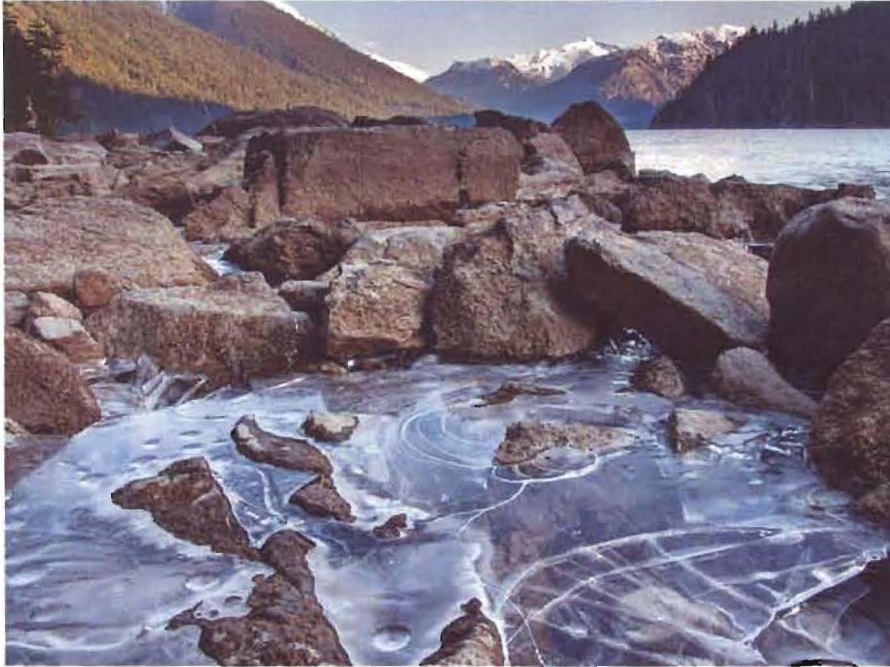


ES322 Geomorphology – Class Assignment

Key Word Search on Weathering

I. Physical Weathering

The process in which rocks are eroded and broken down into smaller rocks by natural physical processes such as wind, water, ice, plants, gravity, and climate. The type of



a. Exfoliation

Rock is buried (ex: Lava chamber or Batholith cools underground) Overtime land above is eroded as tectonic uplift pushes rock up. The rock becomes exposed and flakes off in layers as the overburden of soil and tremendous pressures the rock experienced at the depths in which it formed are lifted. The rock is composed of deep hot lava rocks that are not as stable at the earth's surface and as such are more susceptible to erosion.



b. Freeze-Thaw

Changing climate throughout the year (ideally that of the 45th parallel) produces conditions whereby rocks freeze and thaw in a relatively wet environment. As rain falls it percolates down through tiny cracks and fractures in the rock and stays there as temperatures drop in the winter and freezes. Due to the density of water compared to ice, the ice expands in volume as it freezes increasing the pressure inside the cracks and expanding them. As this persists the effect is exponential whereby more cracks are formed allowing more water to intrude in and freeze, eventually breaking down the rock.



c. Thermal Expansion

$PV=NRT$ or the ideal gas law can be used to explain thermal expansion. As the temperature goes up, so must the pressure of the gas on its container or, if the gas is uncontained, higher temperatures result in higher volumes or greater gas diffusion. This same idea can be applied to rocks. At higher temperatures, and at constant pressure, the outside of rocks will expand in volume and this jump can cause jointing and fracturing resulting in a form of physical weathering. A great example of this is when a fire passes through an area causing the rocks outer layers to flake off in sheets. The rock itself is not a good conductor of energy so the heat of the fire expands the outside of the rock, but since the heat doesn't travel through the rock, only the hot outside expands as the inner cool core stays neutral. This expansion in volume results in layers of heated rock flaking and popping off the heated areas.



II. Chemical Weathering

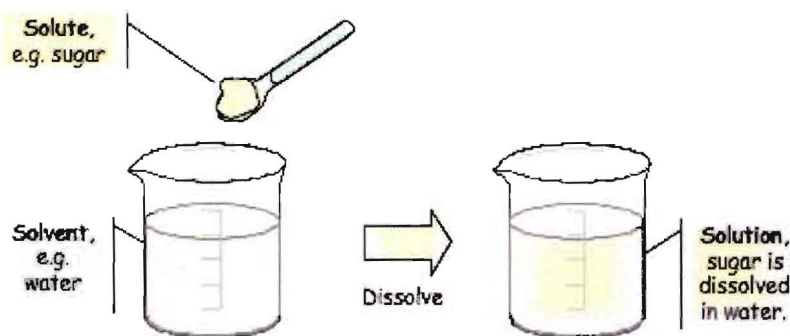
Chemical weathering is the process where chemicals, such as acids and bases, breakdown rocks into smaller pieces. The most common and prevalent form of this is acid rain which is caused when water precipitates on CO_2 molecules in the atmosphere and forms HCO_3^- or carbonic acid. The acid breaks down potassium and other soluble ions trapped in the crystalline lattice of minerals releasing and altering the mineral.

a. Oxidation and Reduction

Oxidation is loss, reduction is gain. When a chemical reaction occurs, occasionally it occurs in such a way that an ion exchange happens or where one atom in the reaction is ionized (Ex: Iron rusting, it is oxidized as oxygen strips its electrons, the oxygen is then reduced). Both atoms in an oxidation reduction reaction, having lost and gained electrons, have been ionized.

b. Solution

A solution is a homogenous mixture where a solute is dissolved in a solvent. (Ex: salt (solute) is dissolved in water (solvent)).



c. Hydrolysis

Hydrolysis is a chemical reaction where water is split into proton donors and acceptors and reacts with other chemicals. Geologically, the weathering of spheroidal boulders is thought to be caused by this process. This is also the process whereby K^+ can be split off of granites breaking them down into gruss.

d. Clay Formation

Clay is created due to the breakdown of potassium aluminosilicate feldspars and other aluminosilicate minerals at the earth's surface and the subsequent thermal maturation of the eroded materials due to burial and then geothermal heating. The minerals are broken down due to chemical weathering from carbonic acid rain at the earth's surface where they pool and collect in rivers, lakes, or marine basins. Once the eroded materials percolate down or are buried for a long period of geologic time, the silicates are then heated at 100 to 200 degrees celsius because of either geothermal or hydrothermal (heated groundwater) heat. Over more geologic time, the

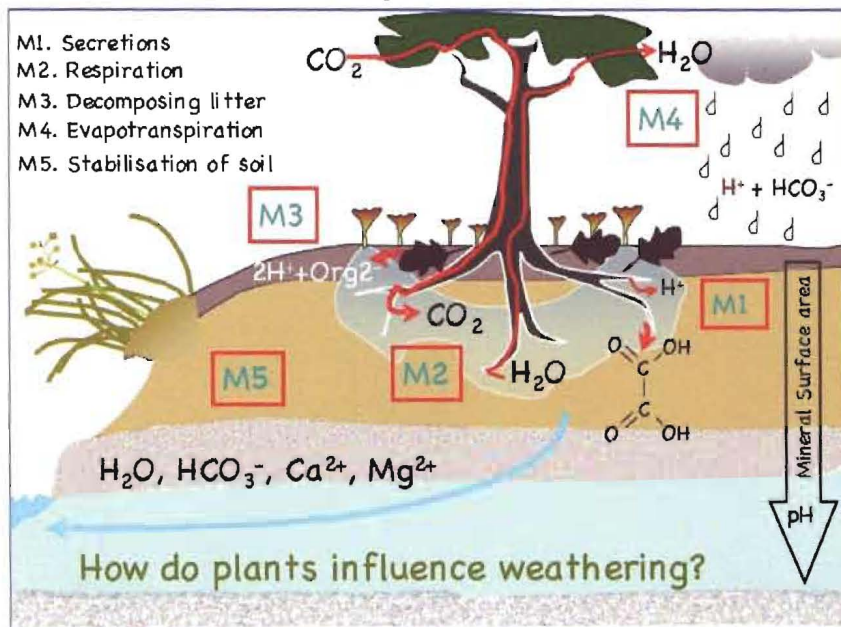
eroded minerals become clay and over more time, the clay may be tectonically uplifted and exposed and then mined for commercial use.



Excavation pit at A&K Clay Co. where the high-purity "Ohio Slip" clay is quarried and processed for distribution to pottery and ceramics customers across the country. Photo: Paul Potter

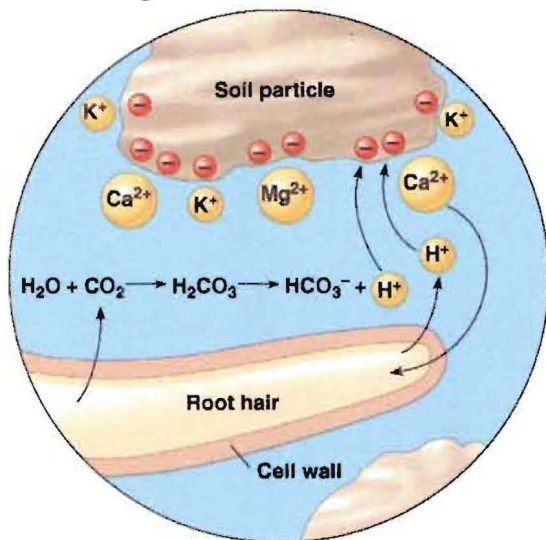
e. Chelation

Chelation is the process where organic compounds gain metal elements or ions through breaking down minerals in rocks. lichens, fungi, moss, and even trees can do this when they grow on top of or next to rocks. Using an ion exchange the plant or fungi attach Iron, magnesium, calcium, manganese or copper to it's organic compounds, either incorporating the metal into its structure or removing the whole compound altogether. Overtime the continuous removal of these metals weakens the structure causing it to erode and breakdown.



f. Cation Exchange

H^+ , K^+ , Ca^{2+} , and Al^{3+} are all common cations found in soils. Soil scientist can determine how many of these are in the soil and thus how acidic the soil is, as well as how suitable the soil is for certain plants. This is very useful as some plants require acidic soils to thrive. The process happens as plants convert CO_2 and H_2O into carbonic acid providing H^+ ions that are available for exchange with the desired ions from the soil.



III. Soils

a. Five Soil Forming Factors

Organisms: From humans to termites, organisms have a great impact on soil development and transport. Massive anthropogenically altered landforms are now present all around the globe and represent a new age for soil development.

Climate: different soils form in different environments. A humid environment with warm temperatures will form soil much more rapidly than a cool dry environment.

Time: soils need time to form (thousands of years) and are constantly changing due to the other soil forming factors.

Parent Material: Different rock materials erode at different rates and are susceptible to different types of erosional processes. Felsic granites erode at a much higher rate than mafic basalts.

Topography: Different topographic features influence different soils differently. For instance, a valley bottom between hillslopes will collect eroded material from the hillslopes making the valley fertile. If a river passes through the valley it will carry that eroded material and with enough time it the materials will make it to the ocean. However if that same river valley floods, the flood water may bring in additional nutrients to the soil rejuvenating its nutrient content.

b. Eluviation

Some soils have greater rainfall than evaporation causing the excess water to percolate downward due to gravity. This water can have dissolved ions and particles suspended in it bringing these materials down to lower soil horizons, a process referred to as Eluviation.

c. Illuviation

The process where dissolved ions and particles in one soil horizon travel due to groundwater flow and are redeposited in either in a hillslope environment or river environment. The deposition of the illuvium is dependent on the porosity and permeability of the underlying soils and bedrock.

d. A Horizon

The first soil horizon, it is generally characterized by coarser grained particles than the underlying horizons and an increased porosity and permeability. Earthworms like to hang out here.

e. B Horizon

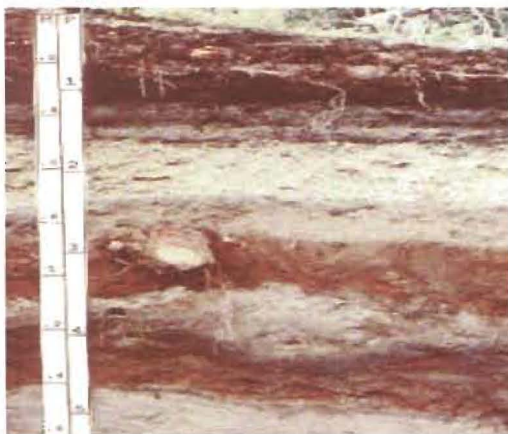
The second soil horizon, it has less permeability than the above layers of soil and thus is more dense. This horizon along with the underlying generally catch Eluvium.

f. C Horizon

The third and lowest soil horizon, it has some bedrock in it and has the lowest permeability of the three soil horizons.

g. Andisol

A soil composed of volcanic ash with high glass content and amorphous colloidal materials.



h. Aridisol

A soil which is located in a arid or semi-arid environment. They are dominant in the shrub lands or 'badlands' which accounts for about 1/3 of earth's surface land



i. Mollisol

The soil found in grasslands. The A horizon is dark and nutrient rich due to continual deposition of organic materials from the grassland plants. They commonly form in semi-arid to semi-humid environments and are considered the most arable soil for farming.



j. Spodosol

The soils of the coniferous or boreal forest. They are often sandy in nature and thus poor for agriculture, however their constant supply of decaying organic material from trees and shrubs keeps the forest supplied with enough nutrients to survive.



k. Oxisol

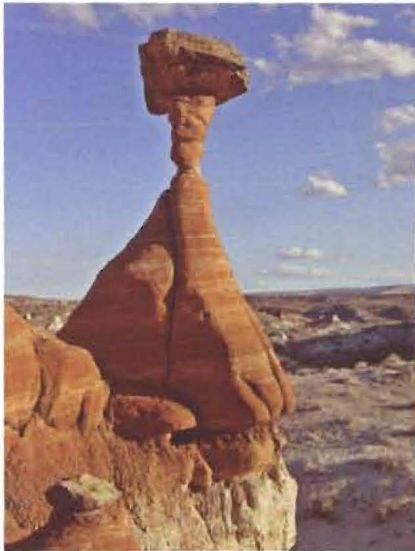
Tropical rainforest grow on top of oxisols. They are characteristically rich in iron (III) and aluminum oxides as well as hydroxides giving them their yellow red color. Oxisols are extremely nutrient deficient and the vegetation on them gathers the majority of its nutrients from decaying leaf litter. The humid environment actually prevents the soils from holding as many nutrients as the water percolating down through the leaf litter forms carbonic acid due to the leaching of carbon from decaying organic material. As the carbonic acid percolates down into the soils, it leaches Ca^{+2} , K^{+} , and Al^{+3} ions through the H^{+} ions in the Carbonic acid performing an ion exchange. After this happens the cations are carried away suspended or dissolved in the water, through the natural processes of groundwater and watersheds

a. Spheroidal weathering

Spheroidal weathering occurs when large blocks of rock are weathered around their joints producing spheroidal boulders. This is common in basalt as when it cools, it contracts and it forms hexagonal pillars which would preferentially erode into a more spherical shape. The process is not fully understood as there are differing opinions on how the joints originate since not all spheroidal corestones are of igneous origin. Another school of thought asserts that the process is caused by hydrolysis where water is split into proton acceptors and donors (bases and acids) and preferentially splits the rock in joints and weathers the corners down.

b. Hoodoo

A tall spindly canyon or badland rock pillar topped with a boulder or wider section of harder rock resulting from differential erosion. As the climate changes throughout the year freeze thaw cycles crack and fracture rocks in addition to acid rain which causes the underlying softer rock to erode more quickly than the above harder cap rock.





I. Paleosol

an ancient soil, a soil that formed in the past, may contain fossils. (all soils could be paleosols by this definition) soil science definition: a soil that has formed in the past wherein the above topography does not match the underlying soils composition, chemically or texturally.



m. Soil Chronosequence

A quantified way of sequencing the underlying layers of soil in order of age and origin (parent material). Generally, the lower the soil, the older in age, however in some specific situations that may not be the case. Soil chronosequences are interested in the environment of deposition and how the soils evolve overtime with changing environmental conditions.

IV. Weathering Landforms