ROCKS

TOPIC 1
**FORMATION OF ROCKS**

**Lithology:** refers to the *physical* and *chemical* characteristics of a rock. The study of Lithology is how geologists can determine the nature and topography (shape) of a particular landscape.

*Physical characteristics* → ex: grain size, shape, permeability  
*Chemical characteristics* → ex: calcium carbonate in limestone

Each individual rock type has different characteristics, so it is capable of producing its own characteristic scenery.

The formation of landforms is conditioned by the following:
1. The rock’s vulnerability to weathering
2. Permeability
3. Rock structure
1. WEATHERING

Weathering is the disintegration and decomposition of rock at or near the Earth’s surface. It affects the rocks on place and does not involve movement/transportation of rocks (when transportation is involved, it is called erosion). There are 2 types of weathering processes:

MECHANICAL/ PHYSICAL WEATHERING
• physical disintegration of rocks into smaller fragments, each with the same properties as the original rock

CHEMICAL WEATHERING
• The process by which the internal rock structure is altered by the addition or removal of a mineral. 
  Ex: CaCO3 in limestone is dissolved by the carbonic acid in rain water.
2. PERMEABILITY

Permeability is the process by which rocks allow water to infiltrate (to pass) through them. Not all rocks have the same **infiltration capacity** (the maximum rate at which water percolates into the ground).

**There are 2 types of permeability:**

**PRIMARY PERMEABILITY/ POROSITY**

- Porous rocks allow water to flow from the pore spaces found in the rock.
- The size and alignment of pore spaces in a rock determines the amount of water which can be stored or pass through the rock.
- Saturation occurs when all pore spaces are full of water.

**SECONDARY PERMEABILITY/ PERVIOUSNESS**

- Pervious rocks have joints (aka – vertical lines of weakness).
- These can be bedding planes and fissures along which water can flow.
- The most pervious rocks are those which have their joints widened by weathering.
3. ROCK STRUCTURE

The structure of rocks determines the rock’s resistance to weathering and erosion.

This depends on the composition of the rocks and on the amount of joints and bedding planes they have.
In this topic, we will be talking about the uses and examples of 3 different rock types:
IGNEOUS ROCKS

Igneous rocks result from volcanic activity. They consist of tiny crystals which formed as a volcanic rock cooled down. Two examples of this rock type are:

<table>
<thead>
<tr>
<th>Types of Igneous Rocks</th>
<th>Formation</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>Magma rises from the Earth’s mantle and cools within the crust. The slow rate of cooling produces large crystals.</td>
<td>Building materials (houses &amp; roads), sites for reservoirs, and can attract tourists.</td>
</tr>
<tr>
<td>Basalt</td>
<td>Magma reaches the Earth’s surface as lava. As it cools rapidly, it creates small crystals.</td>
<td>Foundations for roads, weathers into fertile soil, can attract tourists.</td>
</tr>
</tbody>
</table>
SEDIMENTARY ROCKS

Sedimentary rocks are those that have been laid down in layers. They usually consist of small particles of other rocks that have been eroded and transported (ex: sandstone) or of the remains of plants and animals (ex: coal, chalk and limestone).

<table>
<thead>
<tr>
<th>Types of Sedimentary Rocks</th>
<th>Formation</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td>Remains of shells and skeletons of small marine organisms (ex: coral) that lived in warm, clear seas.</td>
<td>Quarried for lime and cement, used for stone walls, attracts tourists, and provides pastureland for sheep.</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Grains of sand being compressed and cemented together.</td>
<td>Building materials, and can produce fertile soil.</td>
</tr>
</tbody>
</table>
Metamorphic rocks are rocks that have been altered by extremes of heat and/or pressure. Examples include marble and slate.

<table>
<thead>
<tr>
<th>Types of Metamorphic Rocks</th>
<th>Formation</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marble</td>
<td>Limestone changed by heat and pressure.</td>
<td>Monuments.</td>
</tr>
<tr>
<td>Slate</td>
<td>Shales and clays changed by pressure.</td>
<td>Roofing materials.</td>
</tr>
</tbody>
</table>
LIMESTONE & KARST LANDSCAPES

Limestone is a sedimentary rock consisting of at least 80% calcium carbonate (CaCO3). This rock is composed of sediments and remains of dead organic matter.

In Malta we have 3 types of limestone:

1. Upper Coralline Limestone
2. Lower Coralline Limestone
3. Globigerina Limestone
CARBONIFEROUS LIMESTONE FORMATIONS

✓ Limestone has thick beds (layers) which are separated by almost horizontal bedding planes and with joints at right angle.

✓ Limestone is pervious but not porous (along bedding planes & joints).

✓ It has a high content of calcium carbonate which is soluble when limestone comes in contact with rain water.

Carboniferous Limestone formations can be classified into 4 types...
A. SURFACE FEATURES CAUSED BY SOLUTION

Limestone pavement

✓ Limestone pavements are flat areas of exposed rock.
✓ They are flat because they represent the base of a dissolved bedding plane.
✓ They have been exposed to the surface due to the removal of soil.

✓ When joints reach the surface, they can be widened by the acid rain water to form narrow channels.
  • These channels are also known as Grykes
  • The flat top blocks between grykes are known as Clints

When grykes & clints are eroded completely, the next bedding plane is exposed!
B. DRAINAGE FEATURES

Swallow holes

- The widening of joints by rain water at the surface can lead to the formation of *swallow holes*.
- Water which passes from these holes will widen underground joints to form *pot holes*.
- Water will then flow along *bedding planes* contributing to the formation of *underground caves*.

Resurgence

- When rainwater continues to infiltrate downwards until it reaches an *impermeable rock layer*, water will then reappear on the surface as a *spring* or *resurgence*.
C. SURFACE FEATURES RESULTING FROM UNDERGROUND DRAINAGE

- If the surface of limestone collapses, over an *underground river*, a *gorge* is formed.

- If the surface of limestone collapses on an individual cave, a surface depression known as *Doline* is formed.

- If the surface of limestone collapses on a *series of caves*, a much larger depression called *Polje* forms.
D. UNDERGROUND DEPOSITIONAL FEATURES

Stalactites
1. Water containing CaCO3 in solution (derived from limestone) continually drips from the ceiling of underground caves.
2. Aided by the loss of some moisture by evaporation, increases the CaCO3 concentration.
3. The dripping of water containing CaCO3 forms stalactites (a spike of ice/rock).

Stalagmites
1. As water drips onto the floor beneath the stalactites, further deposits of CaCO3 will produce the more rounded stalagmites.

Pillars
1. When stalactites and stalagmites meet, they form a pillar.
Quarrying is the mining (removal of minerals from Earth’s crust) of stone or rock for different purposes, mainly to be used for building.

A quarry is a whole or pit in the ground from which workers remove stone. During quarrying, workers cut or blast stone into smaller pieces so that it would be easy for them to handle.

**Uses of quarried stone**

- Businesses all over the world use quarried stone and in fact almost every country has quarries.
- Uses include building things such as:
  - Large buildings, monuments, sculptures, bridges, tunnels and dams.
  - We also use crushed stone to build roads and make concrete.
### ADVANTAGES & DISADVANTAGES OF QUARRYING

#### ADVANTAGES
- Local roads improved
- Raw material which helps the economy
- Local councils get money from quarry firms
- Multiplier effect; more jobs, more money, more services
- Jobs in areas of limited employment

#### DISADVANTAGES
- Wildlife habitats and farmland lost
- Noise and vibrations from blasting and heavy lorries
- Lorries block narrow country lanes
- Flooding of disused quarries
- Scarred hillsides and soil heaps
- Pollution of water supplies and a lot of dust
REDUCING THE ENVIRONMENTAL IMPACT OF QUARRYING

1. Earth mounds: built around the quarry to reduce the noise impact from blasting
2. Water sprays: used to reduce the spread of dust from quarries
3. Restrictions as to how big the quarry can be.
4. Blasting only allowed in designated areas to minimise impact on locals.
5. Quarries are often screened off e.g. by trees to reduce the visual impact
6. Restoration plans following the decommissioning of a quarry
   • Ex: wetland habitats, lakes, conservation/recreational areas
WEATHERING

Weathering is the disintegration and decomposition of rock in situ (on-site). This means that no transport is involved.

Weathering refers to the **first stage** in the denudation (wearing down) of a landscape. The **second stage** involves erosion and transportation of the weathered material by water, wind, etc..

*Weathering can be in 2 forms...*
## TYPES OF WEATHERING

### MECHANICAL WEATHERING
- Frost shattering
- Pressure release / Exfoliation
- Thermal expansion
- Salt Crystallisation

### CHEMICAL WEATHERING
- Carbonation & Solution
  - Hydrolysis
  - Organic
  - Acid rain
  - Hydration
  - Oxidation

### BIOLOGICAL WEATHERING
- By vegetation
MECHANICAL WEATHERING

A. Frost Shattering

✓ This type of weathering is also referred to as freeze – thaw weathering.
✓ It occurs both in mountains and hot deserts in places where the temperature fluctuates around 0 degrees Celsius.
✓ It occurs in rocks which have cracks and joints (lines of weakness).

When this happens on steep slopes, a scree/talus of boulders forms at the foot of the slope.

When it happens on gentle slopes, blockfields or felsenmeer form.
Boulder screes/talus at Majjiesa Cliffs

Felsenmeer in Odenwald
B. Exfoliation / Pressure Release

*The process:*

1. This process occurs when the overlying layers wear away and expose the rock beneath leading to a release of pressure (no pressure on the rock).
2. The rock weakens leading to the formation of cracks within the rock.
3. The other layer peels away in the process – *sheeting*.
4. Sheeting is responsible for the formation of *Exfoliation Domes*.

✓ Rocks which develop under pressure are very strong ex: granite.
CHEMICAL WEATHERING

A. Carbonation & Solution/ Limestone Solution

Rain water is never 100% pure. It picks up CO2 in the atmosphere to form carbonic acid (weak acid/not acid rain).

Process:
1. The CO2 content in the rain dissolves the Calcium Carbonate present in limestone.
2. The Calcium Carbonate is removed by solution by the running water.

(If the rain is acidic – acid rain – the calcium carbonate in the limestone dissolves at a much faster rate. Acid rain dissolves insoluble metals in rocks such as Aluminium, Copper and Zinc, which are very harmful to plants and animals).
BIOLOGICAL WEATHERING

- By vegetation

Example:
1. Tree roots start to grow in the cracks of the rocks (lines of weakness).
2. The cracks expand and the rocks start to weather down.

- By living organisms/animals

Example:
1. Borrowing creatures such as moles as they burrow into the soil.