock Basalt.
- Basalt is found on the Giant's Causeway in Co. Antrim

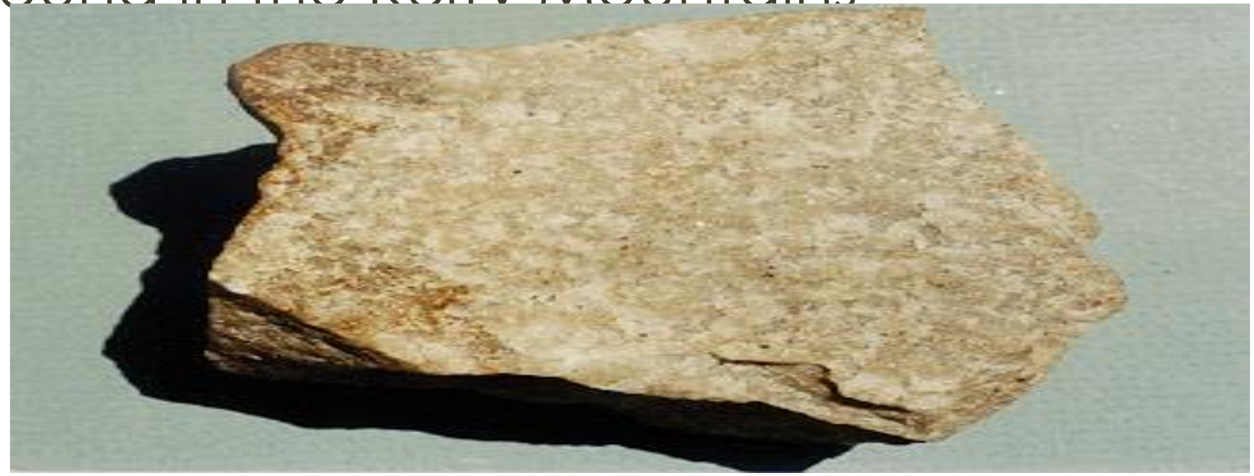
Igneous Rock

- If the lava cooled slowly it formed Granite
- Granite is found in the Dublin Mountains

Sedimentary Rock

Inorganic Sedimentary Rock:

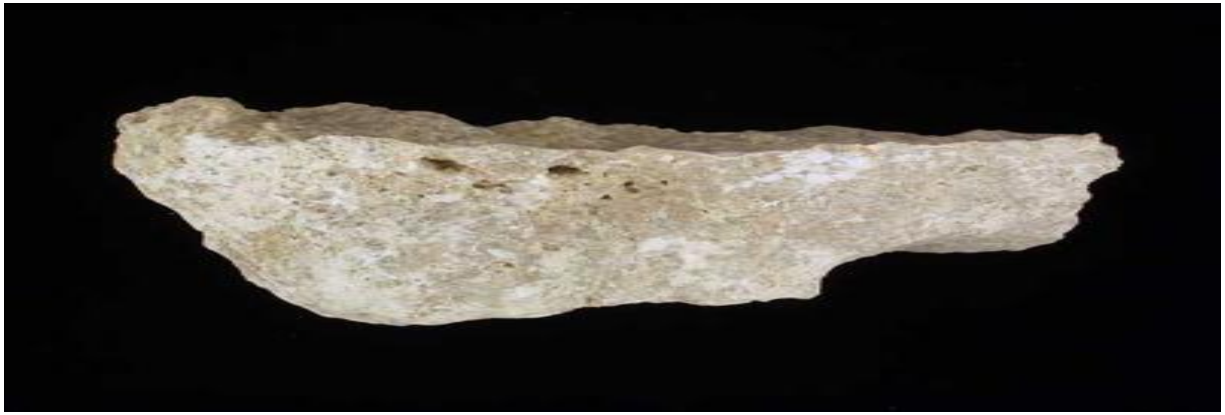
- Broken fragments of rock joining together to form a rock.
- Example is Sandstone
- Found in the Kerry Mountains



Sedimentary Rock

Organic Sedimentary Rock:

- Remains of dead plants and animals join together to form rocks
- Example is Limestone
- Found in the Burren, Co. Clare



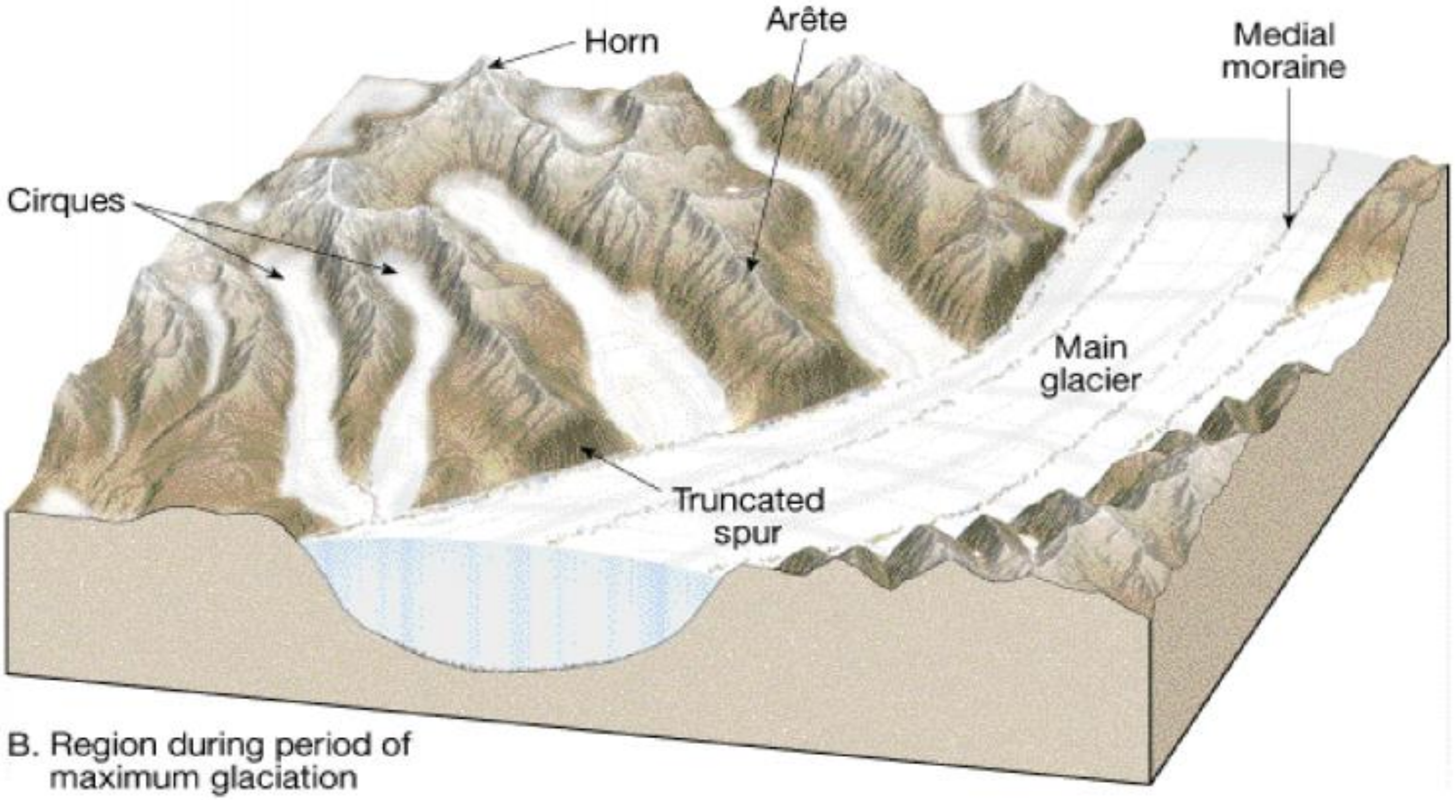
Metamorphic Rock

- Formed when sedimentary rocks are exposed to extreme pressure and heat.
- Examples:

Marble (changed from Limestone)

Glaciation

- Glaciation is when snow and ice accumulate in mountain river valleys and move slowly downwards due to gravity.
- When glaciers reach lowland areas, they join together and form larger glaciers.
- In turn these large glaciers join together to form giant ice sheets. These ice sheets can cover thousands of kms and are moving constantly.



B. Region during period of maximum glaciation

Glaciation

- When glaciers and ice sheets move they scrape all soil and loose rock from the surface.
- This material becomes mixed in the lower layers of the ice and are deposited as glacial drift, a good distance away from its original position.
- After glaciation this material serves as transported parent rock for soil formation.

Glaciation

- Glaciations have occurred in Ireland in the past and have contributed to Ireland’s climate and soil.
- North Europe is said to be in an inter-glacial period.

Peat Bogs

- There are 3 types of peats:

1. Blanket Bogs
2. Basin Bogs
3. Raised Bogs

Blanket Bogs

- Found in mountainous areas with high rainfall
- Form a blanket of peat over a wide area
- Shallow (1 - 2 meters deep at most).
- Peat not cultivated
- Soil wet, acidic and infertile

Blanket Bogs


Basin Bogs

- Occurs in land with a depression i.e. a hollow lake or river.
- Dead remain of plants accumulate at the bottom of the lake.
- The build up of the dead vegetation causes the lake to close over and become land.
- Occurs in water logged and flooded conditions.
- Drier and of more agricultural use than blanket bogs

Basin Bogs

Raised Bogs

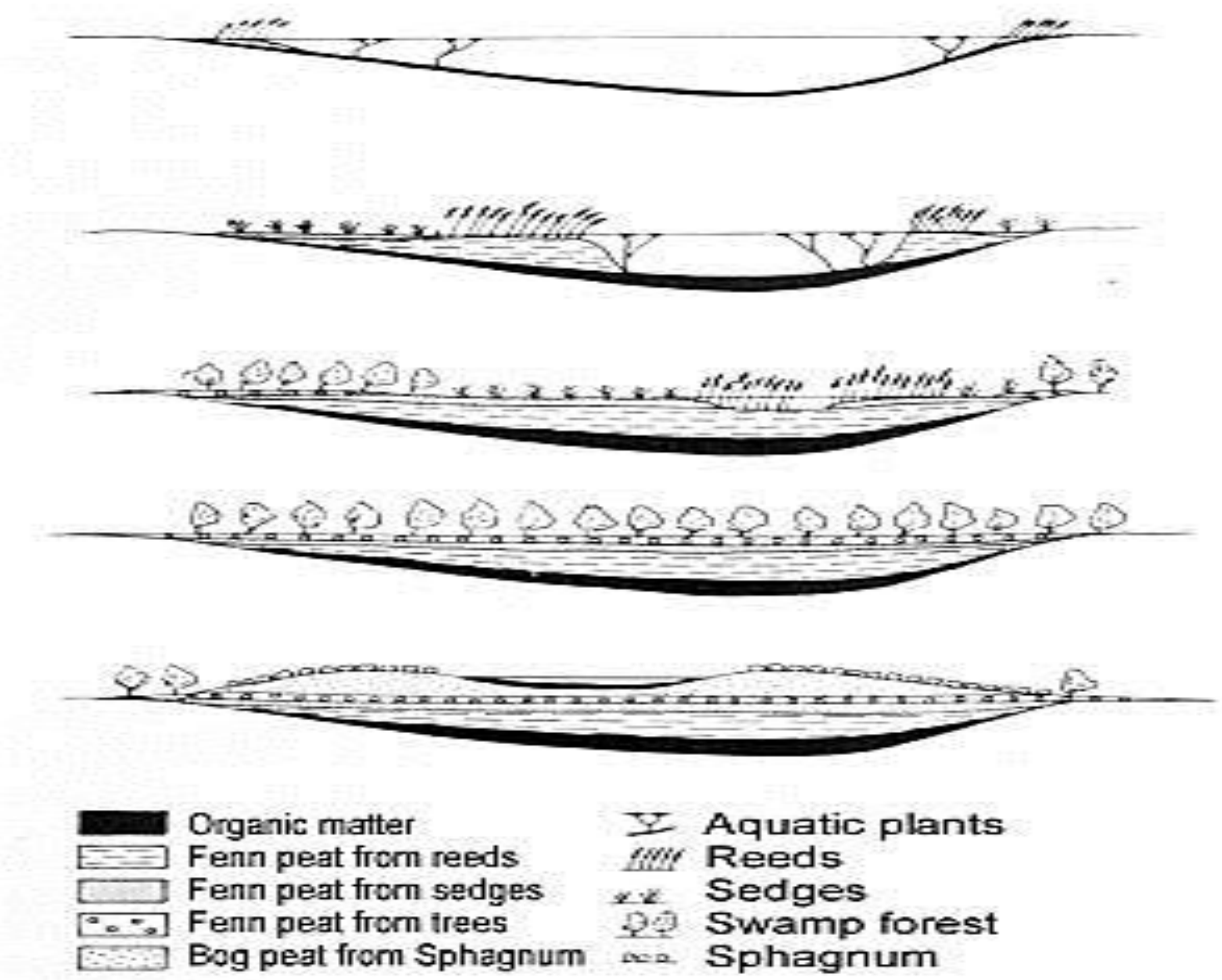
- Further development of basin bogs.
- Dead plant remains continue to build up
- The peat can be cultivated with Bord na Mona
- Peat is harvested for power stations
- Turf and briquettes are harvested for fuel

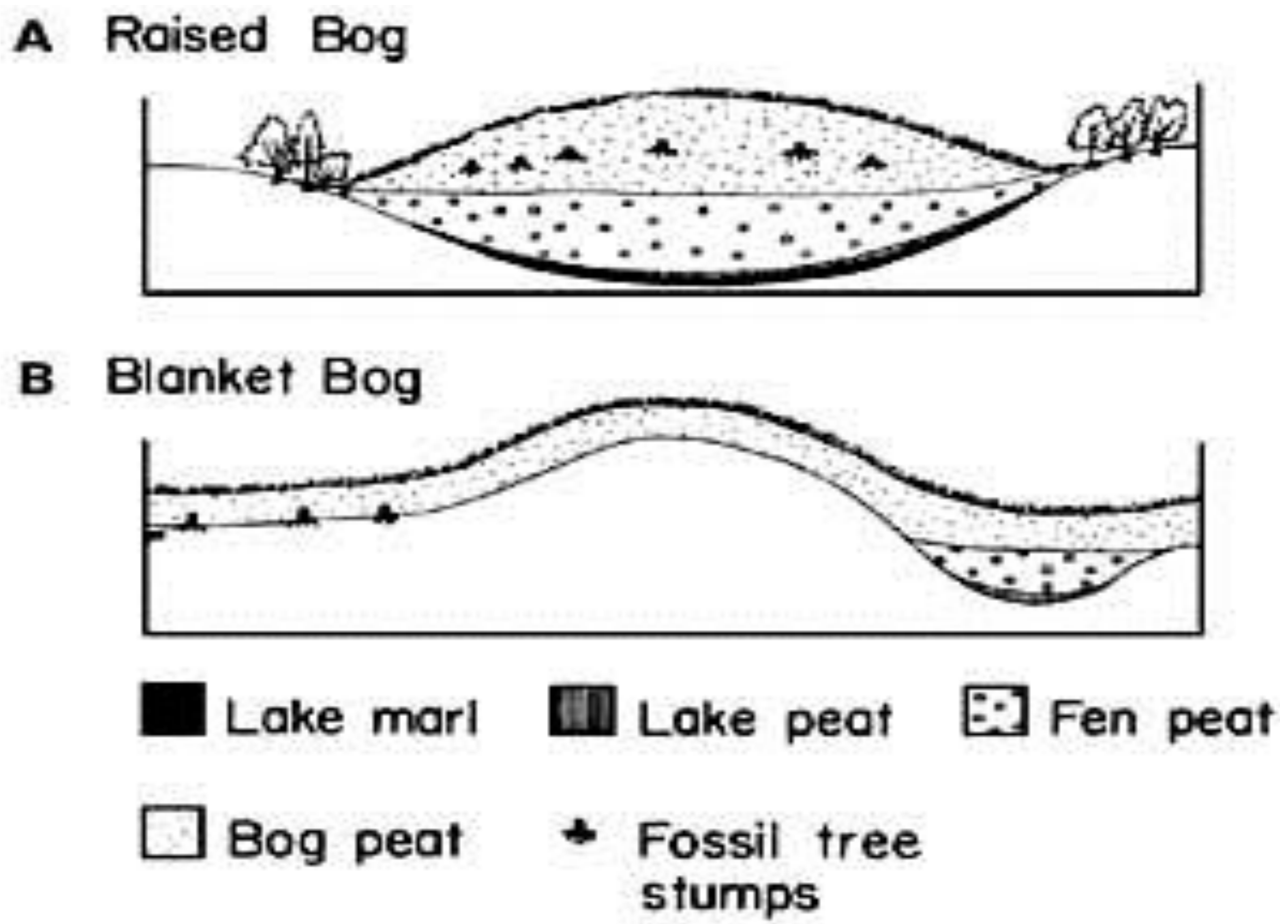
Formation of peat bogs

- After the Ice Age, glaciers left a vast amount of small, shallow lakes around Ireland, these were taken over by vegetation (plants like reeds and sedges)
- Decaying plants filled the lake
- Trees such as birch and alder and shrubs then moved in once all the water had gone.

Formation of Peat bogs

- These trees would eventually die as well and become part of the decaying mass.
- Cumulose parent material is formed from half decomposed plants under very wet anaerobic (no oxygen) soils or in lakes; This prevents the full break down of the plants.
- Peat soils are very wet and full of half decayed plant remains.


Organic matter
Fenn peat from reeds
Fenn peat from sedges
Fenn peat from trees
Bog peat from Sphagnum
Aquatic plants
Reeds
Sedges
Swamp forest
Sphagnum


A Raised Bog
B Blanket Bog
Lake marl
Lake peat
Fen peat
Bog peat
Fossil tree stumps

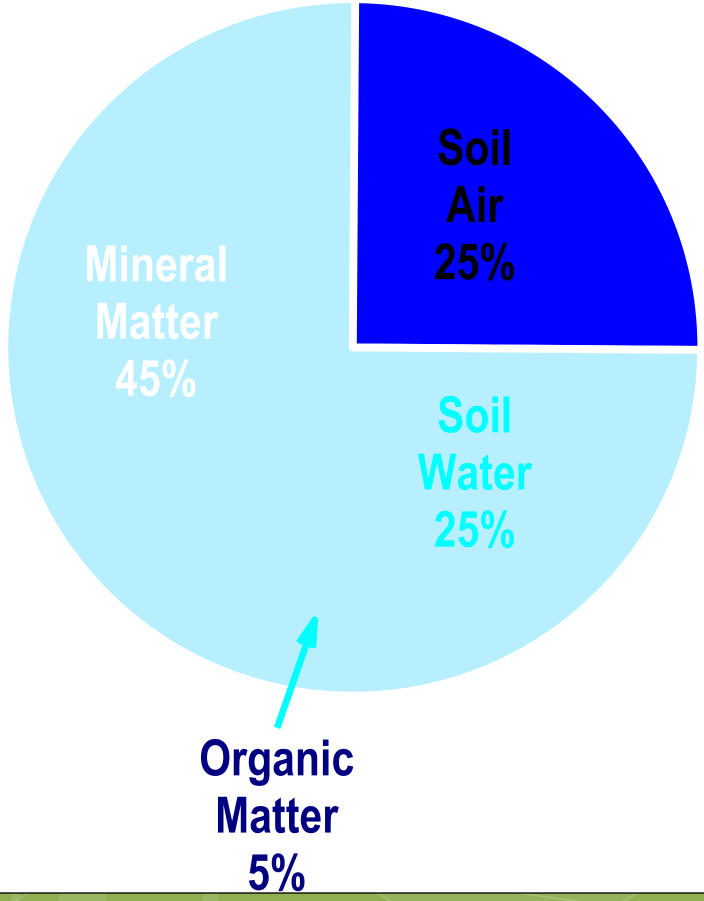
Soil Composition

Did you know?

- There are more living things in a tablespoon of soil than there are people on Earth.
- Each year in just one hectare, 37 tonnes of dry soil passes through earthworms.
- Almost all of the antibiotics we take to help us fight infections were obtained from microscopic soil life-forms.

The ideal composition of soil

About ½ of the soil volume is solid particles



About ½ of the soil volume is pore space

The ideal composition of soil

- Ideally, the soil should have 50% solids and 50% space or soil pores

Soil composition

- Soils are made up of water, air, organic matter and mineral matter.
- Organic matter is dead plants and animals
- Mineral matter is made up of particles of gravel, sand, silt and clay

Properties of gravel and sand

- Gravel and sand are the largest and heaviest soil particles
- They create large soil pores
- The large pores allow water to drain away quickly
- Also it encourages air flow in the soil
- Sandy soils tend to suffer from drought in the summer months and are not as fertile as other soils

Properties of silt and clay

- Silt and clay are smaller and lighter soil particles
- Have undergone more weathering then gravel and sand
- Clay and silt particles help soils to improve their fertility
- Clay particles have a large surface area which allows cation exchange to occur (more about this later)

Properties of organic matter

- Particles range in size
- Large particles are called *Plant and Animal Debris*
- Smaller particles are called *Humus*
- Large organic matter particles do not react and help with the drainage of a soil
- Smaller organic matter (humus) are a good source of nutrients to the soil

Properties of organic matter

- Also chemical activity increases and humus is said to be very active in cation exchange.
- Humus colloids can carry out cation exchange up to three times faster than clay colloids
- This is due to the fact that humus has both internal and external surfaces involved in cation exchange while clay particles only have cation exchange on the external surface
- Soil colloids refers to the chemically active constituents in soil

Summary of soil particle size

Particle size	Mineral solids	Organic solids	Properties
Large- Gravel greater than 2 mm Sand less than	◆Gravel Greater than 2 mm ◆Course & fine sand	Plant and animal debris	◆Creates large soil pores ◆Improves drainage ◆Chemically inactive
Intermediate between 0.05 mm and 0.002 mm	Silt	Partially decomposed organic matter	◆Little effect on drainage ◆Provides some nutrients ◆Slightly active chemically
Small – Less than 0.002 mm	◆Clay ◆Colloidal clay	◆Humus ◆Colloidal humus	◆Very active chemically ◆Acts as nutrient source ◆Retains nutrients from leaching ◆Retains water

Types of soils

Types of soils

- The main soils we have to study are:

1. Sandy soils (high % of sand)
2. Clay soils (high % of clay)
3. Loam soils (mixture of sand, silt and clay)

Characteristics of sandy

	Advantage	Disadvantage
Sandy Soil	Large air spaces Drains well Light soil- easy to work with. A warm soil	Tends to dry out quickly- does not hold water Does not hold minerals Poor soil – no nutrients in sand
Clay Soil	Holds water over long periods Holds minerals against leaching Naturally fertile	Poor drainage Heavy soil- hard to work with Cold soil

Generalised soil types

Sandy Soils

- Have large air holes. Good aeration
- Free Draining soils. Good drainage
- Warm up quickly in Spring
- Easy to cultivate (work with)
- Prone to drought
- Low fertility

Generalised soil types

Clay Soils

- Holds water easily. Good water holding capacity but poor drainage. Can water log easily
- Poor aeration
- Naturally a fertile soil.
- Doesn't warm up quickly in Spring
- Hard to cultivate, a heavy soil

Generalised soil types

Loam Soils

- Characteristics of both clay and sandy soils.
- More good characteristics than bad
- A good mixture is 40 % Sand, 40 % Silt and 20 % clay.

Characteristics of sandy

	Advantage	Disadvantage
Sandy Soil	Large air spaces Drains well Light soil- easy to work with. A warm soil	Tends to dry out quickly- does not hold water Does not hold minerals Poor soil – no nutrients in sand
Clay Soil	Holds water over long periods Holds minerals against leaching Naturally fertile	Poor drainage Heavy soil- hard to work with Cold soil

Soil Properties

The 3 main Soil Properties

- Physical
- Chemical
- Biological

Physical Properties

- Soil texture
- Soil structure
- Soil water
- Soil air
- Soil temperature

Soil Texture

Soil Texture

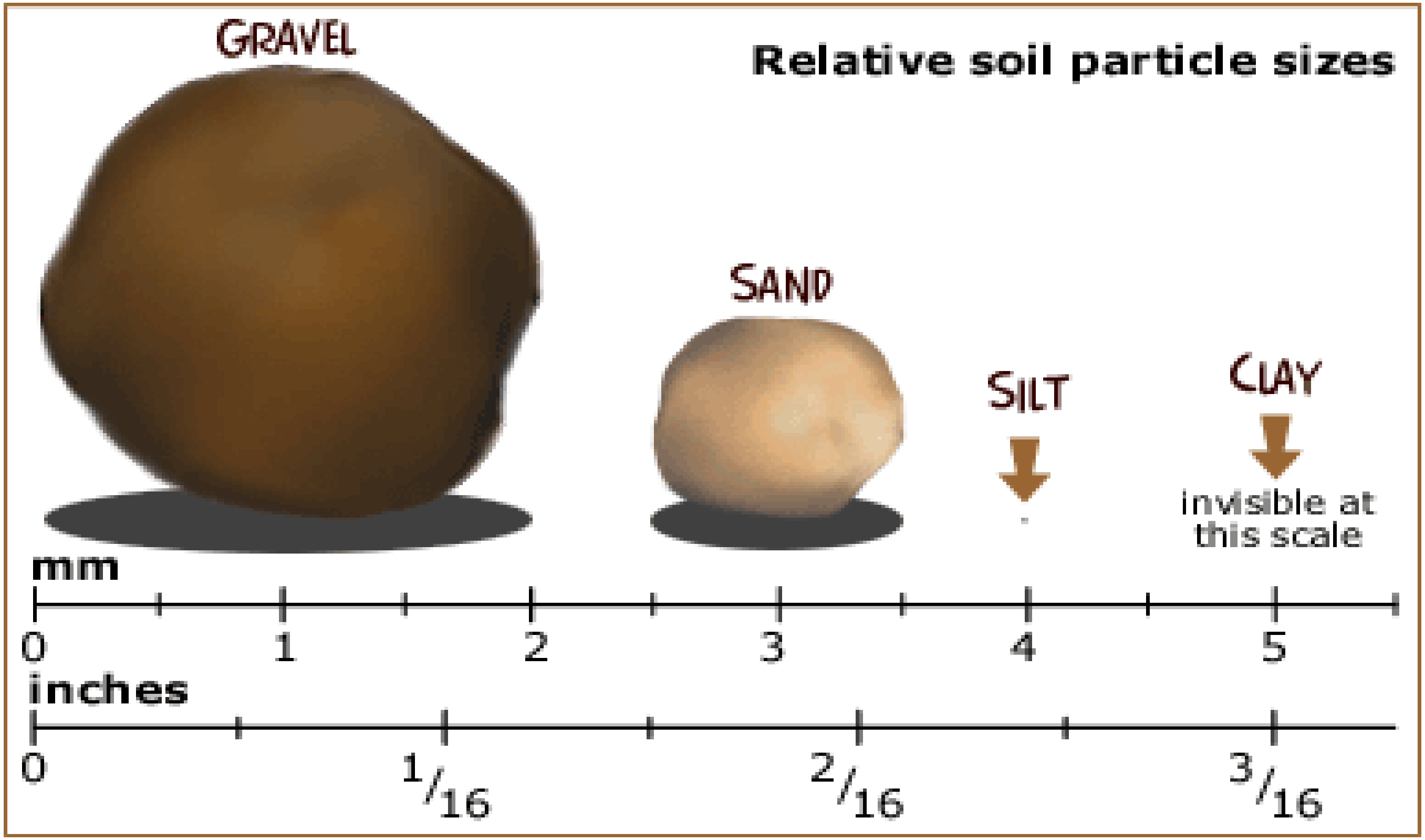
- Soil Texture is the most important soil property
- Soil texture is how a soil looks and feels
- It's the amount of sand, silt and clay particles in the soil

What does soil feels like ???

Soil Particle Size

Gravel	> 2mm
Coarse Sand	~ 2mm
Fine Sand	< 0.2mm
Silt	< 0.02mm
Clay	<0.002mm

Soil Particle Size



Soil Sieve

- Place the soil sample in the sieve
- Each layer of the sieve gets smaller as they go down
- The soil particles get trapped in each layer depending on their size
- You can get the % of each soil particle

Soil Sieve

Soil Types

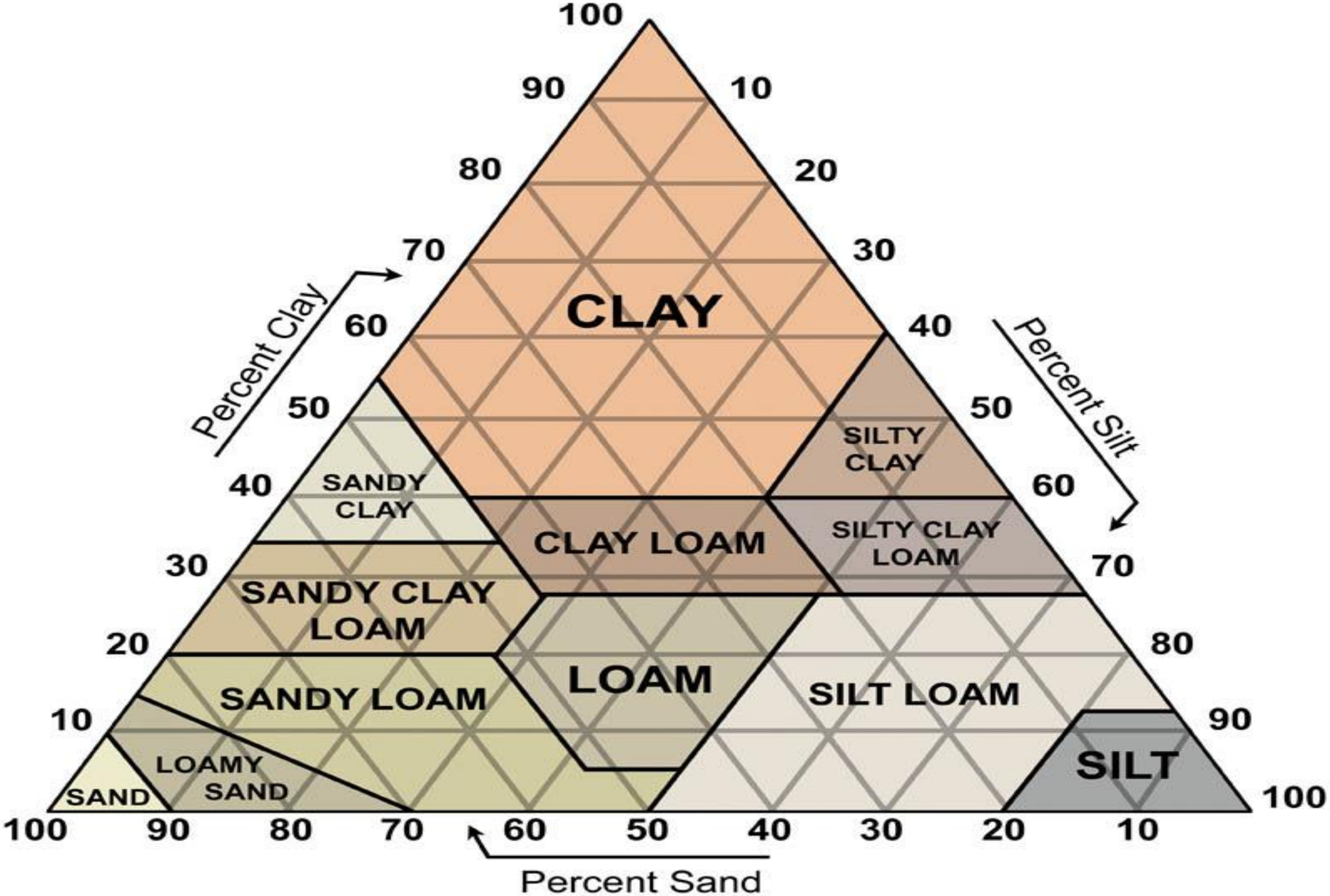
- The texture of a soil depends on the relative mixture of sand, silt and clay particles.
- The most common method of classifying soils is based on the percentage clay in the oil.
- E.g. Soils that contain 0 – 5 % clay are known as sandy soils.

Soil Types

- As mentioned before soils are classified by the amount of clay in the soil.
  - 0 – 5 % Clay Sandy Soil
  - 5 – 10 % Clay Sandy Loam
  - 10 – 20 % Loam
  - 20 – 30 % Clay Loam
  - 30 – 40 % Clay Soil
  - 40 % Up Heavy Clay Soil

Soil Textural Triangle

- A more accurate way of determining a soils texture is to use a soil textural triangle



50% Sand, 30% Silt and 20% Clay

What effect will soil texture have on crop growth?

Soil texture affects:

- Drainage
- Aeration
- Soil temperature
- Compaction of soils

Sandy Soils – gritty texture

- Good drainage
- Good aeration
- Easy to cultivate
- Warm up quickly in spring
- Low in organic matter
- Not as fertile

Clay Soils – smooth texture

- Poor drainage – good water holding capacity
- Poor aeration
- Warms up slowly in spring
- Difficult to cultivate
- High in organic matter
- High fertility

What is the benefit of adding sand to a soil?

- Improves drainage
- Improves aeration
- Helps the soil to warm up

What is the benefit of adding clay to a soil?

What is the benefit of adding clay to a soil?

- Helps the soil to hold onto more water – prevents drought
- Adds more nutrients to the soil
- Less leaching of nutrients

Why are loam soils suitable for crop production?

Why are loam soils suitable for crop production?

- Good drainage
- Easy to cultivate
- Reasonable level of organic matter
- Warm soils

Sandy Soils

Advantages

- Have large air holes. Good aeration
- Free Draining soils. Good drainage
- Warm up quickly in Spring
- Easy to cultivate (work with)

Disadvantages

- Prone to drought
- Low fertility

Clay Soils

Advantages:

- Holds water easily. Good water holding capacity but poor drainage. Can water log easily
- Naturally a fertile soil.

Disadvantages:

- Poor aeration
- Doesn’t warm up quickly in Spring
- Hard to cultivate, a heavy soil

Loam Soils: A soil with a mixture of sand, silt and clay

- Characteristics of both clay and sandy soils.
- More good characteristics than bad
- A good mixture is 40 % Sand, 40 % Silt and 20 % clay.

Soil Structure

Soil Structure

- Soil Structure is smaller particles of soil coming together to form larger units
- These larger units are called peds or aggregates
- A good soil structure is 50% solids and 50% pores

The importance of good soil structure

- Ensures good drainage and aeration
- Allows roots to develop correctly
- Makes the soil easy to cultivate
- Encourages high populations of earthworms

Compaction of the soil

- Poaching:

Animals compact the soil and cause it damage

- Puddling:

Similar to poaching but animals turn the soil into mud

Figure 3:8. A puddled soil (left) and a well-granulated soil (right). Plant oots and especially humus play the major role in soil granulation. For that eason a sod tends to restore the structural condition of cultivated land. (Photo

How to improve soil structure

- Bring animals indoor over the winter to prevent the soil compacting
- Add organic matter e.g. slurry/manure
- Carry out soil cultivations e.g. harrow the soil (break it up)

Cementation and Separation

- Cementation:

Soil particles are pushed together to form larger peds

- Separation:

Large soil units (peds) are broken up into smaller soil particles

Cementation and Separation

- Cementation and Separation are involved in forming the structure of a soil

Examples of cementation and separation in soils

Wetting and Drying

- Drying causes the large units to lose water and crack
- This causes the large soil units to separate

- Wetting causes the smaller soil particles to join together to form larger units

Freezing and Thawing

- Freezing causes the water in large soil units to freeze and expand, causing the soil units to separate
- Thawing produces water which will encourage the smaller soil particles to join together

Activity of roots

- Small roots like those found in grasses, cause small soil particles to join together to form larger units

- Large roots grow through the large peds causing them to crack and separate

Activity of earthworms

- Earthworms travel through large soil units, breaking them up into smaller particles

Tillage operations

- Tillage operation e.g. ploughing, harrowing will slice through large soil peds and cause them to separate into smaller soil particles

Soil Water

Granular Structure:

- Like cookie crumbs
- Less than 0.5cm in diameter
- Common where roots are growing

Soil Water

- Important for plant growth and also for survival of bacteria and earthworms
- Too little or too much water can be harmful.
- The amount of water a soil can hold onto depends on it's texture

The effects of too much water on a soil

- It reduces the amount of air in a soil
- Crop growth is reduced
- Wet soils warm up slowly, reducing crop yield

Types of water found in a soil

Hygroscopic water

- Water that is unavailable for the plant to use.
- This water is held tightly within the soil
- Drought

Capillary water

- Water held between the small pores in a soil
- This water is available to plants
- A normal state for soils to be in

Gravitational water

- Water held between the small pores and the large pores
- There is no space left in the soil for air
- Usually found after heavy rainfall
- Can lead to waterlogged and flooded soils

Describing the water content of a soil

Saturated

- All pores in the soil are filled with water
- Gravitational water is present

Saturated

Waterlogged

- All soil pores are filled with water
- If you stand on the soil water will run out of the soil

Flooded

- All soil pores filled with water and water lies on top of the soil

Field Capacity

- Only the small (capillary) pores are filled with water
- The large soil pores contain air
- Capillary water present
- Ideal soil water content

Permanent wilting point

- No water present between the soil pores
- Only hygroscopic water is present (unavailable to plants)
- Drought conditions

Available water capacity

- This is the amount of water in a soil that is available to plants
- It's the difference between field capacity and permanent wilting point
- The difference between all the water in a soil and the water that is unavailable

Soil	% water – field capacity	% water – permanent wilting point
A	6	2
B	24	12
C	30	22

Exam Q

- Calculate the % available water in each soil
- What soil would you think suffers from drought?
- What soil would you think suffers from a wet climate?

Soil Air

Soil Air

- Living organisms e.g. earthworm need oxygen to survive
- Crops need oxygen to grow and respire

Soil Air

- An ideal soil should have 25% air
- Id soil air levels drop under 8% crops will fail

Difference in soil air and atmospheric air

	Oxygen	Carbon dioxide	Nitrogen
Atmospheric Air	20.97 %	0.03 %	79 %
Soil Air	20.65 %	0.25 %	79.10 %

Reasons for the difference

- More carbon dioxide in soil air because of respiration of crops and animals
- Less oxygen in soil air because of greater respiration. Also plants and animals require oxygen to decompose
- Less nitrogen in soil air because of nitrogen fixation - bacteria change the composition of nitrogen in soils

Soil Temperature

Soil Temperature

- The warmer a soil, the higher crop yield will be
- Every 10 degree rise in soil temperature, doubles the rate of crop growth
- Soils with good drainage and aeration, will be warmer soils

Factors that affect soil temperature

Water content

- Soils with high water levels with warm up slower than those with lower water levels

Aspect

- South facing slopes receive more sunlight, therefore will have higher soil temperatures

Altitude

- Temperature decreases with altitude
- Soils in mountainous areas will be colder than lowland soils

Colour

- Darker soils will absorb more heat, and hold onto it longer than lighter coloured soils

Chemical Properties

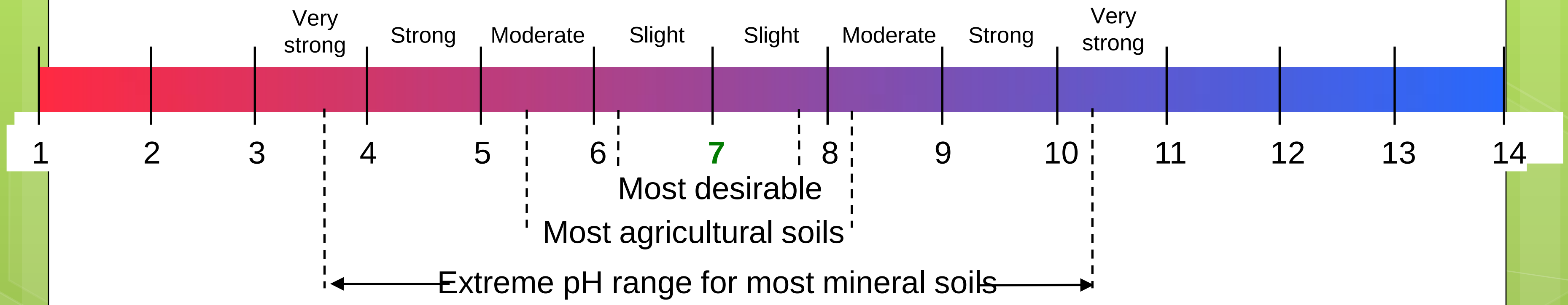
Chemical Properties

- Soil Ph
- Cation Exchange Capacity

Soil Ph

- Soil Ph is the measure of how acidic or how basic a soil is
- Ph can also be defined as the amount of hydrogen ions in solution
- Most Irish soils are slightly acidic
- Acidic soil have less soil organisms e.g. earthworms, don't break down organic matter well and are poor at allowing plants to absorb nutrients form the soil

Ph scale


Very strong
Strong
Moderate
Slight
Slight
Moderate
Strong
Very strong
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Most desirable
Most agricultural soils
Extreme pH range for most mineral soils

Factors that influence soil Ph

- The ph. value of the parent rock (Granite and Sandston are acidic rocks, while Basalt and Limestone are basic rocks)
- The amount of rainfall
- Pollution
- Adding fertilisers to a soil, makes it more acidic
- Adding organic matter e.g. slurry, makes soils more acidic

Cation Exchange

- Cations are positive ions eg H^+, K^+ and Ca^{2+}.
- Cations are attracted to negatively charged humus and clay particles.
- Humus and clay particles can release cations from their surface and replace them with other cations.

- Cation exchange is the ability of soil particles (clay and humus) to attract, retain and release cations

- Cation exchange capacity is the ability of a soil to exchange cations between the soil surface and soil water

-

Soil colloids

- Soil colloids are the smallest particles that exist in a soil.
- They are also the most chemically reactive.

How to increase CEC in a soil

- Add more clay
- Add more humus
- Add slurry/FYM

Soils with low CEC

- Sandy soils carry out CEC at the lowest rate

The effect of Liming on the CEC of a soil

- You can increase the CEC in a soil by adding lime.

- When you add Lime ($CaCO_3$) to an acidic soil, Hydrogen ions (H^+) are replaced by Calcium ions (Ca^{2+}).

- A calcium ion are replace 2 Hydrogen ions. This is turn allows the soil to loss acidic hydrogen ions and replace them with more basic calcium ions.

Biological Properties

Biological Properties

- Soil Organisms - Earthworms
- Soil Organic Matter

Soil Organisms

- Soil organisms include earthworms and other small insects and worms, fungi and bacteria
- Bacteria and fungi are essential in the decomposition of dead matter
- They use oxygen to break the matter down while releasing carbon dioxide

- Bacteria:

Single celled organisms responsible for converting soil organic matter into humus

Convert nitrogen into nitrate

- Fungi:

Responsible for humification

Some are parasites and attack crops

Earthworms

- Earthworms are hermaphrodite because they have both male and female sex organs present
- They are important as they eat dead matter in the soil and tunnel through the soil creating drains for air and water movement

The importance of earthworms

- They improve drainage/aeration
- They add organic matter (nutrients) to the soil
- They bring dead leaves on the surface of the soil down into it
- They mix the soil layers

The ideal conditions for earthworms

- Ph of the soil must be between 6 and 8
- Soil temperature must be greater than 10°C
- Organic matter must be present (food)
- Soil must be moist but not waterlogged

Influence of earthworms

- Describe the influence of earthworms on a soil's structure and development

Earthworm populations

- Describe how earthworm populations can be affected by

1. Soil cultivations
2. Spreading FYM

Soil Cultivations - Decrease

- Cultivation eg plough, harrow etc can directly kill earthworms

- Ploughing turns up a section of soil which exposes the earthworms to birds

FYM - Increase

- FYM is organic matter which is food for the earthworms, this in turn increases their population

Soil Organic Matter

- Organic matter is anything that is dead, but used to be alive in the soil
- Once dead, it decays and releases nutrients into the soil
- It is very beneficial to the soil

Biomass v Humus

- Biomass:

Is the total amount of living matter (plants and animals) in a soil

- Humus:

The remains of dead plants and animals

Humus

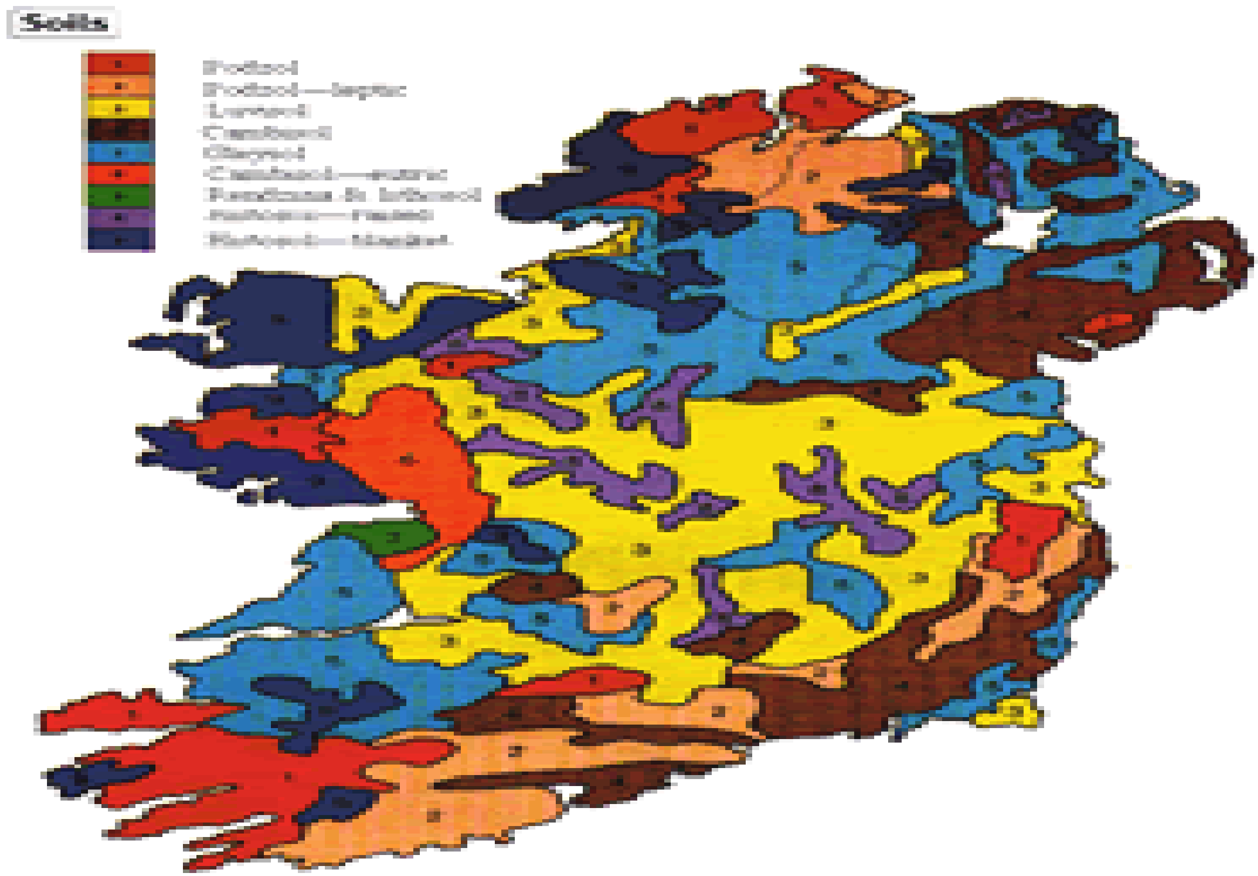
- Humus is dark in colour
- It has a good water holding capacity (which can help sandy soils)
- Humus is full of nutrients, which are released slowly
- Humus improves the CEC of a soil

Humification

- Humification: the process by which a soil organic matter is converted to humus
- Actinomycetes: Bacteria that are responsible for humification

Soil Groups

The general soil map of



The general soil map of Ireland

- This was first published in 1969, with a second edition in 1980.
- These show the distribution of the major soil groups throughout Ireland.

- The soils of Ireland
- Podzols: Acidic , highly leached, waterlogged soils
- Brown podzolics: some leaching, better suited to crop production
- Brown earths: well drained, fertile soil, wide range of agri use
- Grey-brown podzolic: good agri soils with little leaching

- Gley: poor structure, waterlogged soils, little agri use
- Blanket peat: poorly drained, acidic soils, rich in organic matter, limited agri use
- Basin peat: deep, waterlogged soils, rich in organic matter, limited agri use
- Rendzinas: shallow, lime rich soils restricted to grazing
- Regosols: lack horizon development, derived from alluvial deposists
- Lithosols: shallow, stony soils restricted to

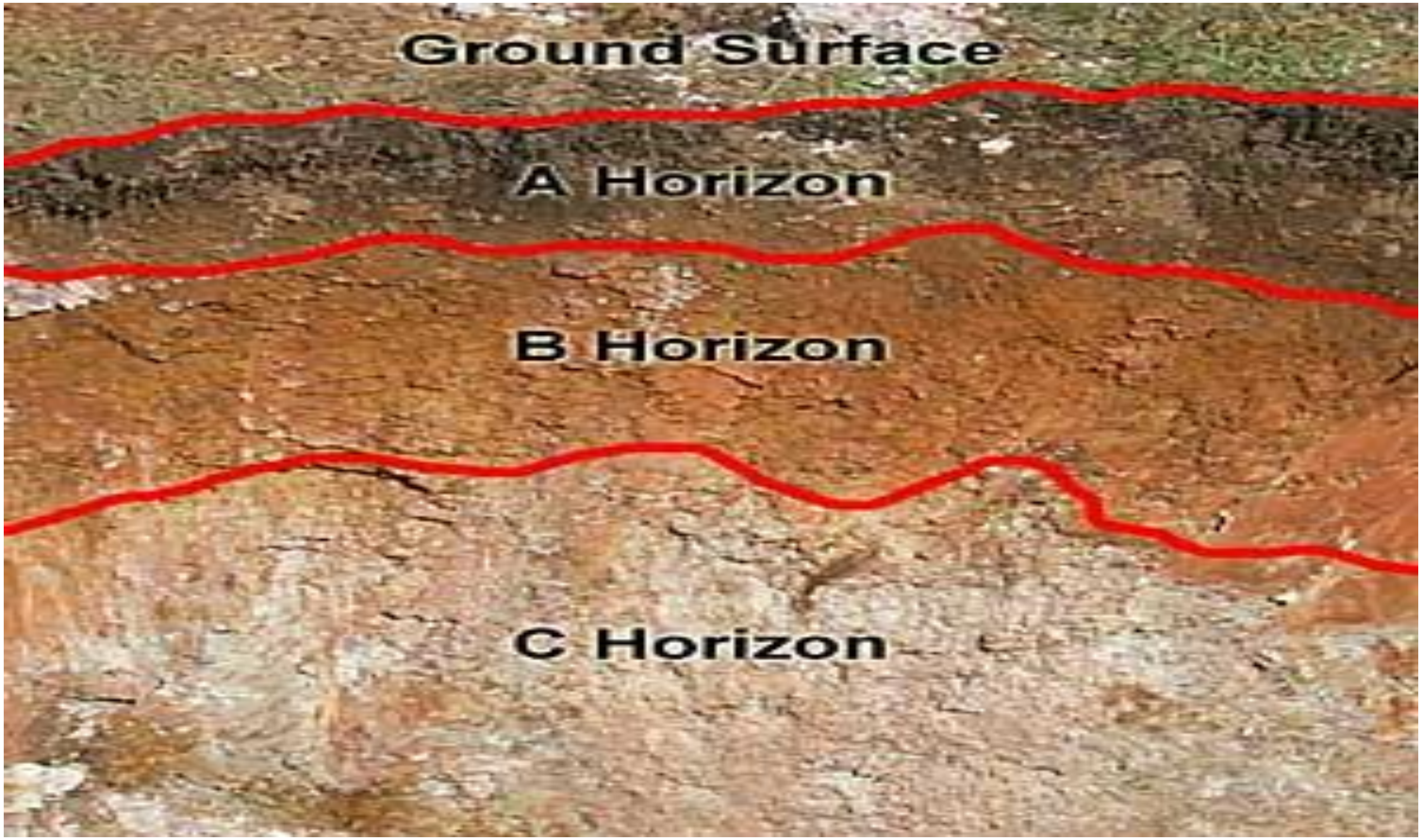
- Leaching: soluble matter eg minerals dissolve in water that filters through a soil and is carried downwards in the soil. The leached minerals may accumulate at a lower horizon
- Podzolisation: occurs in acidic conditions. Minerals eg Iron are leached from the A horizon, leaving it bleached iin colour, and accumulates in the B horizon, forming an iron pan that is impermeable to water.

Soil Profiles

- You can take a soil's profile by digging down vertically into a soil to its parent rock and looking at it's different layers.
- Profiles using the colour, texture and depth of a soil tell us all the properties of that particular soil.

- A soil profile can be broken up into 3 distinct horizons
- A – Top Soil
- B – Sub Soil
- C – Parent Rock

Simple Soil Profile


Ground Surface
A Horizon
B Horizon
C Horizon

Main Soil Profiles

The main soil profiles you must study are:

1. Podzolics
2. Grey/Brown Podzolics
3. Brown Earths

Podzol

Podzol

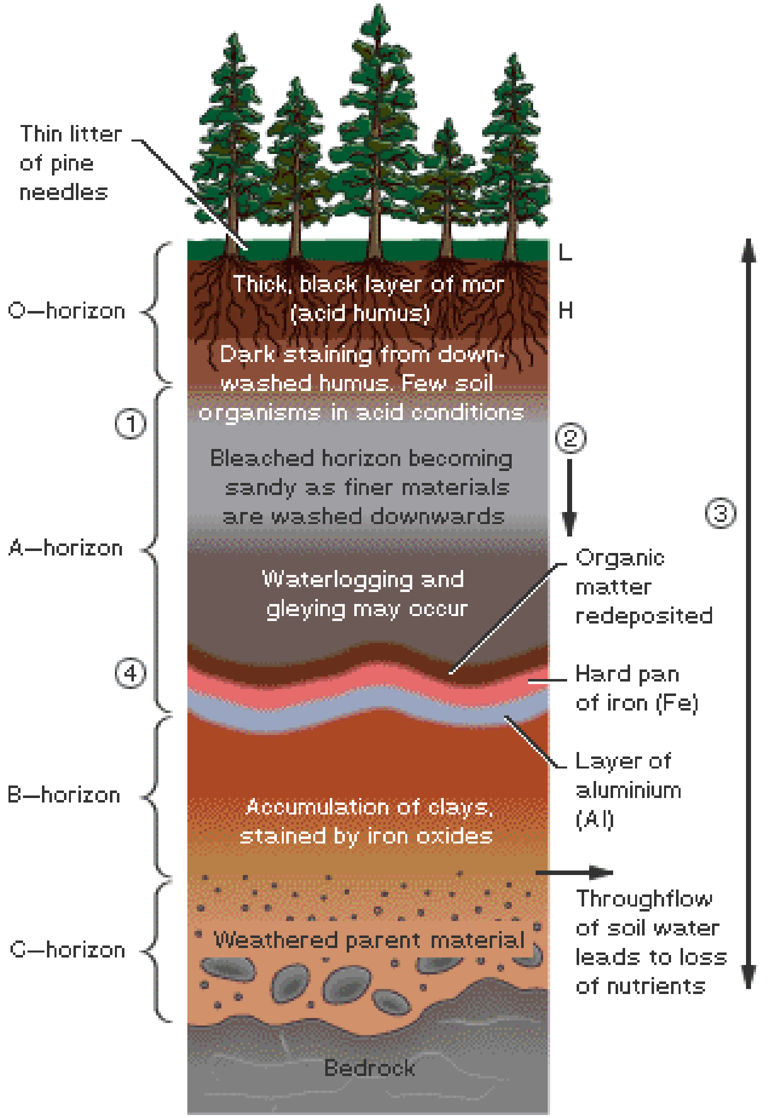
- A podzol is a very poor soil
- It's usually found in mountainous areas with acidic parent rock eg sandsotne and granite
- Mainly used for forestry or rough grazing
- Prone to leaching of minerla sdue to acidic behaviour
- Iron and allimium is leached from A
- A becomes bleached
- Minerlas acumlate in the B and form an iron pan

- O horizon: organic matter has not decomposed due to acidic conditions
- A : thin A 1 and thixck A 2 bleached inb clour bcause of leaching
- B : red brown I colour accumlation of minerals
- Iron pan forms at the B2

Podzol

- Iron is an example of a mineral that is leached from the A2 horizon
- It accumulates in the B2 horizon, forming a hard pan
- This leaves the A2 bleached in colour and the B2 with a very strong orange coloured soil

Podzol



① E (zone of eluviation)

② Increasing acidity
Precipitation exceeds evaporation, resulting in leaching of clays, organic matter, bases, oxides

③ Soil depth rarely exceeds 1 m (3 ft) ④ Zone of illuviation

How Podzolic Soils are improved

- Lime the soil to raise the Ph, thus reducing acid leaching
- Fertilise the soil to replace leached nutrients
- Deep plough or use a sub-soiler to break up the hard pan

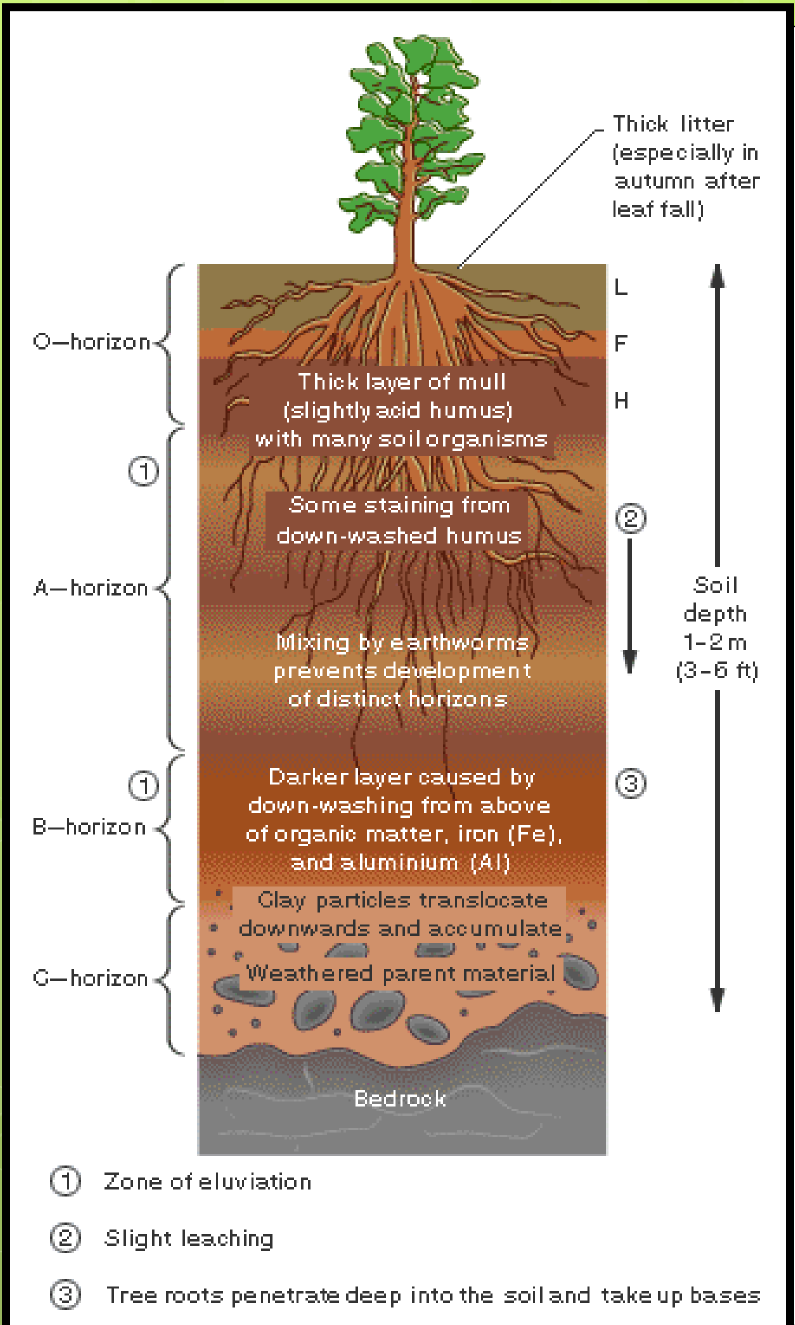
Brown Podzolic Soil

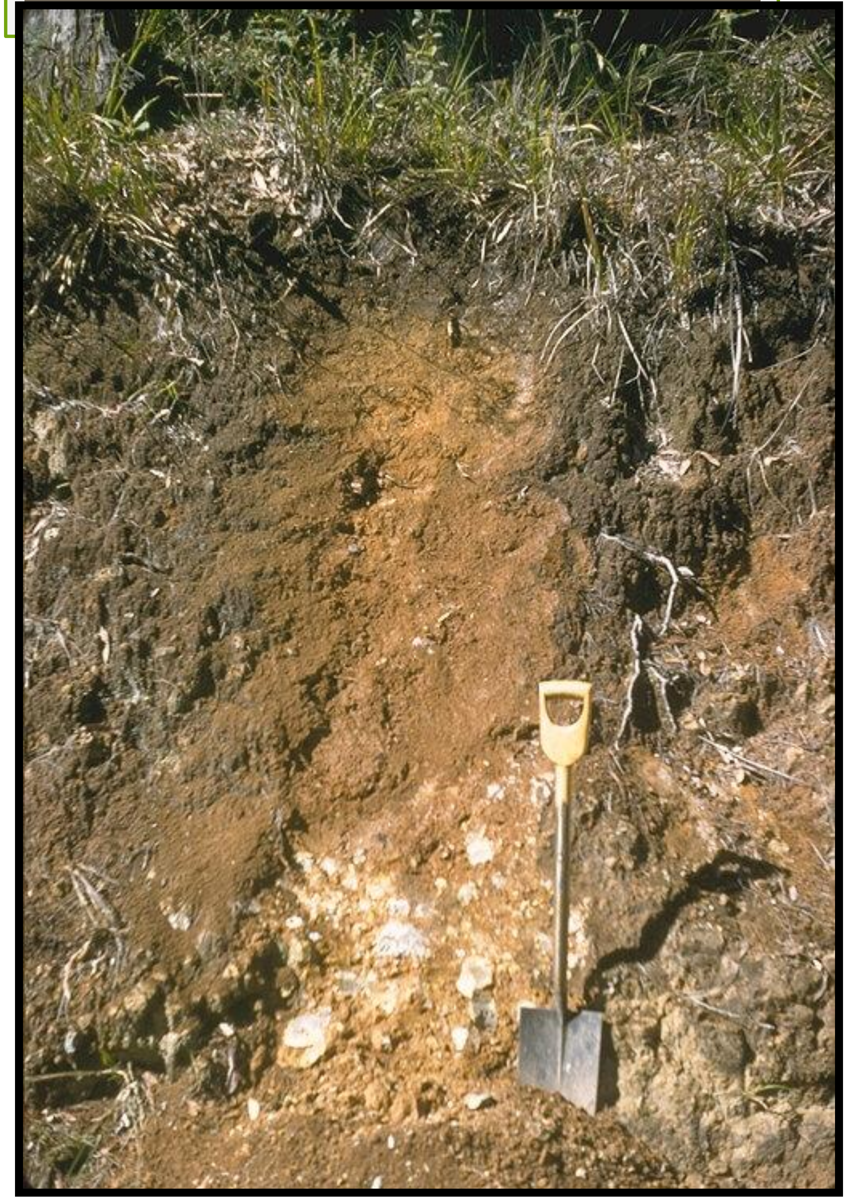
- Found in lowland areas
- Suitable for forestry, can be used for rops and grazing
- Liming and fertilisation help improve these soils
- Similar to podzols parent acidic rock
- Leaching does not occur as much

- A horizon: large amount of organic matter
- In A1. A2 is thin with litle development
- B horizon: red brown due to acculation of leached minerlas eg iron

Brown Earths

Brown Earths


Thick litter (especially in autumn after leaf fall)
O–horizon
A–horizon
B–horizon
C–horizon
L
F
H
Thick layer of mull (slightly acid humus) with many soil organisms
Some staining from down-washed humus
Mixing by earthworms prevents development of distinct horizons
Darker layer caused by down-washing from above of organic matter, iron (Fe), and aluminium (Al)
Clay particles translocate downwards and accumulate
Weathered parent material
Bedrock
Soil depth 1–2 m (3–6 ft)
① Zone of eluviation
② Slight leaching
③ Tree roots penetrate deep into the soil and take up bases



- Using points AND diagrams describe the structure of a Podzol Soil Profile

Brown Earths

- One of the best soils in agricultural terms, but only if the parent rock is basic
- No distinct horizons
- Brown earths have low lime and fertiliser requirements

Grey/Brown Podzolic

Grey/Brown Podzolic

Grey Brown Podzolics

Grey/Brown Podzolic

- Good soils for agricultural use especially for tillage
- Malting barley will only grow to the specification required by the brewers on a grey/brown podzolic

Grey/Brown Podzolic

- Basic parent rock is present, which prevents acid leaching
- However, leaching of clay particles still occurs
- The clay is leached form the A2 and accumulates in the B2
- Clay has a good water holding capacity

Grey/Brown Podzolic

- Therefore, during dry spells, crops with long roots, like barley can grow down into the B2 and absorb this extra reserve of water, while still remaining dry on top of the soil

Gley Soils

Basin and Blanket Peats

Brown Earths

- These soils are mature, well drained mineral soils.
- They have not suffered from serious cases of leaching (loss of minerals)
- They have a uniform profile (i.e. No distinct horizons or layers)
- The Brown Earths in Ireland are mainly found in areas where the

Brown Podzolics

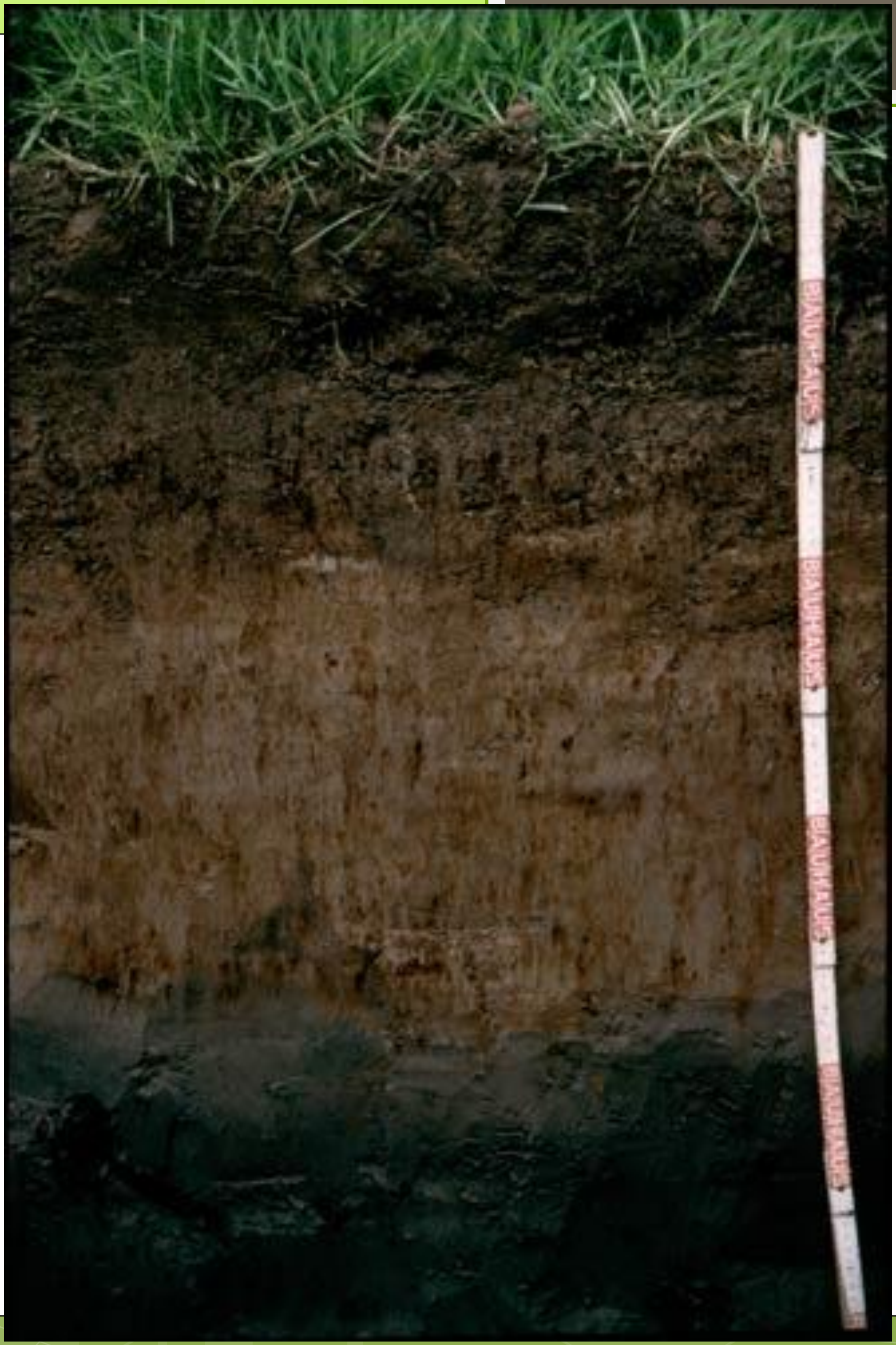
- Brown Podzolics are similar in structure to the Podzols, but have not been exposed to serious leaching.
- They have a well developed A1 horizon, a weakly developed A2 and accumulation of iron, aluminium and humus in the reddish brown B2 horizon.
- They can be used for pasture and arable crops as long as they are fertilised and limed regularly.

Grey Brown Podzolics

- Grey Brown podzolics are very similar in appearance to Brown Earths.
- They have a uniform profile, with no real differences between horizons.
- However, they are usually formed on limestone parent material.
- They have a high pH and acid leaching does not occur.
- Some clay particles are leached to the B2 horizon.
- Grey Brown Podzolics are excellent soils

Gleys

- Gleys occupy over 25% of the island of Ireland.
- Ground Water Gleys are water logged soils in areas of topographical depressions.
- Surface Water Gleys are formed over impervious layers of rock.
- Gleys have limited use in agricultural (low intensity grazing only) except where successful draining has occurred.
- Gleys have a A and B horizon only.

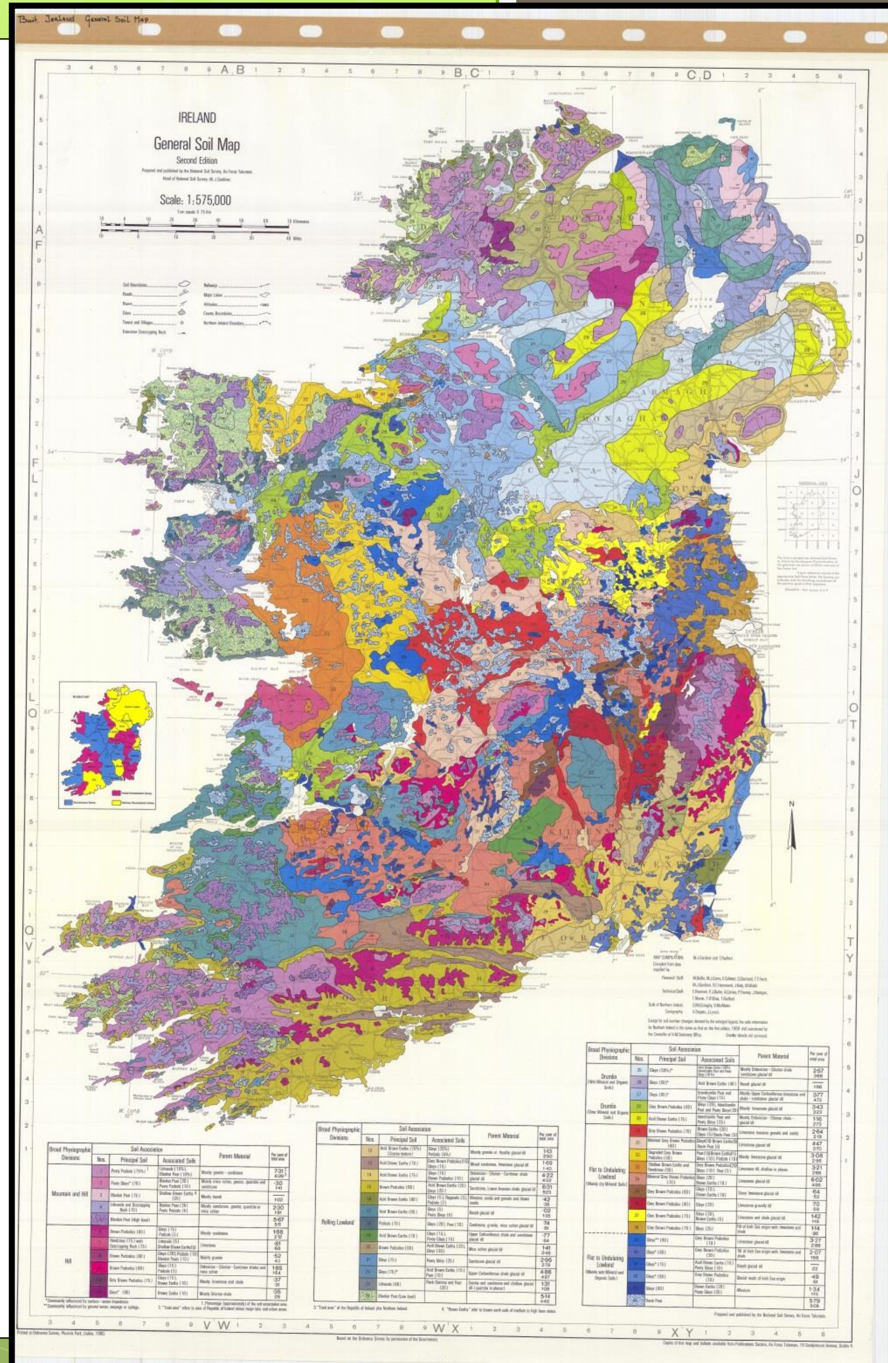


Blanket Peats

- Blanket Peat soils have a single A horizon ranging from 1 to 2 metres deep.
- They are black / brown in colour.
- They have poor drainage, low pH and are found in areas of high rainfall.
- A typical blanket peat soil has approx 90% water.
- Blanket peats are used for forestry or harvested for fuel.

Basin Peats

- Basin peats are similar to blanket peats but are deeper, ranging from 3 to 10 metres.
- They consist of a single O Horizon, with the level of organic matter degradation increasing with depth.
- They are found in various areas all over Ireland.
- They can be harvested for fuel or drained, limed and fertilised to use for intensive farm practices including grass.


IRELAND
General Soil Map
Second Edition
Scale: 1:575,000

Soil Fertility and Crop Nutrition

- Macro Nutrients
- Micro Nutrients

- Essential elements
- Benefical elements

Macro Nutrients

Nitrogen

Phosphorus

Potassium

Calcium, magnesium and Sulfur

Micro Nutrients

Availability of Soil Nutrients

Liming

- Liming needs to be carried out every 5 – 10 years

Advantages:

- Makes soil more neutral
- Improves drainage
- Improves flocculation
- Increases earthworm numbers

Disadvanages:

- Can reduce Copper uptake by plants
- Trace elements can become unavailable causing deficency diseases in animals
- Can damage light sandy soils (structure)

Ground Limestone -

Requirements

- Have a TNV (Total Neutralising value) of greater than 90%
- Entire product must pass through a sieve of 3.35 mm
- More than 35% must pass through a sieve of 0.15mm
- Moisture content less that 3%

Soil Testing

Taking a soil smaple