

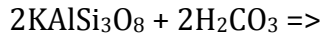
Weathering and Soils2

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S18

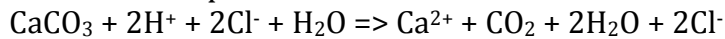
Chemical weathering by dissolution, acid attack, and hydration:

potassium feldspar and carbonic acid => kaolinite and dissolved silica, K, and bicarbonate:



S19

Acid attack: exposure to acid enhances dissolution of the mineral in water.



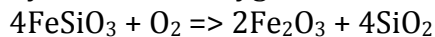
S20

Pitting of a 2,500-yr old, limestone Greek temple caused chiefly by acid attack. Segesta, Italy.

S21

Weathering by oxidation, mediated by water:

Pyroxene and oxygen => hematite and dissolved silica



S22 Table 5.1

Minerals that remain in detrital sediments following low to intense weathering of a granite.

S23

Chemical weathering of a granite.

S24

Spheroidal weathering of a boulder.

S25

The negative charges on the surface of a clay mineral attract the positive ends of water molecules.

S26

Ion exchange between a plant root and a clay mineral.

S27

Spheroidal Weathering

Spheroidal weathering creates rounded rocks in outcrops as weathering advances into the bedrock by first attacking corners

Rounded shapes in rocks are usually contributed to physical movement such as rolling in a river

S28

Weathering Rates
Rock Characteristics
Climate
Differential Weathering

S29 Table of Bowen's Reaction Series minerals plus
Weathering rates of common minerals. Those that weather the most slowly (top) dominate detrital sediments and sedimentary rocks.

S30

Variations in weathering type and intensity with variations in climate (rainfall and temperature)

S31

Resistance to physical and chemical weathering determined by rock type. Slate (left) is resistant, marble (right) is less so.

S32

Dissolving Bedrock Limestone Areas of bedrock limestone (which contains the mineral Calcite) are dissolved by natural carbonic acid found in rainwater
This process creates a type of landform called Karst
Moderate to heavy rainfall is needed to create Karst features

S33

Weathering Creates Sediments
Physical Fragments of rocks & minerals as well as chemicals in solution are created by the weathering process
Weathered debris is referred to as Sediment

Sediments are often cemented back together to form sedimentary rocks

S34

Soil

Soil covers most land surfaces and is one of our resources – plants use the minerals in soil and make the minerals available to animals

Soil is an intersection between the geosphere, hydrosphere, atmosphere, and biosphere

Soil develops in response to complex interactions between the spheres

S35

Soil

Regolith is the layer of rock and mineral fragments produced by weathering

Soil is a combination of mineral, organic matter, water, and air – the portion that supports plant growth

Soil water is not pure water but a complex solution containing soluble nutrients

S36

Soils: Composition

45 % Mineral Matter

25 % Water

25 % Air

5% Organic Matter

S37

Controls of Soil Formation

Parent material determines how fertile the soil will be

underlying bedrock -> residual soil

unconsolidated material such as a stream deposit -> transported soil

Time – how long the process has been operating influences the soil characteristics

Climate – temperature and precipitation affects the type, rate, and depth of weathering

Plants and Animals – provide organic matter to the soil

Topography- steep slopes lead to no soil, flat leads to no drainage

S38

A typical soil profile, showing the A, B, and C horizons.

S39

Soils: Horizons

O Horizon: Organic Material

A Horizon: Minerals/Humus

E Horizon: Zone of Eluviation

B Horizon: Accumulation Zone

C Horizon: Partly Altered Rock

Unweathered Bedrock

(“Unaltered Parent Rock”)

S40

Oxisols (Laterites)

These soils have very little organic matter due to high temperatures & high decay rates

Accumulations of iron & aluminum oxides

S41

Diagram of a laterite soil profile developed on a mafic igneous rock in a tropical climate.

Only Fe- and Al-oxides, Fe-rich clays, Al-OH, and some quartz remain in the A horizon.

S42

Tropical Rain Forest Climates

Rain Forest vegetation is lush & dense and is found in the Amazon Basin, although the vegetation is lush the soils are poor in nutrients

S43

Equatorial Climates: High Precipitation & Temperatures

Rainfall near the Equator can be 60 - 200 inches per year creating extreme leaching of soil minerals, high temperatures create rapid decay of organic debris from the lush, dense vegetation

S44

Oxisols (Laterites): Profile & Location

Nearly all oxisol soils are located in Equatorial South America & Africa

S45

Equatorial Climates: Soil Fertility & Human Impact

Although Lateritic Soils appear fertile, they are poor Agricultural soils in a delicate balance with their natural vegetation

Once cleared by humans, Laterite Soils cannot easily re-grow natural Rain Forest vegetation

S46

Mollisols (Prairie Soils)

Mollisol Soils are rich in calcium (Ca) and Aluminum (Al) and occur in the central United States

This soil group includes the world's most fertile agricultural soils (often called a regions "*Bread Basket*")

S47

Diagram of a pedalfer soil profile developed on granite in a temperate climate with high rainfall.

Only Fe and Al-oxides, quartz, and clay minerals remain in the A and B horizons.

S48

Aridisols: Desert Soils

Aridisols are developed in drier climates, are rich in calcium carbonate and salts They occur in the western United States.

When provided with irrigation water they are often rich agricultural soils

S49

Diagram of a pedocal soil profile developed on sedimentary rocks in a dry climate. The A-horizon is leached and the B-horizon is enriched in precipitated CaCO_3 .

S50

Pedocal soil profile showing (from top down):

A horizon (black).

B horizon (light-red).

K horizon (white, CaCO_3 -rich).

C horizon (light-colored).

Measuring stick is 3 m long.

S51

Aridisols: Vegetation Types

Vegetation in drier climate Soils is adapted to infrequent & low water (rain) during the year

Native plants are drought tolerant & include cactus, grasses, small trees & bushes

Many of these soils have little or *No* organic matter because plants do not lose leaves like forested regions

S52

Dividing Dry & Wet Soils

In United States the line dividing for dry & wet soils is the line for 20 inches per year of precipitation and runs north/south from North Dakota to central Texas

S53

Soil erosion

Due to rain and wind and loss of plant cover

S54

Bauxite – principle ore of aluminum created as a result of enrichment by weathering processes