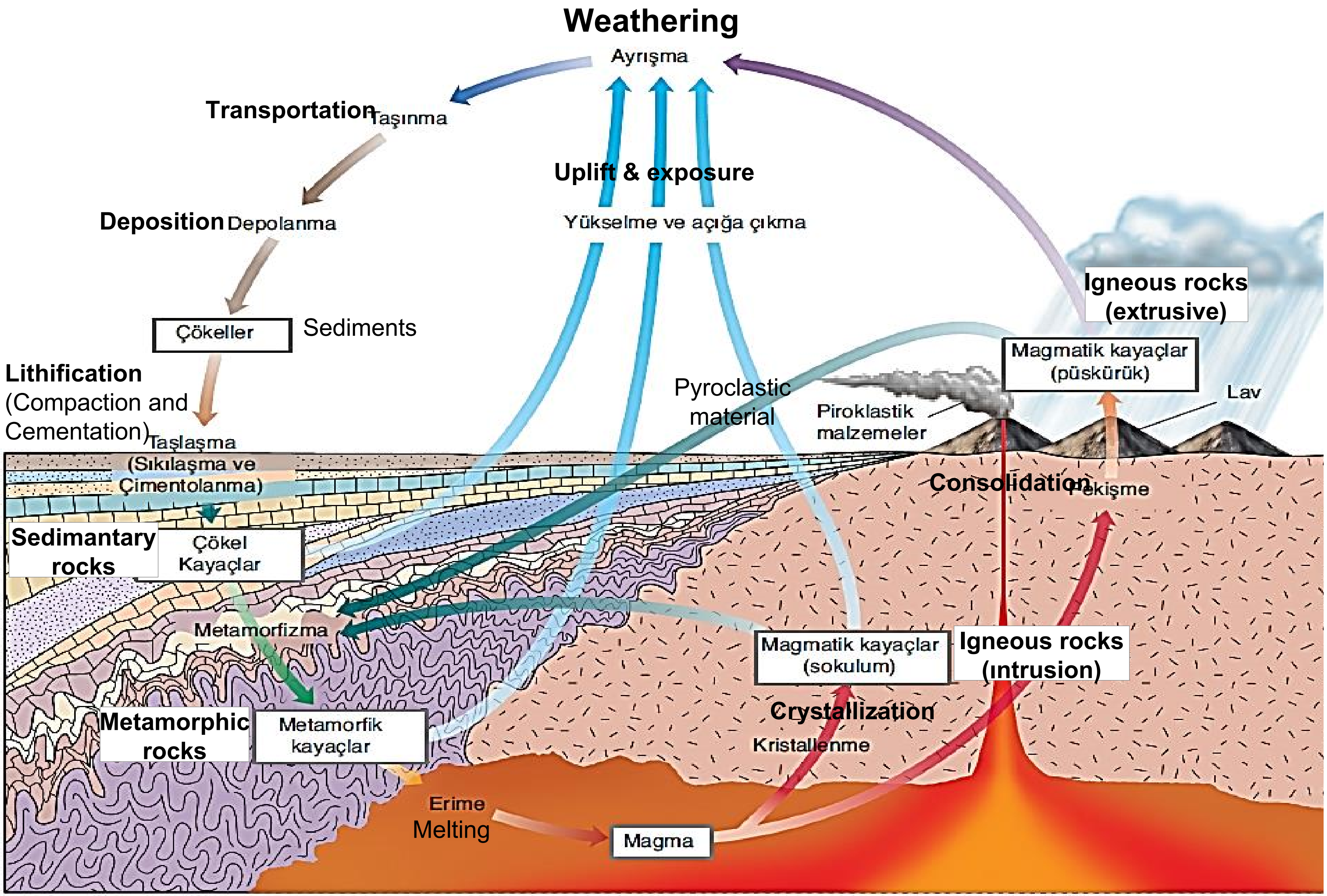

Weathering
Ayrışma
Transportation
Taşınma
Deposition
Depolanma
Çökeller
Sediments
Lithification
(Compaction and
Cementation)
Taşlaşma
(Sıkılaşma ve
Çimentolanma)
Sedimantary
rocks
Çökel
Kayaçlar
Metamorfizma
Metamorphic
rocks
Metamorfik
kayaçlar
Erime
Melting
Magma
Uplift & exposure
Yükselme ve açığa çıkma
Pyroclastic
material
Piroklastik
malzemeler
Igneous rocks
(extrusive)
Magmatik kayaçlar
(püskürük)
Lav
Consolidation
Pekişme
Magmatik kayaçlar
(sokulum)
Igneous rocks
(ıntrusion)
Crystallization
Kristallenme

Şekil 1.14

You may see this chapter in a slide show at the WEB adress:

https://www.slideshare.net/KalebWilson/topic-5-weathering-and-sediments

Weathering, Erosion & Soil

(Ayrışma, Aşınma ve Toprak)

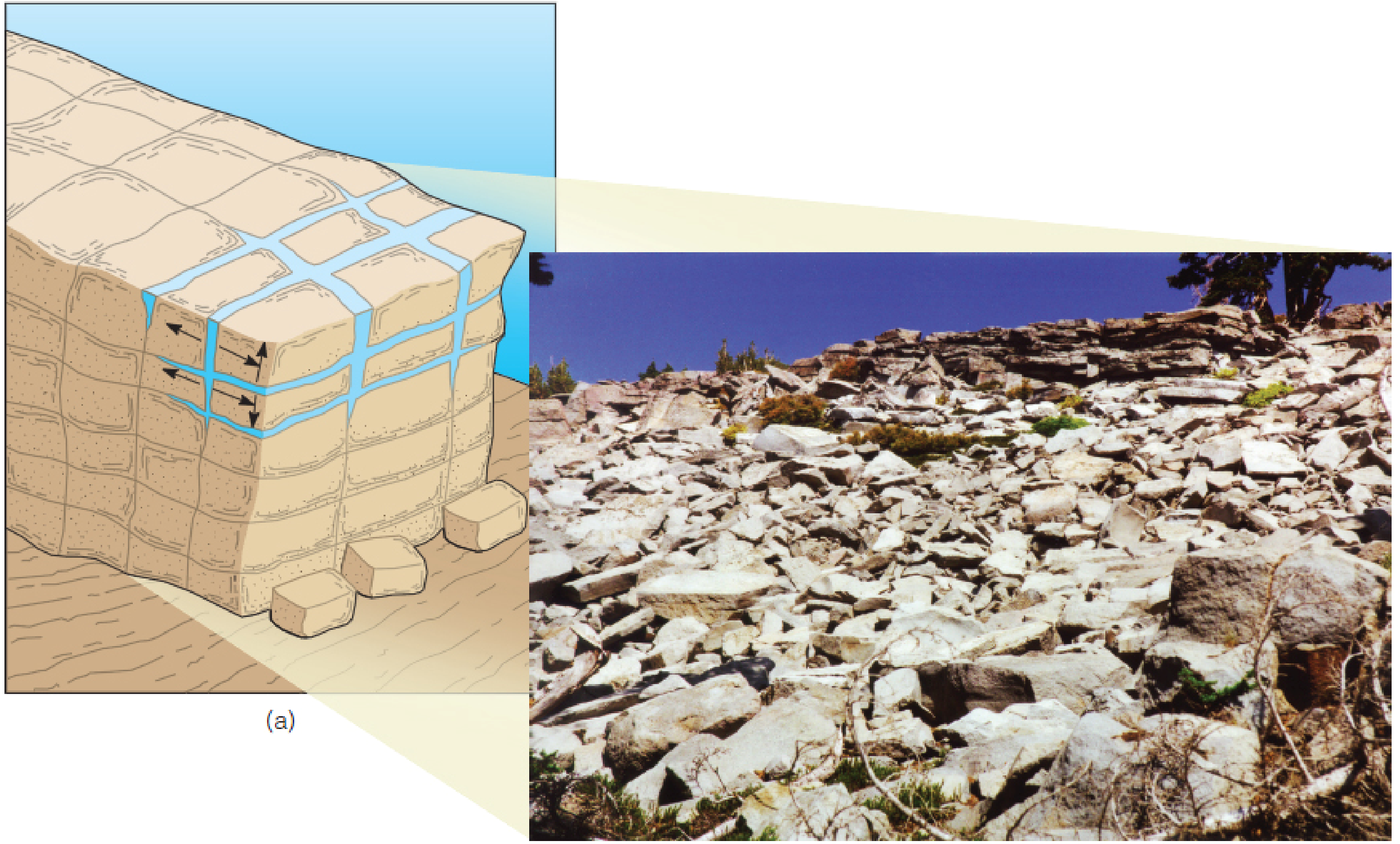
Weathering, defined as the physical breakdown ***(disintigration)*** and chemical alteration ***(decomposition)*** of the rocks and minerals at or near the surface.

Weathering takes place at different rates even in the same area, which commonly results in uneven surfaces. Differential weathering and **differential erosion** - that is, ***variable rate of erosion*** - combine to yield some unusual and even bizarre features.


Monroe & Wicander 2005

Mechanical / Physical weathering (Fiziksel ayrışma)

Mechanical weathering takes place when physical forces break Earth materials into smaller pieces that retain the chemical composition of the parent material. The physical processes responsible for mechanical weathering includes **frost action**, **thermal expansion and contraction**, **salt crystal growth** and **activities of organisms**.



(a)

(b)

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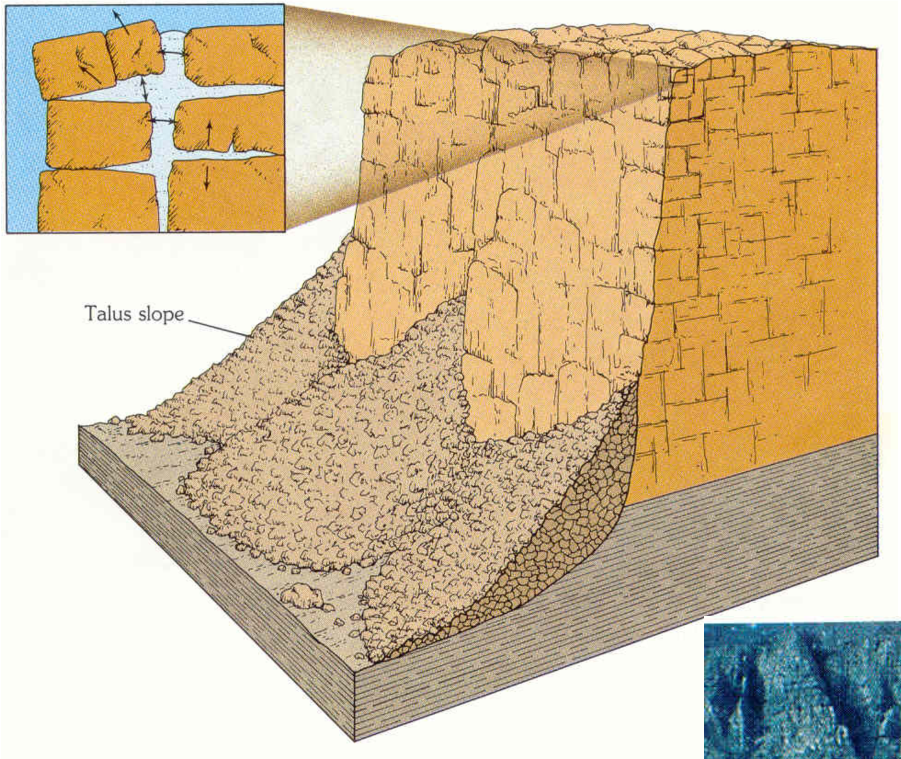
Frost action involving repeated freezing and thawing of water in cracks and pores in rocks is particularly effective where temperatures commonly fluctuate above and below freezing.



Frost wedging (**Don kamalanması**).

takes place when water seeps into cracks and expands as it freezes.

Angular pieces of rock are pried loose (*parçalanmak, ayrılmak*) by repeated freezing and thawing (*çözülmek*). Loose fragments accumulate at the foot of cliff as **talus**.

Monroe & Wicander 2005

Thermal Expansion and Contraction ***(Isıl Genleşme ve Büzülme)***

During ***thermal expansion and contraction,*** the volume of rocks changes in response to heating and cooling. In desert, where the temperature may vary as much as 30°C in one day, rocks expand when heated and contract as they cool. Rock is a poor conductor of heat, so its outside heats up more than its inside; the surface expands more than interior, producing stresses that may cause fracturing.

Fire causes very rapid expansion. During the **forest fire**, rocks may heat very rapidly, especially near the surface, because they conduct heat so poorly. The heated surface layer expands more rapidly than the interior, and thin sheets paralleling the rock surface become detached.

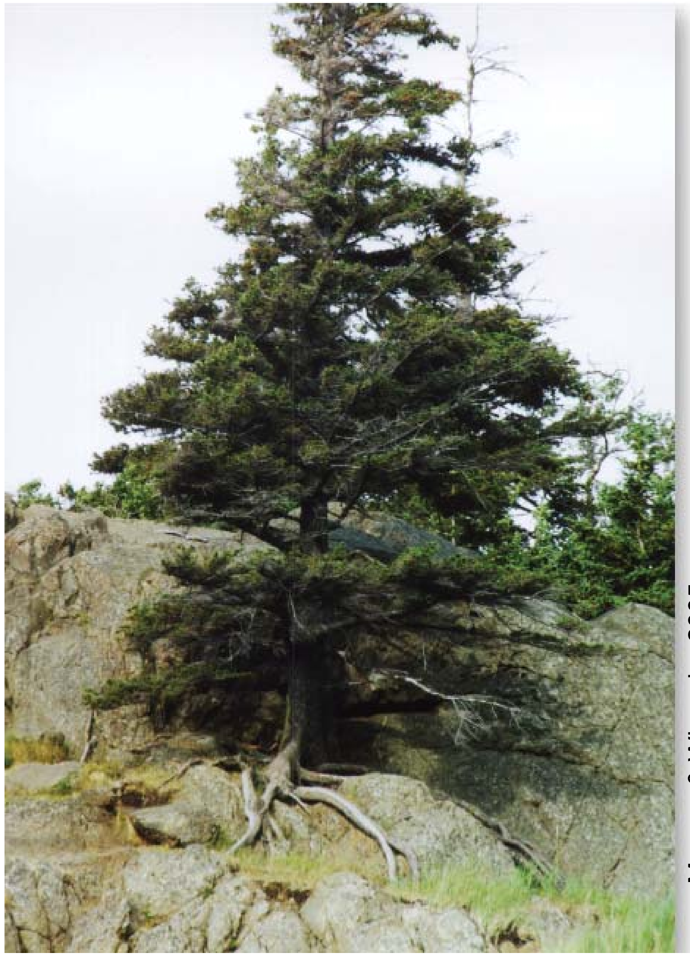
Growth of Crystals *(Kristallerinin Büyümesi)*

Growing crystals exert enough force to widen cracks and crevices or dislodge particles in porous, granular rocks such as sandstone. Even in crystalline rocks such as granite, **salt crystal growth** may pry loose individual minerals. It is similar to frost wedging. Most salt crystal growth occurs in hot, arid areas, although it probably affects rocks in some coastal regions as well.

Activities of organisms *(Canlıların Etkinlikleri)*

Animals, plants, and bacteria all participate in the mechanical and chemical alteration of rocks. Burrowing animals, such as worms, termites, reptiles, rodents, many others constantly mix soil and sediment particles and bring material from depth to the surface where further weathering occurs.

The **roots of plants**, especially large bushes or trees, wedge themselves into cracks in rocks and further widen them. **Lichens** on the rocks derive their nutrients from the rock and contribute to chemical weathering.



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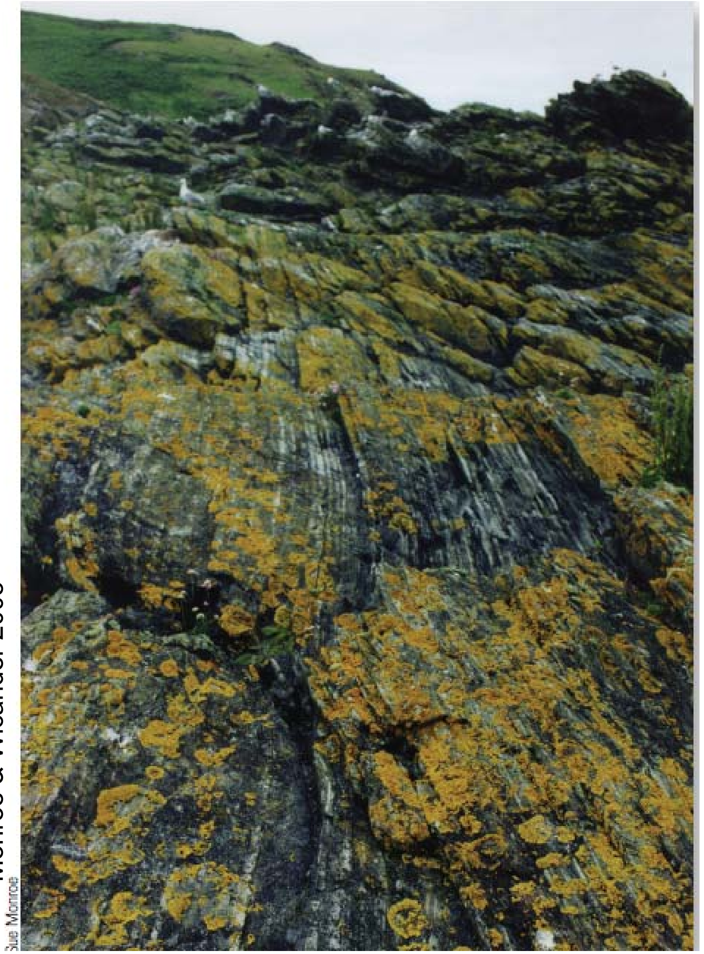


Sue Monroe

Chemical Weathering (decomposition of earth materials)

(Kimyasal Ayrışma)

Chemical weathering includes those processes by which rocks and minerals are decomposed by alteration of parent materials. *In contrast to mechanical weathering, chemical weathering results in a change in the composition of weathered materials.*

Important agents of chemical weathering include atmospheric gases, especially oxygen, water, and acids. Chemical weathering processes include **solution, oxidation**, and **hydrolysis**.

Solution (Çözünme)

During **solution,** the ions of a substance separate in a liquid and the solid substance dissolves.

$$\underset{\text{SU}}{H_2O} + \underset{\substack{\text{KARBON}\\\text{DİOKSİT}}}{CO_2} \rightleftharpoons \underset{\substack{\text{KARBONİK}\\\text{ASİT}}}{H_2CO_3} \rightleftharpoons \underset{\substack{\text{HİDROJEN}\\\text{İYONU}}}{H^+} + \underset{\substack{\text{BİKARBONAT}\\\text{İYONU}}}{HCO_3^-}$$

$$\underset{\text{KALSİT}}{CaCO_3} + \underset{\text{SU}}{H_2O} + \underset{\substack{\text{KARBON}\\\text{DİOKSİT}}}{CO_2} \rightleftharpoons \underset{\substack{\text{KALSİYUM}\\\text{İYONU}}}{Ca^{+2}} + \underset{\substack{\text{BİKARBONAT}\\\text{İYONU}}}{2HCO_3^-}$$

Madagascar rock forest

Oxidation ***(Yükseltgenme / Oksidasyon/ oksitlenme)***

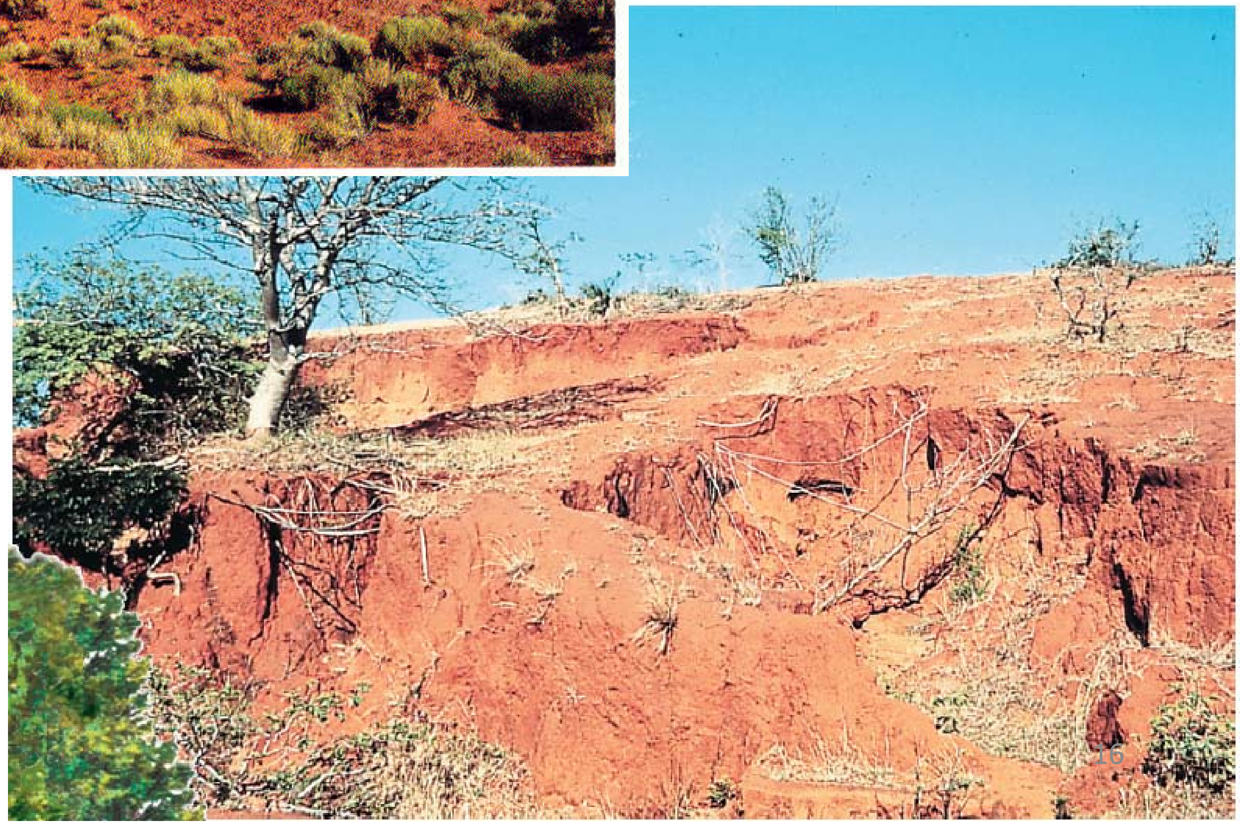
The term **oxidation,** in chemical weathering refers to reactions with oxygen to form an oxide (one or more metallic elements combined with oxygen) or if water is present, a hydroxide (a metallic element or radical combined with OH). Most oxidation is carried out by oxygen dissolved in water.

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

DEMİR + OKSİJEN → DEMİR OKSİT (HEMATİT)

Oxidation is important in the alteration of ferromagnesian silicates such as olivine, pyroxenes, amphiboles and biotite. Iron in these minerals combines with oxygen to form the reddish iron oxide **hematite** (Fe_2O_3) or the yellowish or brown hydroxide **limonite** [$FeO(OH).nH_2O$].

The oxidation of iron sulfide such as the mineral pyrite (FeS_2) is commonly associated with coal, so in mine taiilings pyrite oxidizes to form **sulfuric acid** (H_2SO_4) and iron oxide. Acid soils and waters in coal-mining areas are produced in this manner and present a serious environmental hazard.



Laterite is a deep red soil that formed in Madagascar (below photograph)

Hydrolysis (Hidroliz)

Hydrolysis, is the chemical reaction between the hydrogen (H+) ions and hydroxyl (OH-) ions of water and a mineral's ions.

In hydrolysis, hydrogen ions actually replace positive ions in minerals thus changing the composition of minerals and liberating soluble compounds and iron that then may be oxidized.

The chemical weathering of potassium feldspar by hydrolysis occurs as follows:

$$\underset{\text{ORTOKLAZ}}{2KAlSi_3O_8} + \underset{\text{HİDROJEN İYONU}}{2H^+} + \underset{\text{BİKARBONAT İYONU}}{2HCO_3^-} + \underset{\text{SU}}{H_2O} \rightarrow$$

$$\underset{\text{KİL (KAOLİNİT)}}{Al_2Si_2O_5(OH)_4} + \underset{\text{POTASYUM İYONU}}{2K^+} + \underset{\text{BİKARBONAT İYONU}}{2HCO_3^-} + \underset{\text{SİLİS}}{4SiO_2}$$

In this reaction, hydrogen ions attack the ions in orthoclase structure, and some liberated ions are incorporated in developing **clay minerals**, while others simply go into solution. On the right side of the equation is excess silica that would not fit into the crystal structure of the clay mineral. This **dissolved silica** (SiO2) is an important ***source of cement that binds together the particles in some sedimentary rocks***.

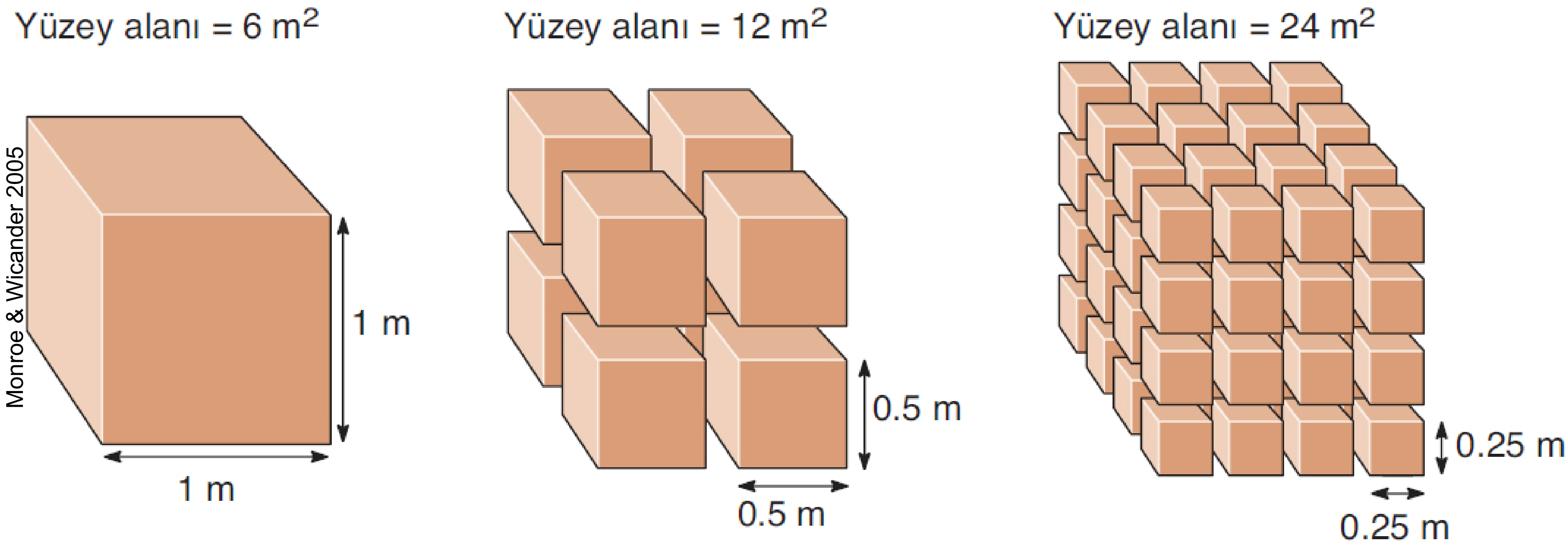
How Fast Does Chemical Weathering Take Place?

Chemical weathering operates on the surface particles, so rocks and minerals alter from the outside inward. Rocks commonly have a rind of weather material near the surface but are completely unaltered inside. **The rate at which chemical weathering proceeds depends on several factors.** One is simply the presence or absence of several fractures, because fluids seep along fractures, causing more intense chemical weathering along these surfaces. Thus, given the same rock type under similar conditions, the more fractures, the more rapid the chemical weathering. Other factors controlling the rate of chemical weathering are particle size, climate, and parent material.

Fluids seep along fractures in rocks where chemical weathering is more intense than it is in unfractured parts of the same rock. Notice too that a narrow white band near the left side of the image. This is a quartz vein that is more resistant to chemical weathering than its granitic host rock.

How Does the Particle Size Affect the Rate of Chemical Weathering?

Because chemical weathering affects particle surfaces, the greater the surface area, the more effective the weathering. It is important to realize that small particles have larger surface areas compared to their volume than do large particles.

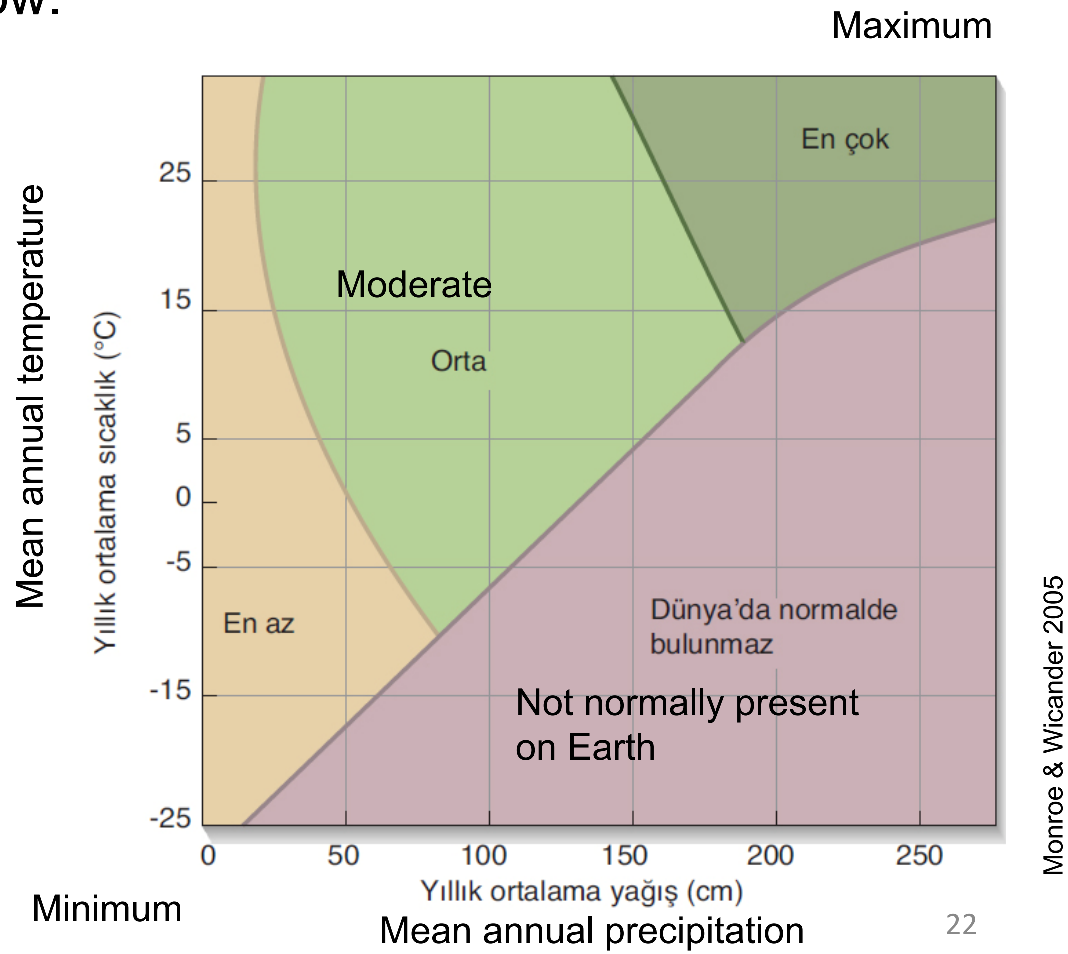


Particle size and chemical weathering. As a rock is divided into smaller and smaller particles, its surface area increases but its volume remains the same. In (a) the surface area is 6 m^2, (b) it is 12 m^2, and in (c) 24 m^2, but the volume remains the same at 1m^3. Small particles have more surface area compared to their volume than do large particles.

Climate and Chemical Weathering (İklim ve Kimyasal Ayrışma)

Chemical processes proceed more rapidly at high temperatures and in the presence of fluids. So chemical weathering is more effective in the tropics than in arid and arctic regions because temperatures and rainfall are high and evaporation rates are low.

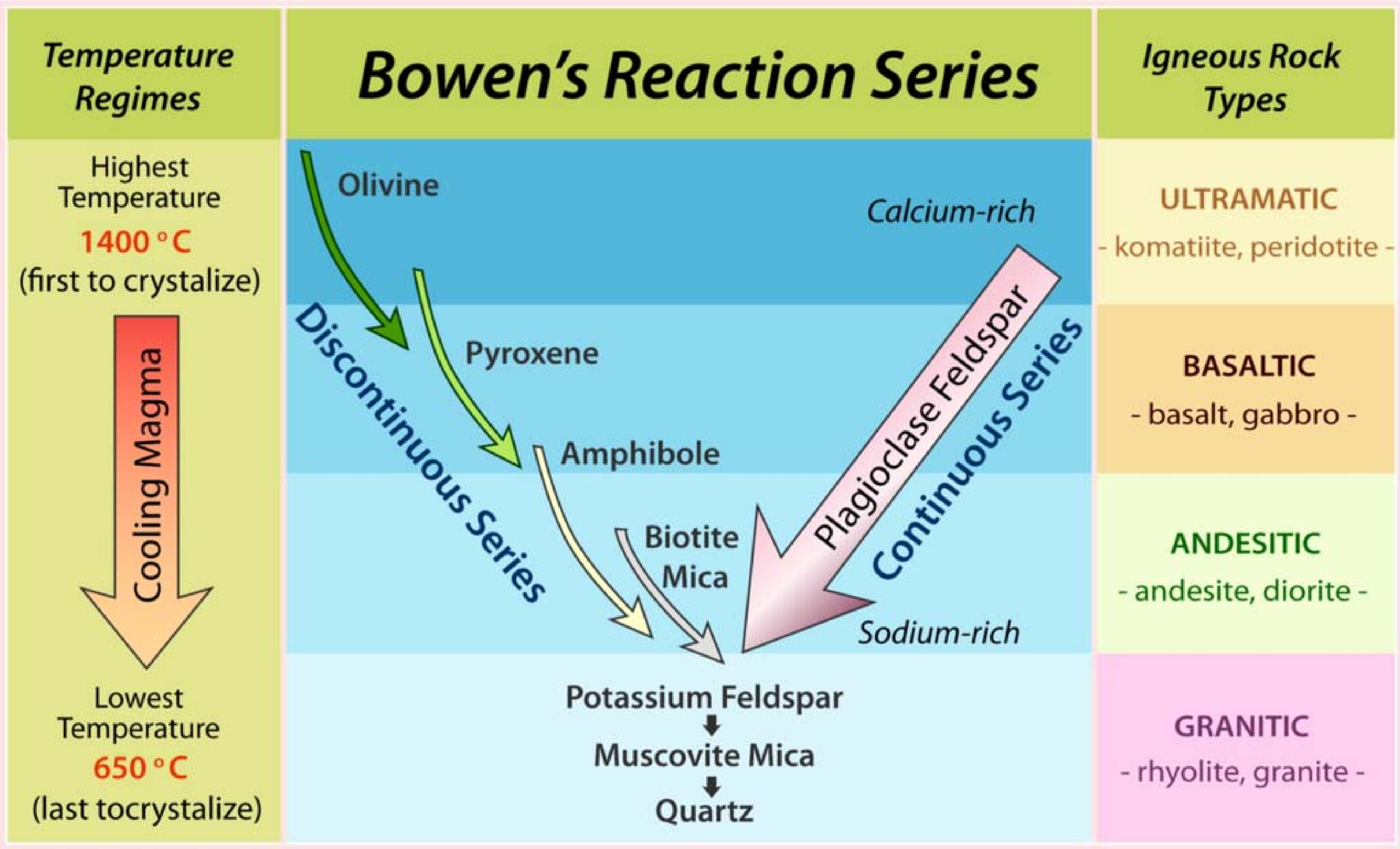
Relationships of chemical weathering rates and climate. Chemical weathering is at a maximum where temperature and rainfall are high, and minimum in arid environments where hot or cold.



The Importance of Parent Material ***(Ana Malzemenin Önemi)***

Some rocks are more resistant to chemical alteration than others and not altered as rapidly. The metamorphic rock quartzite, composed of quartz (SiO_2), is an extremely stable substance that alters very slowly compared with most other rock types. In contrast, basalt, with its large amount of calcium-rich plagioclase and pyroxene minerals, decomposes rapidly because these minerals are chemically unstable. The stability of common minerals is just the opposite of their order of crystallization in Bowen's reaction series.

Bowen's Reaction Series

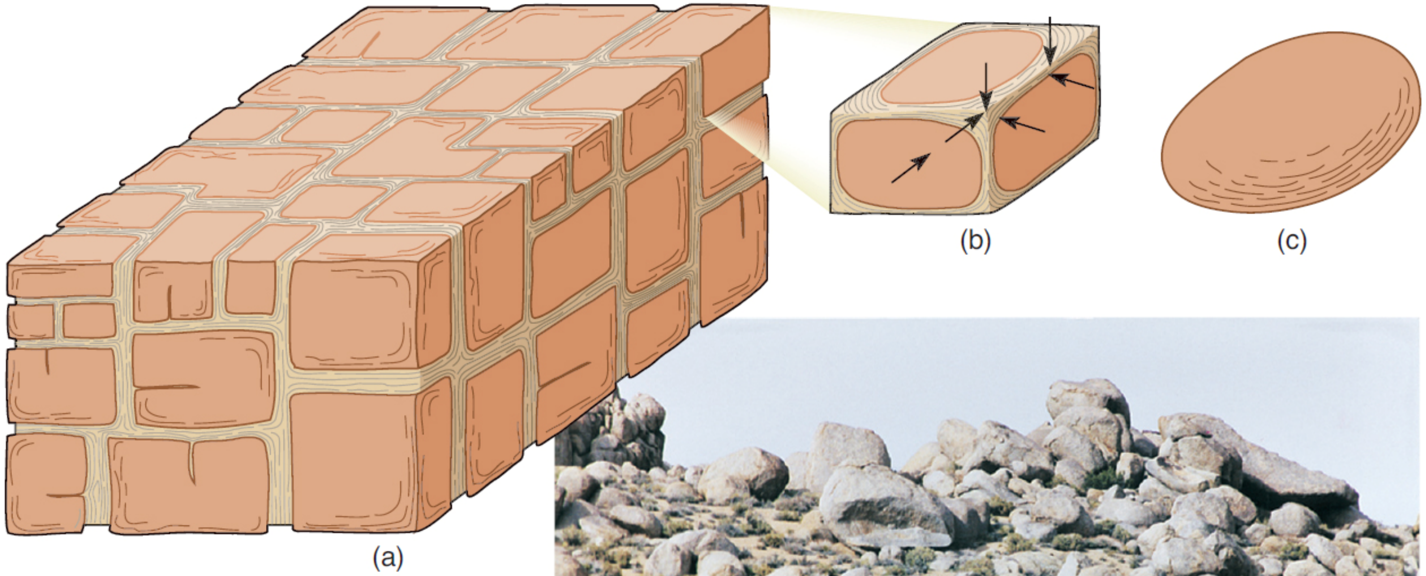


https://quizlet.com/221066826/bowens-reaction-series-geology-diagram/

Stability of Silicate Minerals

	Ferromagnesian Silicates	Nonferromagnesian Silicates
Increasing Stability ↓	Olivine	Calcium plagioclase
	Pyroxene	
	Amphibole	Sodium plagioclase
	Biotite	Potassium feldspar
		Muscovite
		Quartz

Order in which silicate minerals react during mechanical and chemical weathering is the reverse of the Bowen's reaction series.



Monroe & Wicander 2005

Spheroidal weathering (küresel ayrışma). (a) The rectangular blocks outlined by fractures are attacked by chemical wethering processes, (b) the corners and edges are weathered most rapidly. (c) When a block has weathered so that its shape is more nearly spherical. (d) Exposure of granitic rocks reduced to spherical boulders.

Product of Weathering-SOIL (Ayrışma ürünleri / TOPRAK)

Regolith, a collective term for sediment regardless of how it was deposited, as well as layers of pyroclastic materials and the residue formed in place by weathering.

Soil, consists of weathered materials, air, water, and organic matter.

Soil on bedrock

Humus consists of carbon derived by bacteria decay of organic matter and is highly resistant to further decay. It is important source of plant nutrients and it enhances moisture retention.

Residual soil, if a body of rock weathers and the weathering residue accumulates over it, the soil so formed is residual, meaning that is formed in place.

Transported soil, developes on weathered material that was eroded and deposited elsewhere, such as on stream's floodplain.

Soil Profile ***(Toprak Kesiti)***

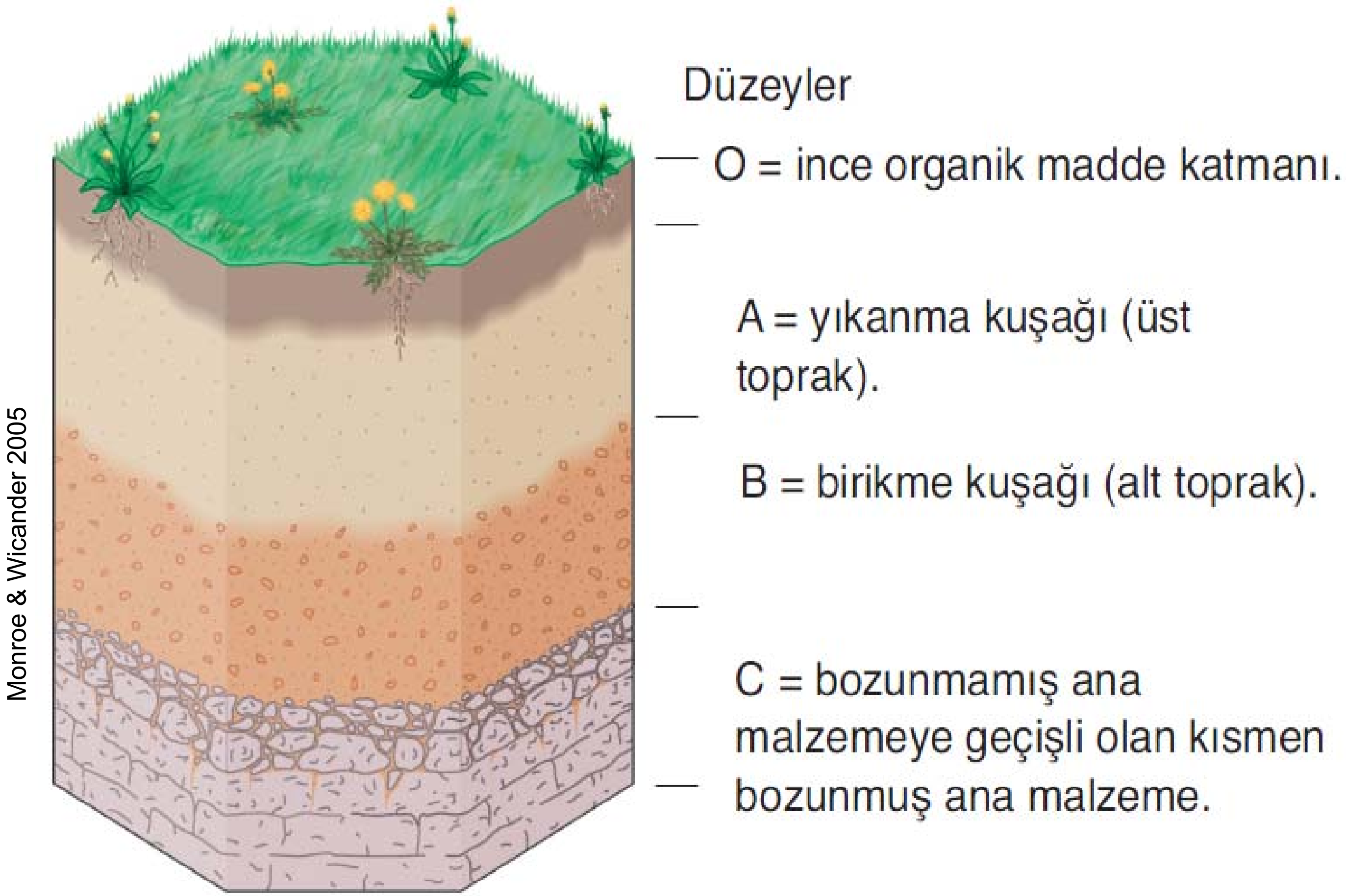
In a vertical cross-section, a soil has distinct layers, or soil horizons, that differ from another in texture, structure, composition and color. Starting from the top, the horizons are designated O, A, B, and C, with transitional boundaries.

Horizon O, consist of organic matter which is named as humus,

Horizon A (top soil), characterized by intense biological activity because plant roots, bacteria, fungi, and animals such as worms are abundant. Horizon A consists mostly of clays and chemically stable minerals such as quartz. Water percolating down through horizon A dissolves soluble minerals and carries them away or down to lower levels in the soil by a process called ***leaching***, so horizon A is also known as ***zone of leaching***.

Horizon B (sub soil), also known as **zone of accumulation**, because soluble minerals leached from horizon A accumulate as irregular masses.

Horizon C, consists of partially altered parent material grading down to unaltered parent material.



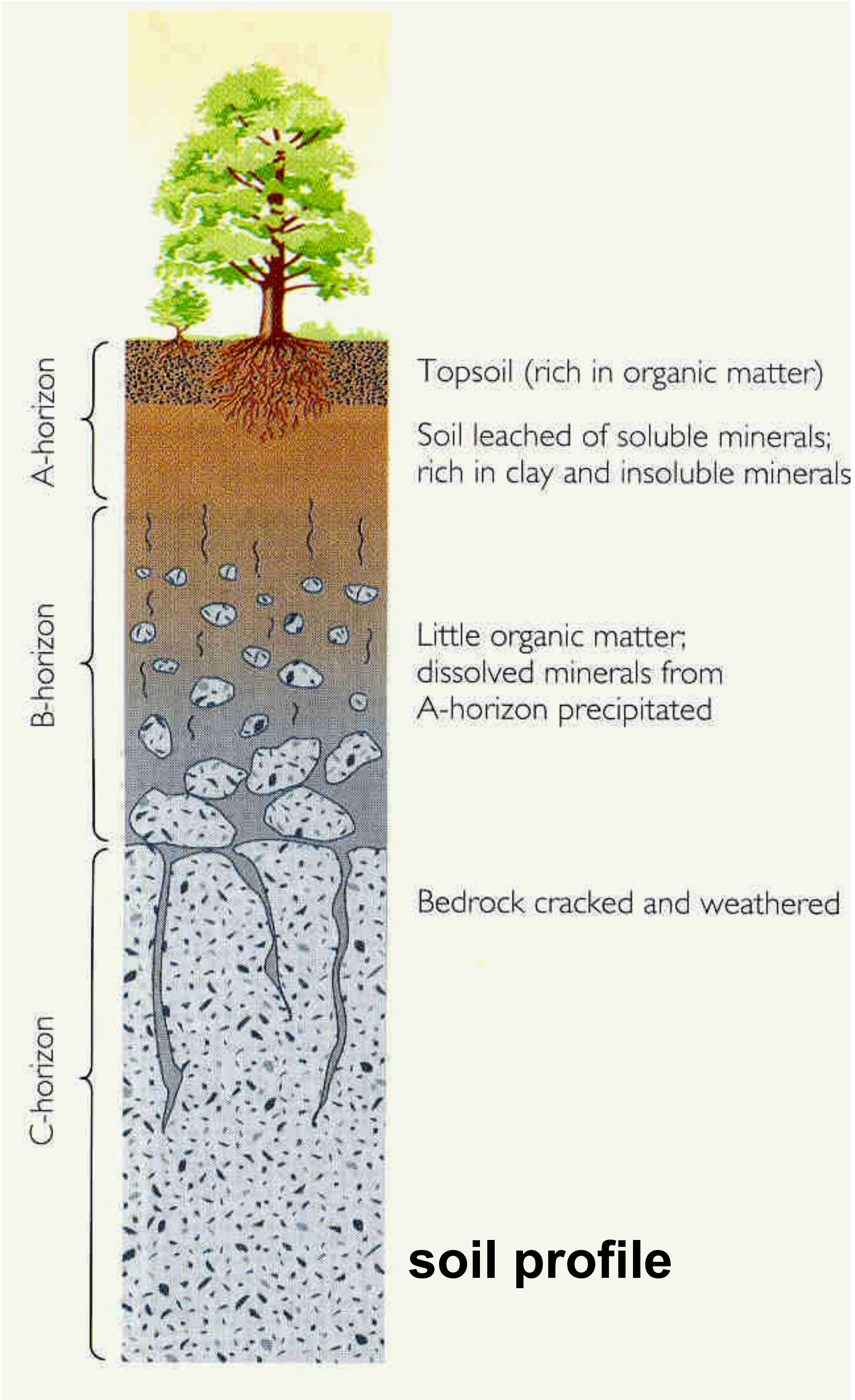
Factors controlling soil formation

Climate, parent material, organic activity, relief and slope, and time are the critical factors in soil formation.

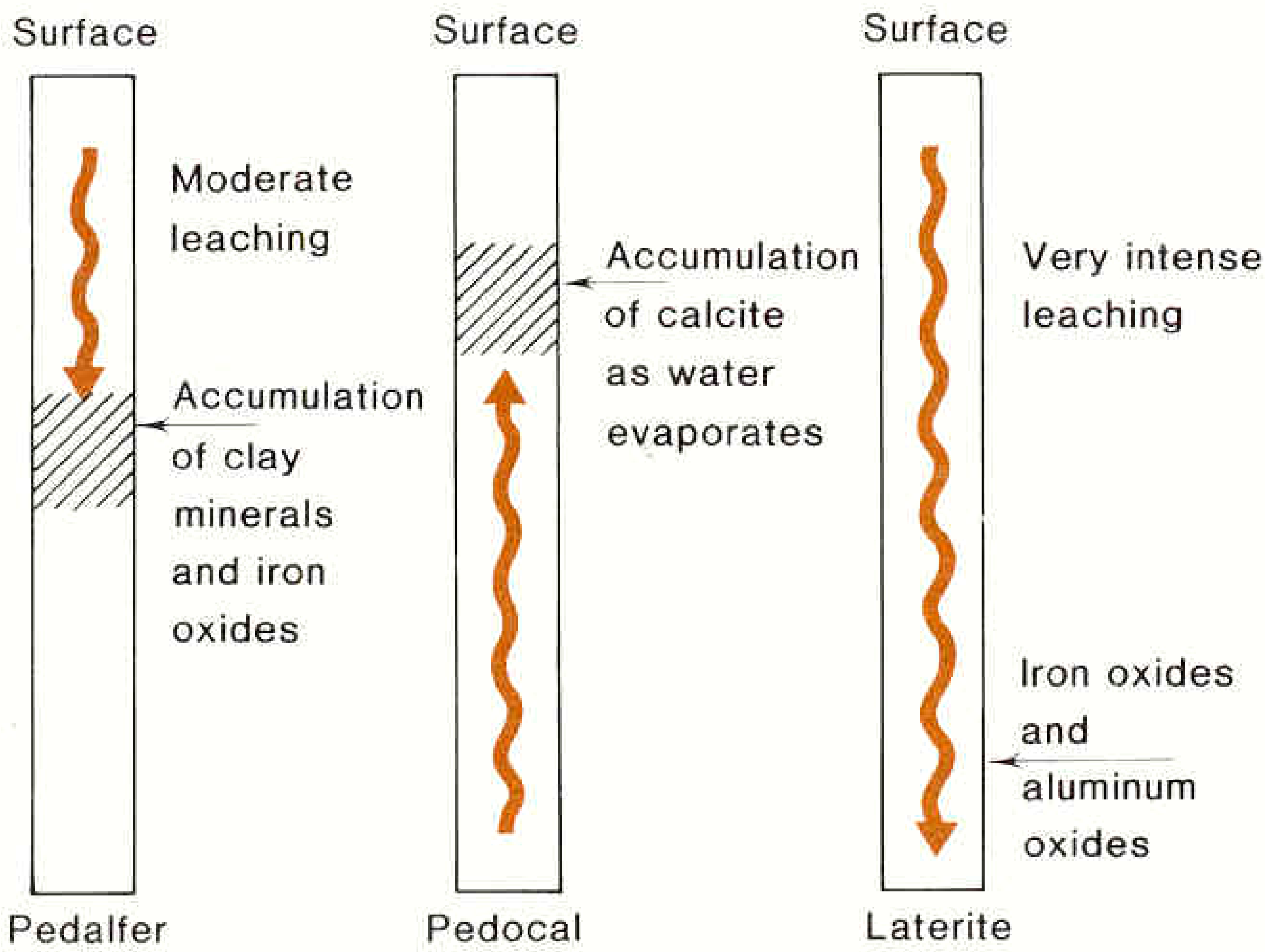
Climate and soil

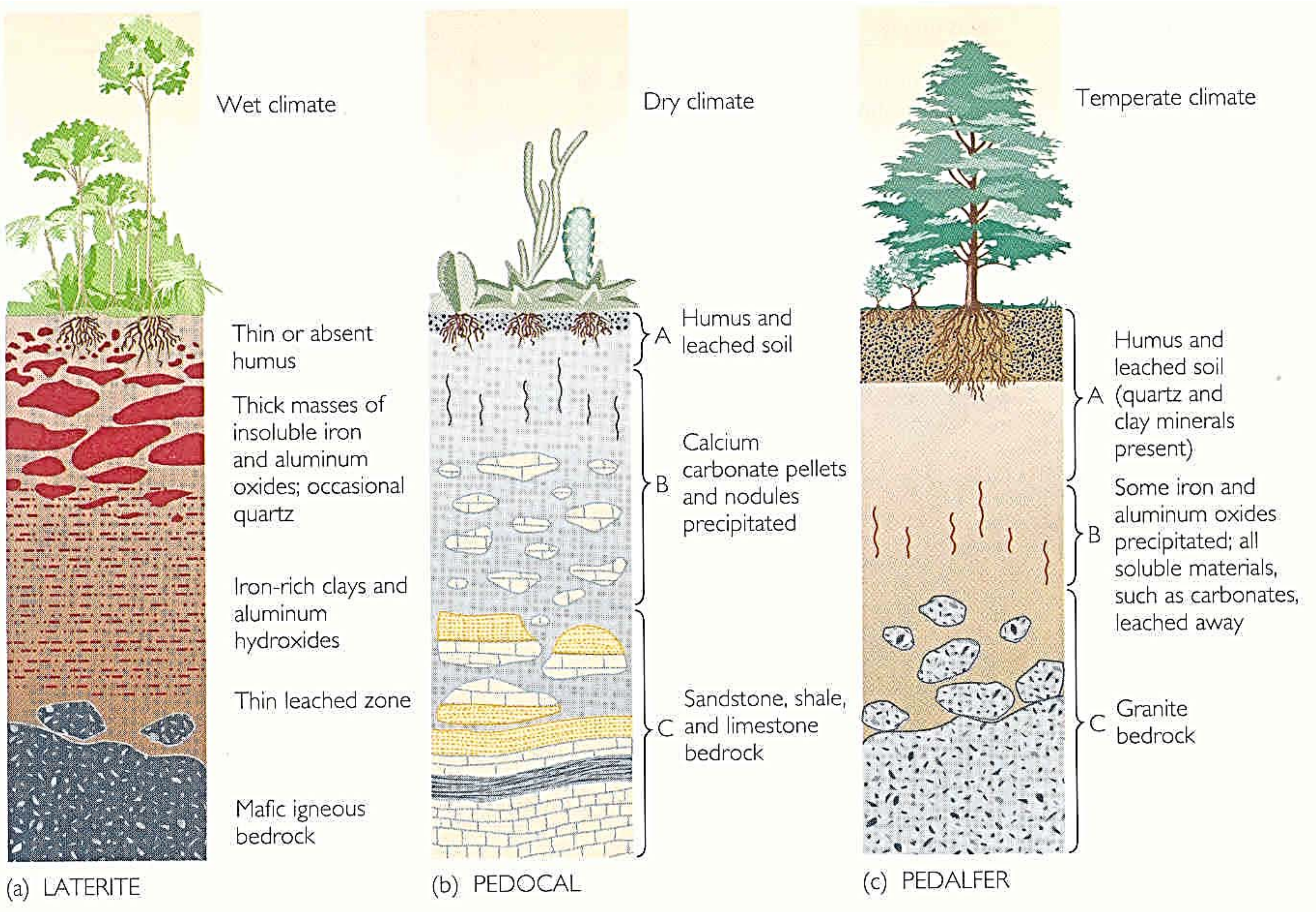
Based on the characteristics of climate setting, soils are classified into three categories: namely pedalfer, pedocal and laterite.

Soils that develop in humid regions are pedalfers, a name derived from greek word pedon, meaning soil, and from the chemical symbols for aluminum (Al) and iron (Fe).



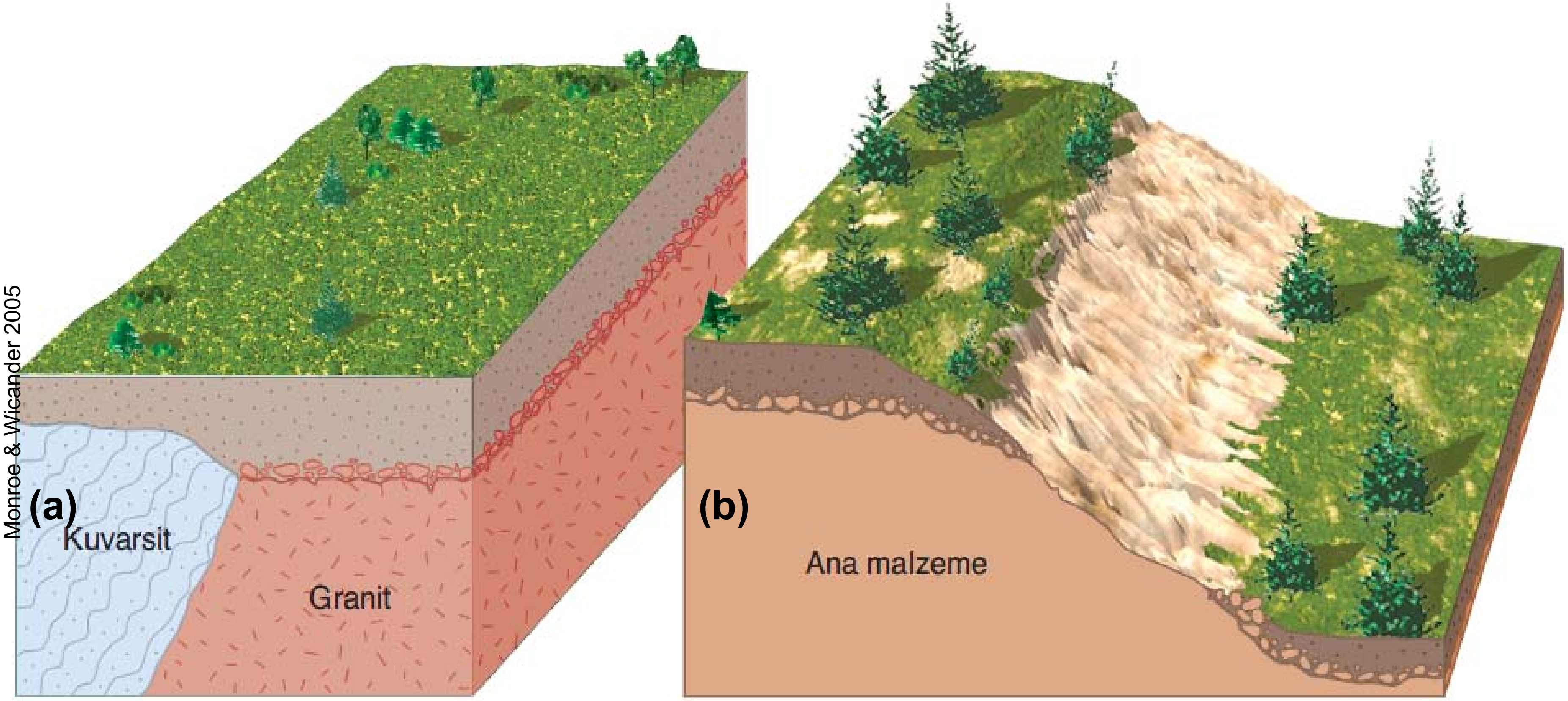
soil profile


Surface
Surface
Surface
Moderate leaching
Accumulation of clay minerals and iron oxides
Accumulation of calcite as water evaporates
Very intense leaching
Iron oxides and aluminum oxides
Pedalfer
Pedocal
Laterite

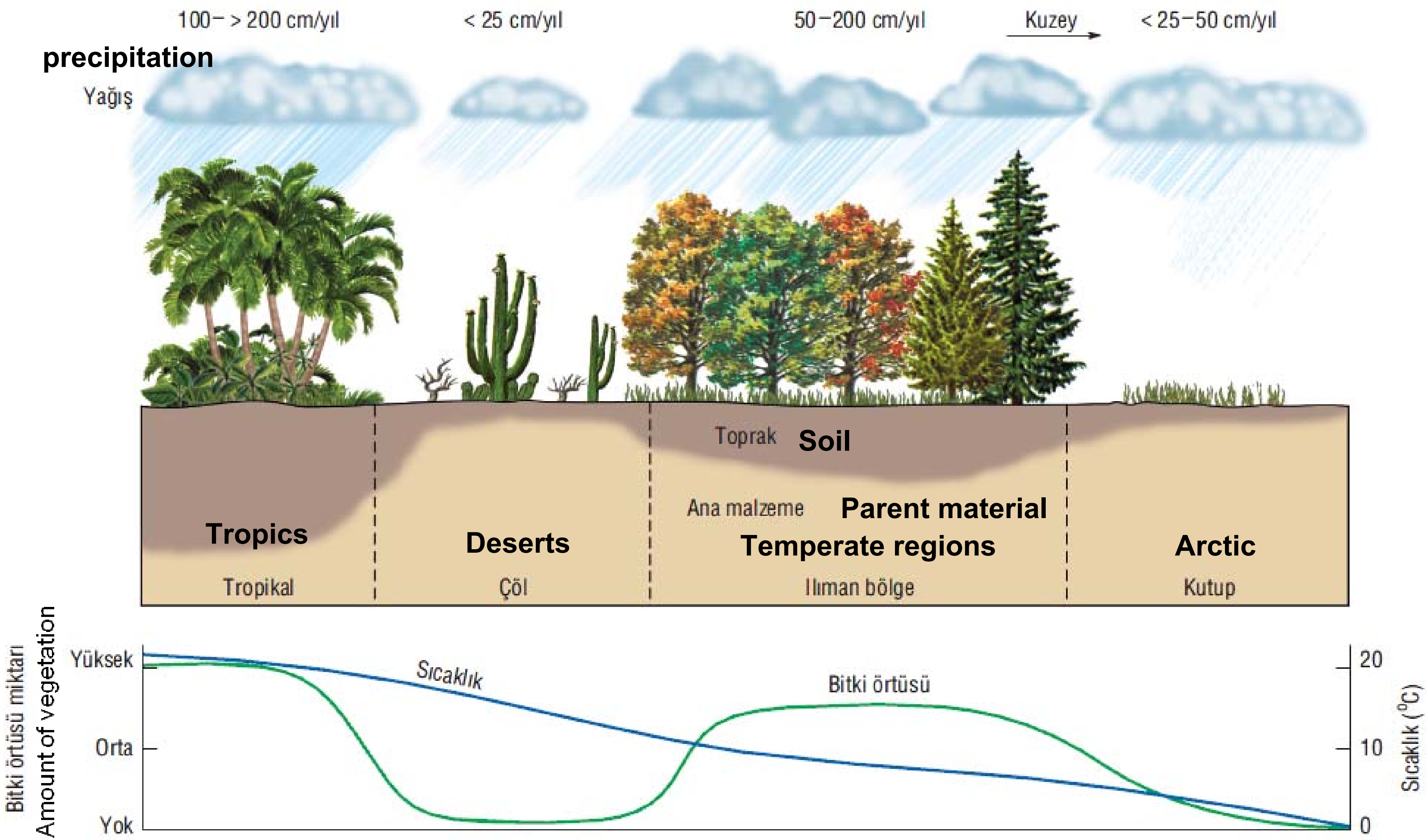


Wet climate
Thin or absent humus
Thick masses of insoluble iron and aluminum oxides; occasional quartz
Iron-rich clays and aluminum hydroxides
Thin leached zone
Mafic igneous bedrock
(a) LATERITE
Dry climate
A
Humus and leached soil
B
Calcium carbonate pellets and nodules precipitated
C
Sandstone, shale, and limestone bedrock
(b) PEDOCAL
Temperate climate
A
Humus and leached soil (quartz and clay minerals present)
B
Some iron and aluminum oxides precipitated; all soluble materials, such as carbonates, leached away
C
Granite bedrock
(c) PEDALFER

The influence of **parent material (rock type)** on soil development. Quartzite is resistant to chemical weathering, where as granite alters more quickly **(a)**.



The effect of **slope** on soil formation. Where slopes are steep, erosion occurs faster than soil can form **(b).**



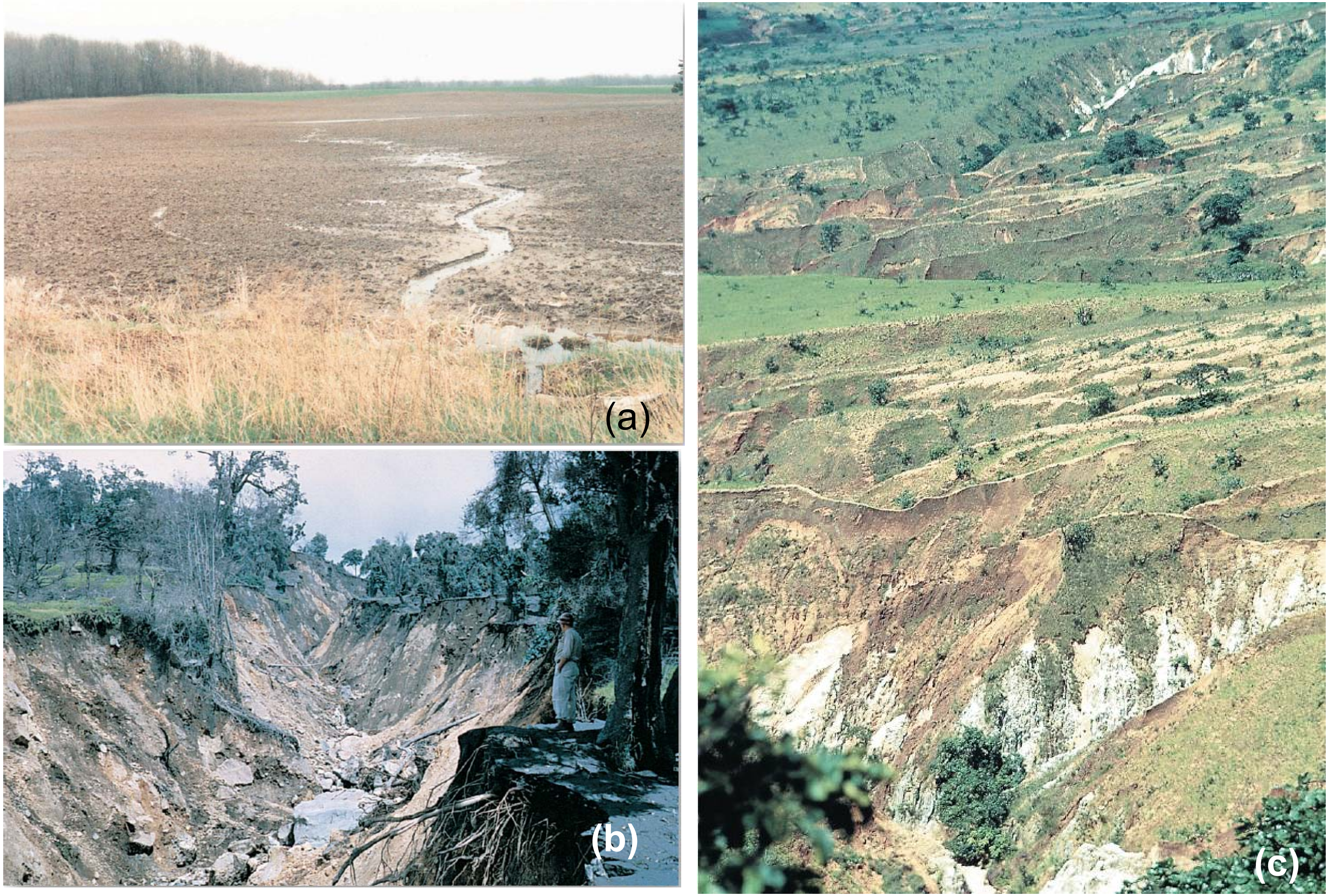
Generalized diagram showing soil formation as a function of the relationships between climate and vegetation, which alter parent material over time. Soil-forming processes operate most vigorously where precipitation and temperatures are high, as in the tropics.

SOIL DEGRADATION

Any loss of soil to erosion or decrease in soil productivity resulting from physical and chemical phenomena is collectively called ***soil degradation.***

The three general types of soil degradation are ***erosion***, ***chemical deterioration***, and ***physical deterioration***, each with seperate but related processes.

Soil Erosion: Wind and running water are responsible for most soil erosion. Wind is certainly effective in some areas, especially on exposed soils, but running water is capable of much greater erosion. Some soil is removed by ***sheet erosion***, which erodes thin layers of soil over an extensive, gently sloping area by water not confined to channels. ***Rill erosion*** takes place when running water scours small, troughlike channels. If these channels are shallow, they are called rills, but if deeper than 30 cm, they are called gullies.



Monroe & Wicander 2005

(a) Rill erosion in a field during a rain storm. (b) A large gully. (c) Accelerated soil erosion on a bare surface that was once covered by lush forest.

WEATHERING AND NATURAL RESOURCES

Soils are one of our most precious natural resources. ***Laterite*** and ***bauxite*** are important for ore of aluminum. If the parent material is rich in aluminum, bauxite accumulates in B horizon of soil profile.

Bauxites and other accumulations of valuable minerals (iron, manganese, clays, nickel, phosphate, tin, diamonds, gold) formed by the selective removal of soluble substances during chemical weathering are known as ***residual concentrations.***

Most of the economic deposits of various clay minerals formed by sedimentary processes or by hydrothermal alteration of granitic rocks, but some are residual concentrations. ***Kaolinite deposits*** are important examples of such deposits. Kaolinite is a type of clay mineral used in the manufacture of ceramics and paper.

A **Gossan** is a yellow to red deposit made up mostly of sulfide minerals such as pyrite (FeS_2). The dissolution of pyrite and other sulfides form sulfuric acid, which causes other metallic minerals to dissolve, and these tend to be carried down toward the ground water table, where the descending solutions form minerals containing copper, lead, and zinc. And below the water table, the concentrations of sulfide minerals forms the bulk of the ore minerals. ***Gossans have been mined for iron, but they are far more important as*** *indicators* ***of underlying ore deposits.***