Soil formation

Weathering of Rocks and Minerals

- Rocks and minerals are formed under a very high temperature and pressure.
- Exposed to atmospheric conditions of low pressure and low temperature and they become unstable and weather.
- Soils are formed from rocks through the intermediate stage of formation of **Regolith**

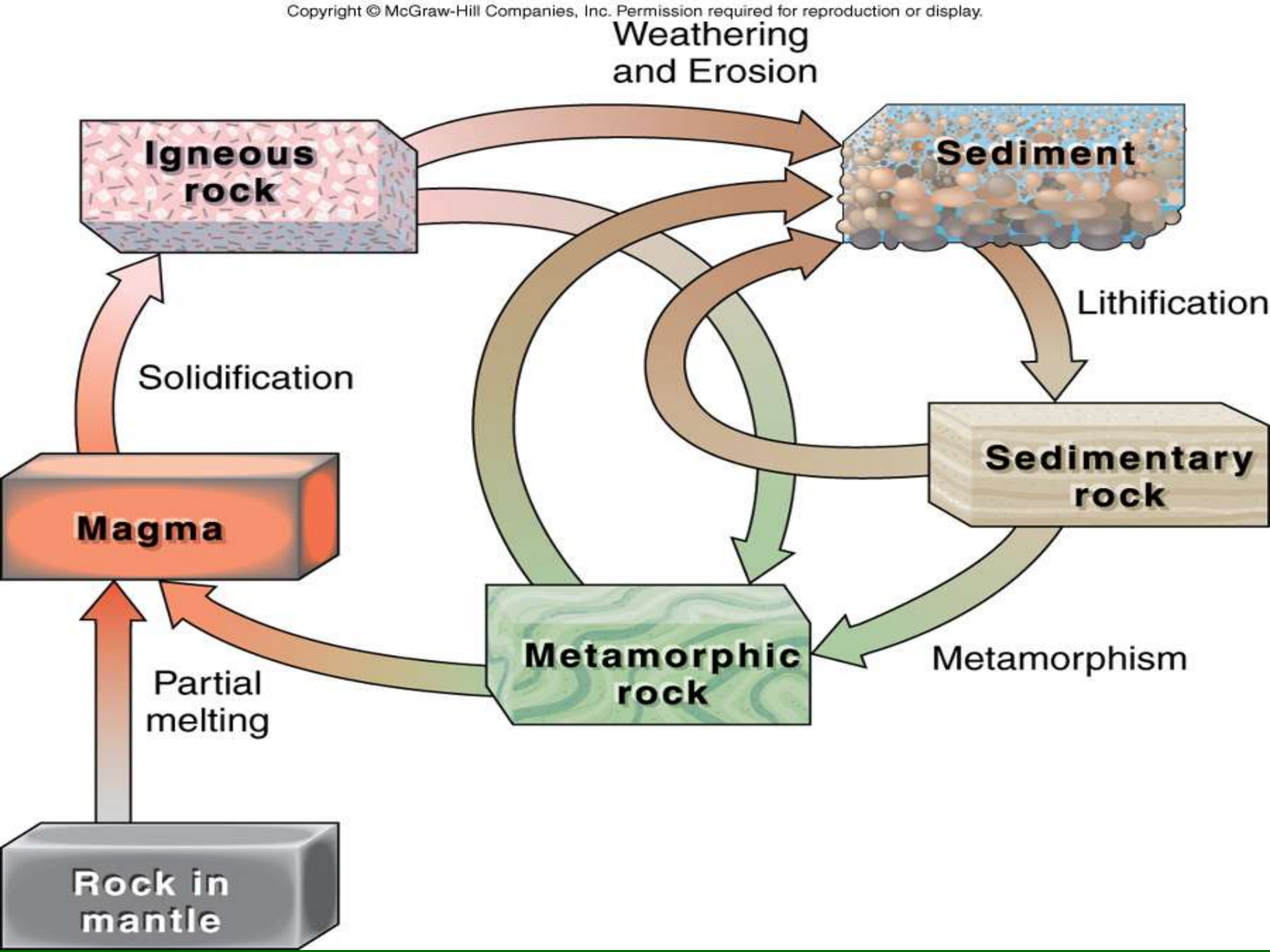
The sequence of processes in the soil formation

Weathering of rocks and minerals → formation of regolith or parent material → formation of true soil from regolith.

Rock → Weathring → Regolith → soil forming factors and processes → True soil

Weathering

A process of disintegration and decomposition of rocks and minerals which are brought about by **physical agents** and **chemical processes**, leading to the formation of Regolith (unconsolidated residues of the weathering rock on the earth's surface or above the solid rocks).



Parent material

- ✓ It is the regolith or at least it's upper portion.
- ✓ May be defined as the unconsolidated and more or less chemically weathered mineral material from which soils are developed.

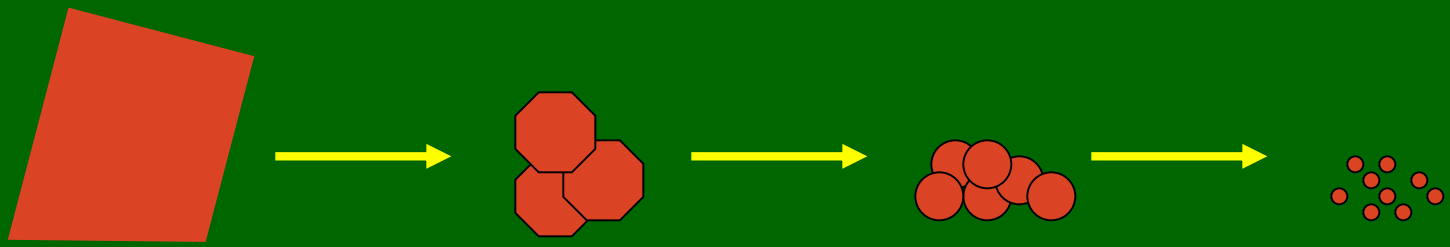
Weathering involves three process/ Types

- Mechanical (or) Physical – disintegration
- Chemical - decomposition
- Biological

Different agents of weathering

Physical/ Mechanical (disintegration)	**Chemical** (decomposition)	**Biological** (disintegration + decomposition)
Physical condition of rock	**Hydration**	**Man & animals**
Change in temperature	**Hydrolysis**	**Higher plants & their roots**
Action of H_2O	**Solution**	**Micro organisms**
- fragment & transport	**Carbonation**	
- action of freezing	**Oxidation**	
- alternate wetting & drying	**Reduction**	
- action of glaciers		
4. Action of wind		
5. Atmospheric electric phenomenon		

Mechanical Weathering: no change in chemical composition--just disintegration into smaller pieces



Mechanical Weathering

Physical process that breaks up earth materials

Temple Crag, Sierra Nevada

Physical weathering

The rocks are disintegrated and are broken down to comparatively smaller pieces, with out producing any new substances

Action of Temperature

- **The variations in temperature exert great influence on the disintegration of rocks. During day time, the rocks get heated up by the sun and expand.**
- **At night, the temperature falls and the rocks get cooled and contract. This alternate expansion and contraction weakens the surface of the rock and crumbles it because the rocks do not conduct heat easily.**

- **This process causes the surface layer to peel off from the parent mass and the rock ultimately disintegrates**

- **This process is called Exfoliation**

Mechanical Weathering

Sheeting or exfolation = rock layers peel like layers of an onion

Mechanical Weathering

Thermal Expansion: repeated heating and cooling of rocks will induce stress and breakage

Columnar joints caused by contraction during cooling of basalt

Action of Water

Water acts as a disintegrating, transporting and depositing agent.

- Fragmentation and transport: Water beats over the surface of the rock when the rain occurs and starts flowing towards the ocean
- Moving water has the great cutting and carrying force.
- It forms gullies and ravines and carries with the suspended soil material of variable sizes.

Action of freezing

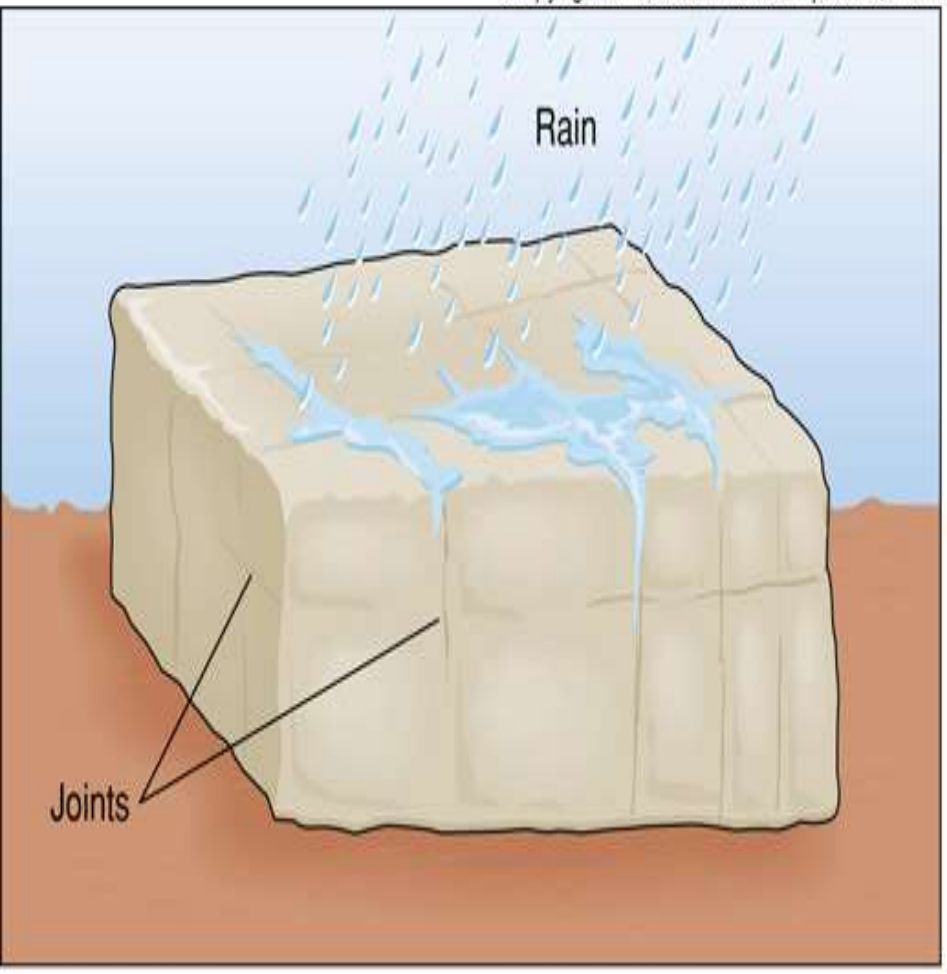
- Frost is much more effective than heat in producing physical weathering
- In cold regions, the water in the cracks and crevices freezes into ice and the volume increases to one tenth
- As the freezing starts from the top there is no possibility of its upward expansion.
- Hence, the increase in volume creates enormous out ward pressure which breaks apart the rocks

Mechanical Weathering

Frost wedging

- **Water enters cracks and expands on freezing**
- **Pressure splits rock**
- **Hundreds of freeze/thaw cycles per year**

Frost Wedging



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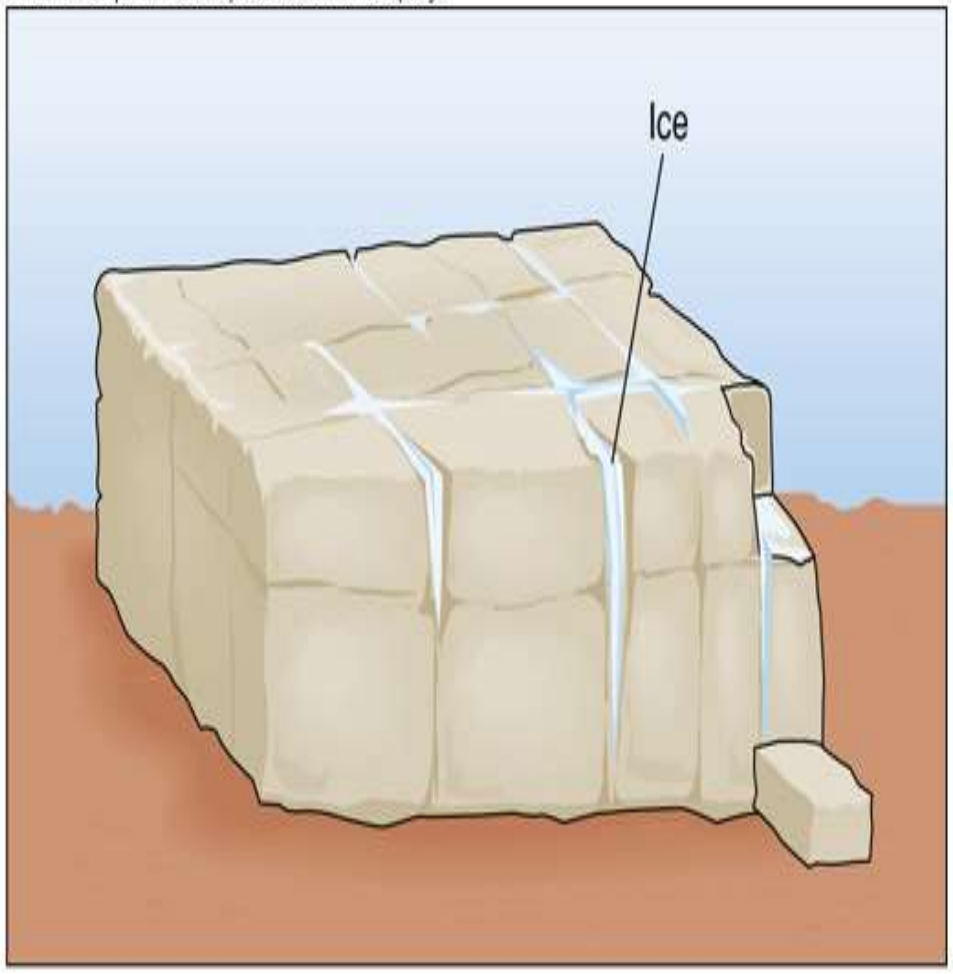

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Shattered rocks are common in cold and alpine environments where repeated freeze-thaw cycles gradually pry rocks apart.

Alternate wetting and Drying

- Some natural substances increase considerably in volume on wetting and shrink on drying. (e.g.) montmorillonite
- During dry summer/ dry weather - these clays shrink considerably forming deep cracks or wide cracks.
- On subsequent wetting, it swells.
- This alternate swelling and shrinking / wetting or drying of clay enriched rocks make them loose and eventually breaks

Action of glaciers

- In cold regions, when snow falls, it accumulates and change into a ice sheet.
- These big glaciers start moving owing to the change in temperature and/or gradient.
- On moving, these exert tremendous pressure over the rock on which they pass and carry the loose materials
- These materials get deposited on reaching the warmer regions, where its movement stops with the melting of ice

Action of wind

- Wind has an erosive and transporting effect. Often when the wind is laden with fine material *viz*., fine sand, silt or clay particles, it has a serious abrasive effect and the sand laden winds itch the rocks and ultimately breaks down under its force

Atmospheric electrical phenomenon

It is an important factor causing break down during rainy season and lightning breaks up rocks and or widens cracks

Mehanical Weathering

Organic Activity: plant roots, burrowing animals, human activity

Chemical Weathering

- Decomposition of rocks and minerals by various chemical processes is called chemical weathering- important process for soil formation.

- Chemical weathering takes place mainly at the surface of rocks and minerals with disappearance of certain minerals and the formation of secondary products (new materials)- Chemical transformation.

- Feldspar + water $\rightarrow$ clay mineral + soluble cations and anions

Chemical Processes of weathering

Hydration:

- Chemical combination of water molecules with a particular substance or mineral leading to a change in structure.
- Soil forming minerals in rocks do not contain any water and under go hydration when exposed to humid conditions.
- Upon hydration there is swelling and increase in volume of minerals. The minerals loose their luster and become soft.
- It is one of the most common processes in nature and works with secondary minerals, such as aluminium oxide and iron oxide minerals and gypsum. (e.g)

a) $2Fe_2O_3 + 3HOH \rightarrow 2Fe_2O_3 .3H_2O$

(Haematite) (red) (Limonite) (yellow)

b) $Al_2O_3 + 3HOH \rightarrow Al_2O_3 .3H_2O$

(Bauxite) (Hyd. aluminium Oxide)

c) $CaSO_4 + 2H_2O \rightarrow CaSO_4 .2H_2O$

(Anhydrite) (Gypsum)

d) $3(MgO.FeO.SiO_2) + 2H_2O \rightarrow 3MgO.2SiO_2.2H_2O + SiO_2 + 3H_2O$

(Olivine) (Serpentine)

. Hydrolysis

- Most important process in chemical weathering.
- It is due to the dissociation of H_2O into H+ and OH- ions
- Which chemically combine with minerals and bring about changes, such as exchange, decomposition of crystalline structure and formation of new compounds.
- Water acts as a weak acid on silicate minerals.

. Solution

- Some substances present in the rocks are directly soluble in water.
- The soluble substances are removed by the continuous action of water and the rock no longer remains solid and form holes, rills or rough surface and ultimately falls into pieces or decomposes.
- The action is considerably increased when the water is acidified by the dissolution of organic and inorganic acids. (e.g) halides, NaCl

$NaCl + H_2O$ Na+, Cl- H_2O (dissolved ions with water)

Carbonation

- ✓ Carbon di oxide when dissolved in water it forms carbonic acid.

$$2H_2O + CO_2 \rightarrow H_2CO_3$$

- ✓ This carbonic acid attacks many rocks and minerals and brings them into solution.

- ✓ The carbonated water has an etching effect up on some rocks, especially lime stone.

Oxidation

- Process of addition and combination of oxygen to minerals.
- The absorption is usually from O2 dissolved in soil water and that present in atmosphere.
- The oxidation is more active in the presence of moisture and results in hydrated oxides.(e.g) minerals containing Fe and Mg.

$4FeO$ (Ferrous oxide) + $O_2 \rightarrow 2Fe_2O_3$
(Ferric oxide)

$4Fe_3O_4$ (Magnetite) + $O_2 \rightarrow 6Fe_2O_3$
(Haematite)

$2Fe_2O_3$ (Haematite) + $3H_2O \rightarrow 2Fe_2O_3.3H_2O$
(Limonite)

Reduction

- Process of removal of oxygen and is the reverse of oxidation and is equally important in changing soil colour to grey, blue or green as ferric iron is converted to ferrous iron compounds.

- Under the conditions of excess water or water logged condition (less or no oxygen), reduction takes place.

$2Fe_2O_3$ (Haematite) $- O_2 \rightarrow$ $4FeO$

Biological Weathering

- Unlike physical and chemical weathering, the biological or living agents are responsible for both decomposition and disintegration of rocks and minerals.

- The biological life is mainly controlled largely by the prevailing environment.

Some biological weathering processes are:

- **Rocks can break because of animal burrowing**
- **Tree roots grow into cracks and widen them, which helps physical weathering**
- **Bacteria, lichens and other organisms secrete acidic solutions, which helps chemical weathering**

Higher Plants and Roots

- The roots of trees and other plants penetrate into the joints and crevices of the rocks.

- As they grew, they exert a great disruptive force and the hard rock may break apart.

Lichens on rocks cause biological weathering.


Making a million friends is not a miracle. The miracle is to make a friend who will stand by you when millions are against you
Thank u