II. GEOMORPHOLOGY

Weathering - chemical
- mechanical

a.) Chemical weathering

- decomposiion of rock
- creates altered rock substances (e.g granite –-chem. w. --> kaoline)

H2O is the key medium

1.) Carbonation-solution
=> takes place on rocks which contain Ca (e.g. limestone, chalk)
=> water (rainfall) combines with CO2 to form weak carbonic acid
$H_2O + CO_2 \leftrightarrows H_2CO_3$

This carbonic acid subsequently reacts with calcium-containing compound (e.g. limestone)

$CaCO_3 + H_2CO_3 \geq Ca(HCO_3)_2$

As the PH of the water differs, it is capable of disolving other rocks containing alcalic-character elements

2.) Hydrolysis
3.) Hydration
=> a process whereby certain minerals absorb water, expand and change

4.) Oxidation
=> takes place when iron elemnts (/compounds) react with (dissolved oxigen) found in the soil or the atmosphere, e.g. $2Fe + O_2 \Rightarrow 2FeO + 02 \Rightarrow Fe_2O_3$

b.) Mechanical weathering

- rock disintegration
- produces smaller angular fragments (of the same rock)

1.) *Freeze-thaw (=frost shattering = ice crystal growth)*
=> takes place when water in cracks and joints freezes @<0°C

=> as water freezes, it increases its volume thus exerting pressure (up to 0.21Pa@-22°C
=> especially effective in regions where moisture is plentiful

2.) Salt crystallization
=> decomposition of rock by solutions of salt
=> has two main types
>in areas where t is oscillates around 27°C Na2SO4 and Na2CO3 expand ~3-times in volume, thus exerting preassure on joint and fissures
>when water evaporates salt crystals may be left behind and, subsequently, whent he temperature rises(!) and exewrt preassure on the rock; this is common in relatively hot and arid regions (because the salt accumulates {water evporates}, as well as in polar regions where salts are deposited from the snow flakes

3.) Disintegration
=> occurs in hot desert areas where the diurnal temperature tends to rise up to 40°C and nocturnal temperatures are usually little above 0°C
=> rock is a poor contractor of heat, that's why strees (contraction caused by the temperature fall) occur only in the outer layers

4.) Preassure release
=> occurs when the overlying rock(s) is(/are) removed by (e.g.) errosion, this causes causes undetlying rock to expand and fracture parallel to the surface
=> the removal of the overlying rock (=preassure release) results into the creation of cracks (or joints) to form at right angle to the unloading surface

If
Overlying preassure is released pseudo-bedding planes will be formed
If horizontal preassure is released vertical joint will develop

<u>Biological weathering</u>

- leverage of fauna and flora resulting into chemical (e.g. organic acids) and mechanical weathering (e.g. plants' roots disintegrative leverage)
- not a separate type of weathering though a combination of a.) and b.)

Weathering undertakes irreversible changes in a rock
1.) from a solid state to a clastic (fragmental state) /e.g. scree/
2.) ----------||---------- a pliable state (clay)

Slopes

A slope = inclined surface or hillslope
= an angle of inclination (slope angle), incleding 0°

Surfaces:

- sub-aerial
- sub-marine
- aggradational
- degradational
- transportational
- mixture of these

Slope development

1.) Geological structure

⇨ rock type, presence of fissures (faults), angle of dip and the vulcanity determine the strenght of a rock and its vulnerability to weathering

2.) Nature of the regolith

⇨ regolith = superficial, unconsolidated material (found @ the earth's surface), includes soil, scree, weathered bedrock and deposited material

⇨ prone to downslope movement (clay-rich r. is extremly unstable)

3.) Vegetation

⇨ can decrease overland run-off (through interseption and moisture storage)

➔ deforested slopes frequently exposed to massive erossion

Theories of slope evolution

1.)Slope decline (W. M. Davies)
2.) Slope replacemnt (Walther Penck)
3.) Slope retreat (L.C. King)

Mass movements

- any large-scale movemnt of the earth's surface lacking a moving agent (e.g. a brook)
- we distingiush

- fluid movement (e.g. mudflows)
- dry movement (e.g. rock falls)
- fast movement (e.g. avalanches)
- very slow movement (e.g. soil creep)

We can clasify the particular process according to certain features:

- water content
- speed of movement
- medium (material) carried
- type of movement (slide, slump, flow, fall...)

It is possible to ascertain sa-called "safety factor" of a slope = the total of forces sustaining the slope compared to the forces "trying" to move it.
Each force has an effect that acts to sustain the slope (a stick component) or an effect that acts to move the medium down the slope (a slide component)

Gravity, for instance, encompasses both, a stick and a slide component.

The downslope movement is directly proportional to slope angle and the weight of the medium (slide component of gravity).

Water may get into spaces between particles, hence so-called pore preassure, immenslyincreasing the ability of the splope to move, is created.

Types of the mass movent

Surface wash – takes place when soil's infiltration capacity has been exceeded, in particular when the gound is frozen or heavily saturated; on the other hand, it might take place also in semi-arid and arid regions where particles' sieze prevent percolation

Sheetwash – unchanelled flow of the water over the earth's surface, usually divides into areas of higher and lower velocity; is capable of transporting material disengaged by rainsplash

Throughflow – takes place when water moves down through the soil; channelled into natural pipes in soil => has sufficient energy to transport material of considerable volume)

Heave/creep small-scale movement occuring mostly in winter

Talus creep - slow ,ovement of fragments on a scree slope

Rainsplash erosion – erosive effect of raindrops on the hillslope (because of sharp enrgy exchange=> raindrops encompass relatively high kinetic energy)

Falls – occur on steep slopes (<70°); once rocks are detached (usually by weathering or human activity), they fall under the effect of gravity;
Short fall => relatively striaght scree is produced
Long fall => concave scree is produced

Slopes – movement of entire mass of material along a slip plane

- ⇨ rockslides and landslides
- ⇨ rotational slides (resulting into formation of of series of massive steps [terraces]

- cause: steep slope + weak rock + active undercutting

slipplanes occur
- @ the junction of two layers
- @ a fault line
- where there is a joint
- along a bedding plane
- @ the point beneath the surfaces where the shear stress exceeds shear strenght

Rockslides
Landslides – a process whereby material(soil+rocks etc.) moves downslope as a result of shear failure (shear stress> shear strenght) @ the boundary of the moving mass

Slumps and flows

- slumps occur on weaker rocks (e.g. clay) and have a rotational movement along a curved slip plane
- flows are more continuous and more likely to contort the mass into a new form

Avalanches – rapid movements of snow, ice, rock and soil down the slope
Dry avalanche – newly fallen (fluffy) snow falls off older snow
Wet avalanche – partially molten snow moves

Debris avalanche = rapid mass movements of sediments

Glaciation and periglaciation

Glaciation (lat. glacies = ice, glacier) = formation of glaciers in certain areas
Periglacliation => periglacial phenomena (gr. π ε ρ ι = around, round, about; lat. glacies = ice, glacier) = kryogennic phenomena

(gr. κ ρ υ ο ς = cold, ice; γ ιγ ν ο μ α ι = I am being craeted) => phenomena determined by the phase metamorphosis of water, especially edging the area already covered by glaciers, each glacial period is preceded and followed by periglacial period

Periglacial enviroment
-characterised by permafrost and freeze-thaw action
=> permafrost (lat. permanere = persist, perserve; fronst[engl.]) = impermiable, permanently frozen soil; ~20% of the Earth's surface is underlain by permafrost

- we distinguish 3 types of permafrost: continuous, discontinuous and sporadic
- above the permafrost so-called active layer is found; a.l. is extremly mobile, because it thaws out seasonally and hence is involved in mass movements

Periglaglaciation advances (esp. during the glacial phases) and retreats (during the process of so called deglaciation, esp. interglacial periods) manus in manu with glaciation

Periglacial processes

Congelifraction = the process whereby rocks are split up by freeze-thaw weathering
Frost heave = occurs when water freezes in the soil, pushes the surface upwards and churns it up; Ice-lensing = growth of ice crystals in the soil
Solifluction (lat. *solum* = soil; *fluere* = to flow) etymologically more properly called congelifraction (lat. *congelare* = freeze [over]; *fluere* = to flow), in winter soil freezes over and is separated into fragments. In spring the water thaws, but because it cannot infiltrate into soil (due to the impermeable permafrost) it moves along the permafrost carrying soil particles (called peds).
Nivation (lat. *nix* [genitive *nivis*] = snow) also called cryoplanation (lat. plannum = plain) or altiplanation (altus = high, [tall]) = a freeze-thaw weathering porcess taking place underneath a snow bank)
Fluvial activity – (lat. fluvius = river)
Anemal (gr. α ν ε μ ο ς= wind) activity
Cambering = a process whereby segments of the rock are disloged from the main body and start to move (but not fall[!]) downhill
Avalanches (see "mass movements")

Process of glaciation

- accumulation of (newly fallen) snow = alimentation (lat. *alimentum* = boost, aliment)

Snow flakes are compressed into a collection of granular ice pellets called neve(firn), as the preassure keeps increasing neve strt to melt. Molten water filles the gaps in the structure and freeze. Apart from this water vapour may change directly to ice whereby the process of desublimation.

Glacial regime = the balnce between (α.=> the rate of supply and the amounth of ice compared to β.=> the amounth and rate of losses
If $\alpha > \beta$ => positive g.r.
If $\alpha < \beta$ => negative g.r.

Glacial classification

1.) Division according to size
a.) Niche glaciers
b.) Cirque glaciers
c.) Valley glaciers
d.) Piedmont glaciers
e.) Ice caps
f.) Ice sheets

2.) Thermal clasification
a.) polar (cold-based) glaciers – ice remains frozen @ the base, hence there is very little water and almost no movement
b.) temperature glaciers warm-based glaciers, water is present in relatively high amounth, acts as a lubricant, water percolates thus increasing weathering processes taking place in the bedrock.

Glacial erosion

- as the glacier moves down the slope it it provides for the processes of plucking (occuring especially in joined rocks or those weakened by freeze-thaw w.) and abration

Features of the glacial erosion
Aretês – formed by headward recession of two or more cirques

⇨ cirque (also [in Slovak alike] called by the german word *kar*) = semicircular end of the glaciated valleys; ice may carve deep rock basins called ribbon lakes, adjacent to the ice mass proglacial lakes are formed. Tributary (to the main one) glaciers form so-called hanging valleys.

Crag and tail rea landforms created by a very large resistant object obstructing ice flow.

DRIFT – in reference with glacial deposition it stands for all glacial and fluvioglacial deposits left after the ice has molten; including:

Erratics – large boulders foreign to the local geology (i.e. borught from another part of the land)
Morains (from French *moraine*) = glacial accreptions, weathered form the valley sides and carried by a glacier

Drumlins – small oval mounds, formed due to friction between the ice and the underlying geology

Glaciers store huge amounth of water and the changes of state of this water leads into eustatical (global) change in the sea level. Glacier also changes isostatically (locally) the level of land underneath. This may result into the formation of fjords and rias (~riased beaches).