Soil Forming Factors

About Weathering

As you drive or ride in a car, take a train or plane, ride a bike ride, or go for a nature walk you see the spectacular and varied landscapes on Earth's surface. As Earth's crust is built up by volcanic and tectonic forces (thrusting and deformation of Earth's crust), weathering forces simultaneously reduce landforms and release minerals from rocks. Natural weathering processes occur around us everyday, continually rearranging and building landforms on Earth's surface.

Chemical Weathering Processes

Chemical weathering occurs as minerals in rocks are chemically altered, and subsequently decompose and decay. Increasing precipitation (rain) speeds up the chemical weathering of minerals in rocks, as seen on tombstones and monuments made of limestone and marble. In fact, **water is an essential factor of chemical weathering**. Increasing temperature also accelerates the chemical reaction that causes minerals to degrade. This is why humid, tropical climates have highly weathered landforms, soils, and buildings.

Carbonation and Solution: this weathering process occurs when precipitation (H_20) combines with carbon dioxide (CO_2) to form carbonic acid (H_2CO_3). When carbonic acid comes in contact with rocks that contain lime, soda, and potash, the minerals calcium, magenesium and potassium in these rocks chemically change into carbonates and dissolve in rain water. Karst topography, originally named after the Krs Plateau in Yugoslavia where it was first studied, is a result of this type of chemical weathering that possesses characteristic sinkholes, caves, and caverns.

Hydrolysis: this chemical weathering process occurs when water (H_20), usually in the form of precipitation, disrupts the chemical composition and size of a mineral and creates less stable minerals, thus less stable rocks, that weather more readily.

Hydration: water (H_20) combines with compounds in rocks, causing a chemical change in a mineral's structure, but more likely will physically alter a mineral's grain surface and edges. A good example of this is the mineral Anhydrite ($CaSO_4$). Anhydrite chemically changes to Gypsum ($CaSO_4\text{-}2H_20$) when water is added. Gypsum is used in the construction industry, to build buildings and houses.

Oxidation: this process occurs when oxygen combines with compound elements in rocks to form oxides. When an object is chemically altered in this manner it is weakened and appears as "oxidized" . A good example of this is a "rusting" sign post . The iron in the metal post is oxidizing. Increased temperatures and the presence of precipitation will accelerate the oxidation process.

Spheroidal Weathering: water penetrates through cracks in rocks and dissolves the cement that binds particles together and also erodes sharp edges and corners of rocks, making a rock appear spheroidal. Physical weathering processes, such as frost wedging, can then act upon the enlargened cracks in rocks.

Physical Weathering Processes

Rocks that are broken and degrade by processes other than chemical alteration are physically or mechanically weathered. A rock broken in to smaller pieces exposes more surface area of the original rock. Increasing the exposed surface area of a rock will increase its weathering potential.

Animals and Plants: Animals burrow into Earth's substrate and move rock fragments and sediment on Earth's surface, thereby aiding in the disintegration of rocks and rock fragments. Fungi and Lichens are acid-producing microorganisms that live on rocks and dissolve nutrients (phosphorus, calcium) within rocks. These microorganisms assist in the breakdown and weathering of rocks.

Crystallization: As water evaporates moisture from rocks located in arid climates mineral salts develop from mineral crystals. The crystals grow, spreading apart mineral grains in the process, and eventually break apart rocks.

Temperature Variation: minerals in rocks expand and contract in climates where temperature ranges are extreme, like in glacial regions of the world, or when exposed to extreme heat, like during a forest fire. Crystal structures of minerals become stressed during contraction and expansion and the mineral crystals separate. For instance, repeated cycles of freezing and thawing (known as Freeze-Thaw) of water in rock cracks further widens cracks and splits rocks apart. Frost-wedging forces portions of rock to split apart.

Unloading and Exfoliation: Cracks in rocks appear when pressure is released as overlying rocks or sediment are removed, thus allowing the expansion of the newly exposed rock. Exfoliation occurs as sheets or slabs of the cracked rock slip off and become further eroded. Domes form as the unloading and exfoliation weathering processes continue. Half Dome at Yosemite National Park , California is a result of unloading (pressure-release jointing) and exfoliation.

Although one weathering process can dominate in a given area, physical and chemical weathering processes occur simultaneously to break down rock parent material. Rocks that are formed under intense temperature and pressure and cool rapidly forms crystalline structures in minerals that are less stable when exposed to low temperatures and pressures at Earth's surface, so they will weather more rapidly.

Rocks that are formed under intense temperature and pressure, but cool more slowly and later in the volcanic magma cooling process, are more stable when exposed to the low temperatures and pressures at Earth's surface. Bonds holding atoms together determine mineral hardness. Rocks that have cooled more slowly have time to build stronger bonds, so they are more resistant to the forces of weathering.

Friedrich Mohs, an Austrian mineralogist, devised a scale of mineral hardness in 1812. He used ten minerals, listed below, as standards by which to determine the hardness of minerals and other objects. These ten minerals were arranged on a scale of increasing hardness. For instance, gypsum can scratch talc, and apatite can scratch fluorite, calcite, gypsum, and talc.Your fingernail has a general hardness of 2.5, so you can scratch gypsum and talc! Diamonds are the hardest mineral in existence and are used as cutting instruments.

Moh's Scale Of Mineral Hardness

Talc	Gypsum	Calcite	Flourite	Apatite	Orthoclase	Quartz	Topaz	Corundum	Diamond
1	2	3	4	5	6	7	8	9	10

(Information derived from Rocks and Minerals, an Eyewitness Book produced and published by Dorling Kindersley Limited, London, England. Also published by Alfred A. Knopf, Inc., New York. 1988.)

Since some minerals weather more rapidly than others and weathering processes vary in intensity and combination, weathering products contain different mineral combinations. Pedologists, or soil scientists, classify these weathered mineral products as soil separates. Soil separates range in size and are known as sand, silt, and clay

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Unless otherwise noted, information contained in this document was extracted from Geosystems- An Introduction to Physical Geography, by Robert W. Christopherson,MacMillian College Publishing Company, New York. Second Edition. 1994.