Weathering - Teacher Background

***Weathering* is a *destructive* process**

When rock is weathered it is broken down into smaller pieces called "**CLASTS**". Weathering only involves the breakdown of the original rock, not the removal of clasts.

Various clasts

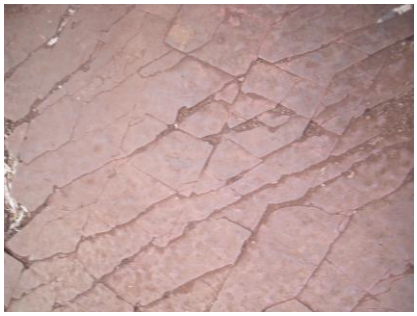
Weathering can be by:
PHYSICAL agents e.g. rain, heating and cooling, wind, ice, gravity.
CHEMICAL agents e.g. acid rain, humic acid in peat bogs, urine.
BIOLOGICAL agents e.g. mosses and lichens, animal feet, tree roots.

Although fresh volcanic basalts can be broken down in less than ten years in the tropics, most weathering takes geological time.
Visit: http://www.kineticcity.com/mindgames/warper/

Physical Weathering
These are physical changes as no new substance is produced.

1. **Unloading**

Most rocks have natural cracks. These can be the result of weakness due to bedding structures or to unloading as tectonic movements raise rock masses from depth. At depth rocks are subject to enormous pressure from overlying material and to increased temperature from within the Earth (25^0C per kilometre). The buried rock becomes fairly plastic. When it is uplifted to the surface however it cools and cracks.



The geometry of the cracks depends on the minerals that make up the rock and any bedding or layering structures present. This is a sandy siltstone from the Hamersley Ranges near Tom Price in Western Australia. The geometry of the cracks relate to the geometry of the clay molecules from which it is made. The cracks fill with water and produce conditions which will allow plants to colonise and chemical weathering to begin.

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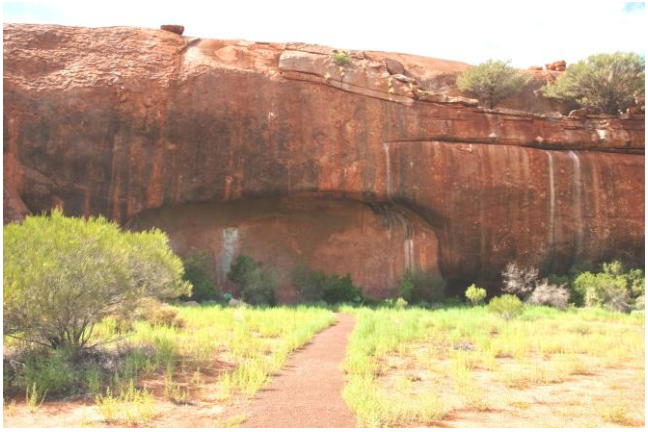
When more homogenous rocks such as granites unload they develop rectangular joints and the rock mass weathers to form massive tors. During weathering some horizontal joints are also formed when load pressure is decreased causing sheets of granite to peel off. This is the beginning of "onion skin" weathering. The Bungle Bungles and Uluru are fine examples of this process



"Onion skin" weathering at Walga Rock near Cue

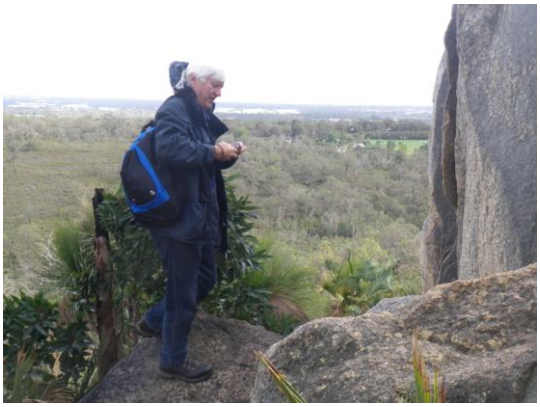
2. **Freezing**

Most substances contract when they cool as a result of decreased kinetic energy of their molecules. Less molecule movement means less space is taken up and the material shrinks. Water is anomalous because it shrinks until about 4^{o}C at which point its hydrogen atoms start to line up and bond. Water entering cracks and pore spaces will freeze and expand breaking rock.

In cold northern countries frost wedging was used to break up rocks in quarries. Thin groves would be cut into the rock and filled with water. Overnight expanding ice would widen and deepen the grooves. The process would be repeated until the crack was sufficiently large.

3. **Heating - Thermal expansion**

When a substance is heated it expands. Rocks heated during the day will cool at night. The rate of cooling is greater on the outside of a rock than at its core. This differential also contributes to onion skin weathering in homogenous rocks.



The outer layer of this granite tor in Lesmurdie has been peeled off by thermal expansion and contraction.

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Chemical Weathering

1. **Oxidation**

The most common form of chemical weathering is oxidation. Oxygen makes up almost 21% of our atmosphere. It reacts with minerals and new products are created.

Weathered crust on clay pellet boulder from the Kimberly

Oxidation reactions work faster if water is present, and faster still if salt and water are present. Sometimes the build up of weathering product can insulate the rock from further attack.
Oxidation rates vary according to weather, exposure and rock type.

2. **Acid rain**

Acid rain is produced when carbon dioxide, sulphur trioxide or nitrogen dioxide are dissolved in water vapour in the atmosphere. It adversely affects plants, animals and buildings. Carbonate rich rocks such as limestone and marble are particularly sensitive to acid rain.

Water + Carbon dioxide =Carbonic acid

$H_2O + CO_2 = H_2CO_3$

Water + Sulphur trioxide = Sulphuric acid

$H_2O + SO_3 + H_2SO_4$

Water + Nitrogen dioxide = Nitric acid

$H_2O + NO_2 = H_2NO_3$

Prior to the advent of the Industrial Revolution people relied on energy from themselves and pack animals. Industrialisation depended on the use of fossil fuels such as coal, oil and gas. Large quantities of carbon dioxide, sulphur dioxide and nitrogen oxide have been released into the atmosphere where they are dissolved in water and fall as acid rain. Acid

rain has badly affected vegetation down- wind from factories. Rocks, houses and masonry have also been damaged.

Although carbon dioxide has been demonized as a greenhouse gas causing a change in global climate, it is necessary to support life. CO_2 in the atmosphere stops heat from the sun being instantly reflected back out into space leaving our planet a cold life-free place. Carbon dioxide is also one of the reactants in photosynthesis, which is the base of life's energy.

Volcanoes are the major producers of carbon dioxide in our atmosphere. Many of Earth's major extinction events have been preceded by unusually wide spreading volcanic outpourings called flood basalts. It is thought that the resultant dust clouds reduced photosynthesis whilst acid rain reduced available food for larger life forms.

Interesting Facts ***Air has 0.039% carbon dioxide***
The air we breathe out contains 4.0% carbon dioxide

Tourists are only permitted to visit the cave paintings at Lascaux for a few days each year because their breath has made the damp cave air acidic and the paintings are becoming affected.

3. **Biological Weathering**

At Ephesus in Greece, roads were carved from solid limestone. Over the last couple of thousand years the wheels of carts going to and from this ancient city have carved channels deeper than your hand. Many ancient Greek monuments are being reduced and damaged by tourists removing broken fragments as souvenirs.
Humans are effective breakers of rock. Human feet have worn dips into the top of stone doorsteps in buildings raised by early settlers.

This photograph is of a human foot cut pathway in Karijini National Park. Tourists who do not stick to established paths and take shortcuts crush and kill the vegetation whose roots stabilises slope. The exposed soil is then subject to erosion carrying away more vegetation.

Our conservation and parks authorities are developing strategies to counter this behaviour. Car parks are solidly fenced and set back from areas of high tourist impact. This deters driving over sensitive scrub.

Dealing with the waste from large numbers of tourists is a challenge.

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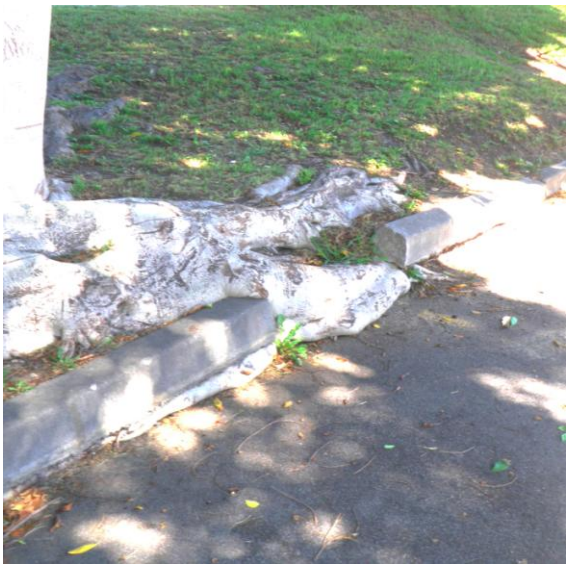
Composting toilets, dedicated camp sites and encouraging visitors to take their garbage away with them is also necessary.

Take only photographs – Leave only footprints

Any visitor to our Western Australian Goldfields will see enormous spoil heaps of rock broken underground and carried to the surface for processing. Guidelines for rehabilitation of these are now rigorous. A working gold mine north of Kalgoorlie was recently sold for $10.00. However the obligation to rehabilitate over one hundred years of damage by previous owners was part of the deal.

This Moreton Bay fig tree was planted 12 years ago and already it has wedged itself into concrete and asphalt.



Often mosses and lichens are the first plants to colonise fresh rock to be followed by more complex plants as soil develops. When plants and animals rot they produce a series of humic acids that chemically break down the rock. These further develop any established cracks and fissures.