

SURFACE PROCESSES

Denudation:

General term for the erosion and weathering of the earth's surface which modifies land areas. By this process a covering of weathered rock has formed over the lands surface. This is continually removed by weathering agents exposing further material beneath. Exceptionally when not removed termed Residual soils.

Weathering:

Process in which rocks exposed to the atmosphere undergo changes due to the action of rain and frost. Also action due to day and night thermal changes and wind originated abrasion.

Soil forms the upper part of the weathered layer and can range from a few centimetres to several metres thickness. It is generally a mixture of inorganic particles (from the parent rock) and vegetable humus (from the breakdown of organic residues e.g. leaves, dead plants).

It is highly compressible and of low strength hence it is removed from any construction site.

Two variations in soil profile:

- 1) Soil layer on subsoil, which originates from the breakdown of the parent material underlying it.
- 2) Soil layer, termed drift , which was deposited by various means onto an underlying material of differing origin. E.g. Boulder clay - the deposition by receding glaciers of material the glacier had scraped up from upstream sections.

Chemical weathering (or decomposition):

The breakdown of minerals into new compounds due to the action of chemical agents. (e.g. Acids in the air, rain and river/sea water.) Depends on presence of water.

e.g.. CO₂ in the air or soil can dissolve in percolating rainwater to form Carbonic Acid



example of action on rocks: Limestone (mineral: Calcium Carbonate) dissolved by weakly acidic Carbon Dioxide in water to produce Calcium Bicarbonate in solution. Is responsible for large caves, underground caverns in chalk/limestone country. When water evaporates leaves behind the original Calcium Carbonate as whitish deposit (Stalactites and Stalagmites)



Other chemical terms:-

Cation: The positively charged ion (in solution) e.g. H⁺, Na⁺ most metals

Anion: The negatively charged ion (in solution) e.g. Cl⁻, most non metals
and salt groups (OH⁻, SO₄⁻)

Oxidation: Combination of minerals with Oxygen to form Oxides or Hydroxides

Reduction: Release of Oxygen from the mineral to it's surroundings.

Hydration: Absorption of water molecule into the mineral structure (Normally accompanied by expansion also greatly increases the rate of oxidation, reduction and hydrolysis)

Hydrolysis: Hydrogen ions in water replace mineral cations.

Leaching: The migration of ions from a mineral due to Hydrolysis.

Cation Exchange: Absorption onto the surface of negatively charged clay particles of positively charged cations in solution.

Mechanical Weathering (Disintegration)

The breakdown of rocks into smaller particles by the action of Temperature, Impact, abrasion. The processes are -

Mechanical UNloading due to the expansion on release of stress. Either due to erosion, excavation or similar. Fractures may open up facilitating weathering by water processes. Frequently seen in Igneous rocks which may split up into 'sheets' a metre or so thick. Spalling can be due to same process but smaller scale.

Mechanical Loading such as impact by raindrops, abrasion by sand particles etc.. Also due to impact by falling rocks, boulders etc..

Thermal Loading from the expansion of rock subject to insolation. Rock surface expands whilst interior remains cool. This causes differential expansion which leads to exfoliation.

Rocks made up of differing minerals particularly affected.

Hairline cracks at surface also open up allowing moisture penetration which on cooling (Deserts often fall below 0° C) form 'ice wedge' effect. Often causes the scree seen at bottom of slopes. (These may be consolidated into Breccias.)

Active areas of Permafrost (shallow zone which thaws in summer) can remain waterlogged and thus readily flow down slopes (solifluction).

Where no water is contained in permanently frozen ground termed Dry permafrost.

Freezing of layers of segregated water leads to formation of 'ice lens'. Where there is a large vertical accumulation of such lenses Frost heaving can take place.

Repeated Wetting (Hydration - expansion) and Drying (Loss of water - contraction) can lead to breakdown due to continual change in dimension.

Crystallisation. Expansion in pores and fissures by formation of crystals from solution can increase internal stresses and aid breakdown.

Pneumatic loading: Air trapped in waves can cause great damage (e.g. wave zones at sea front)

Biological weathering are changes directly attributable to the activities of plants and animals. E.g. Microbial activity leading to changes in PH of ground water.

Mineral by product can accumulate and cause expansion of the ground if not washed away by ground water.

Burrowing animals, roots of plants. Plants retain moisture on faces of rock aiding breakdown.

Weathered rock not only found near surface. Sometimes rock can be severely decomposed for upto 10 metres depth. Also weathered surfaces may have been covered by more recent drift. Thus excavation could reveal more severe weathering which occurred at an earlier age.

In climates where evaporation is rapid and nearly equals precipitation evaporites deposited near the surface. This mineral deposit can affect entire surface for large areas. If evaporation is from calcium bicarbonate solution the deposit is termed Calcareous (light coloured soils- India). If deposit is ferruginous (from basic Igneous rocks) a red concretionary deposit is formed (Africa).

Silica leads to silcrete (Australia & S. Africa) can be up to 5m thick and very hard.

Special deposit Laterite formed from oxides of Iron and Aluminium (Very hard).

Work of Rivers

Major factor in shaping land surface. Widening and deepening of valleys.

Agents of erosion and transportation. Especially in flood.

River system split up into Youth , Maturity and Old Age.

Youth: steep sided gorges in hard jointed rocks. V valley in softer rocks.

Maturity: Max. height between valley floor and ridges

Old age : Adjacent valleys merge. Valley wide and flat. River meanders.

Waterfalls formed when river flows over rocks of differing hardness. Soft layer worn away faster. Undercutting possible. Waterfall gradually recedes upstream.

River deposits: In river channel during normal flow. Over plain either side of River during floods. Across floor of estuary. Deltas.

Alluvium: General term for river deposits. Includes silt, mud, coarse sands and gravels.

Buried valleys should be suspected beneath the alluvium of most lowland rivers. (Ice age affecting sea levels) - Usually very porous and compressible(if rich in clay) Very rapid variation in vertical profile.

Ice Transport and deposits.

Ice ages considerably modified land surface. Valley deepened and straightened, rock surfaces smoothed by erosion. When ice melted away left behind variety of deposits which mark it's former extend.

Glacial deposits in northern hemisphere formed during the Pleistocene period.

A glacier carries along boulders and stones of all sizes, which fall onto it's surface from valleys either side (Bands called Moraines) Heavy material migrates to sole of glacier which then help scour bottom of valley. Fragments plucked from underside as ice moves forward. All material in ice termed englacial material.

This soil and loose rock acts as abrasive and rock floor thus becomes smooth (glaciated surface).

When ice melted (retreated) from an area it left behind a characteristic deposit of sediment termed the glacial drift. Irregularly distributed, shows lack of sorting or arrangement which distinguishes it from water borne remains.

Superglacial and englacial debris which melts from the glacial snout slides off to produce a flow till. This often covers the deposits of subglacial debris called lodgement till. Boulder clay is an example of a lodgement till. The clay content is often composed of ground up debris. Embedded in this clay are boulders and rock fragments of all sizes. It is deposited as an irregular layer over the surface of the ground and is not stratified except where its been modified by action water. Sometimes this material is very hard others very soft and variable.