Leaving Certificate Geography

Section 1: Core Units (ALL HAVE TO BE COVERED)

CORE UNIT 1: PATTERNS IN THE PHYSICAL ENVIRONMENT

Core Topic 1 – Structure of the Earth

Core Topic 2 – Plate Tectonics

Core Topic 3 – Plate Boundaries

Core Topic 4 – Volcanoes, Earthquakes and landforms

Core Topic 5 – Folding, Rocks and Landforms

Core Topic 6 – America's active and passive plate margins

Core Topic 7 – Landforms of limestone rock

Core Topic 8 – Surface processes

Core Topic 9 – Surface processes, patterns and landforms

Core Topic 10 – The process of isostasy and landforms

Core Topic 11 - People's interaction with surface processes

CORE TOPIC 1 - Structure of the Earth

THE CRUST

- The crust may be divided into the continents and the ocean floors

  - ➢ THE CONTINENTS

- The continents are formed mostly of light, granite-like rocks. Continents have an average thickness of 45km, and are up to 70km thick under mountain ranges

    - ➢ OCEAN FLOORS

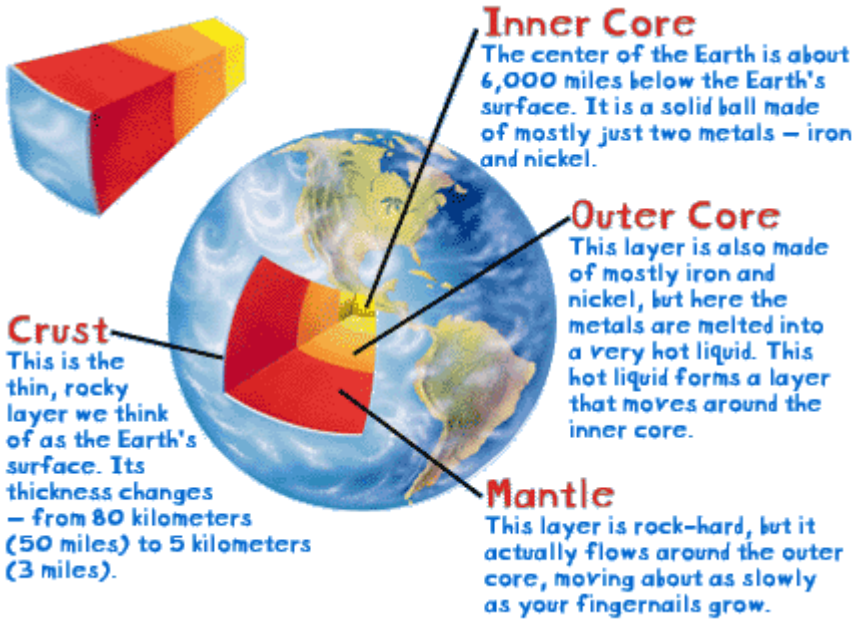
- The Ocean Floors are formed mostly of Basalt, which is a heavy rock. Ocean Floors have an average thickness of 8km but may be as thin as 3km in places.

THE MANTLE

- The continents, the ocean floors and the upper mantle form the lithosphere. All the rocks in this area are solid.
- The lower mantle consists of plastic-like rock that moves to form convection currents. The plates of the lithosphere move about on these slow moving currents. The rock in the lower mantle is in a semi-liquid state because its temperature is very high.

THE CORE

- The core is made up of nickel and iron. It is the hottest part of the Earth, where temperatures are greater than 4,000°C.



CORE TOPIC 2 - PLATE TECTONICS

- The Earth's crust is made up of plates that float on heavy, semi-molten rock and are moved around by convection currents beneath them.
- As the plates move around slowly, so do the continents and oceans that sit on top of them. This movement is known as **Continental Drift.**
- In places, these convection currents

(1) drag the plates apart (Plates Separating)
(2) push the plates together (Plates Colliding)

- High Mountain ridges occur on the ocean floor in places where plates separate: for example, the Mid-Atlantic Ridge.
- Fold Mountains are found in places where plates collide – e.g. the Amorican fold mountains of Munster and the Himalayas in the Indian subcontinent.

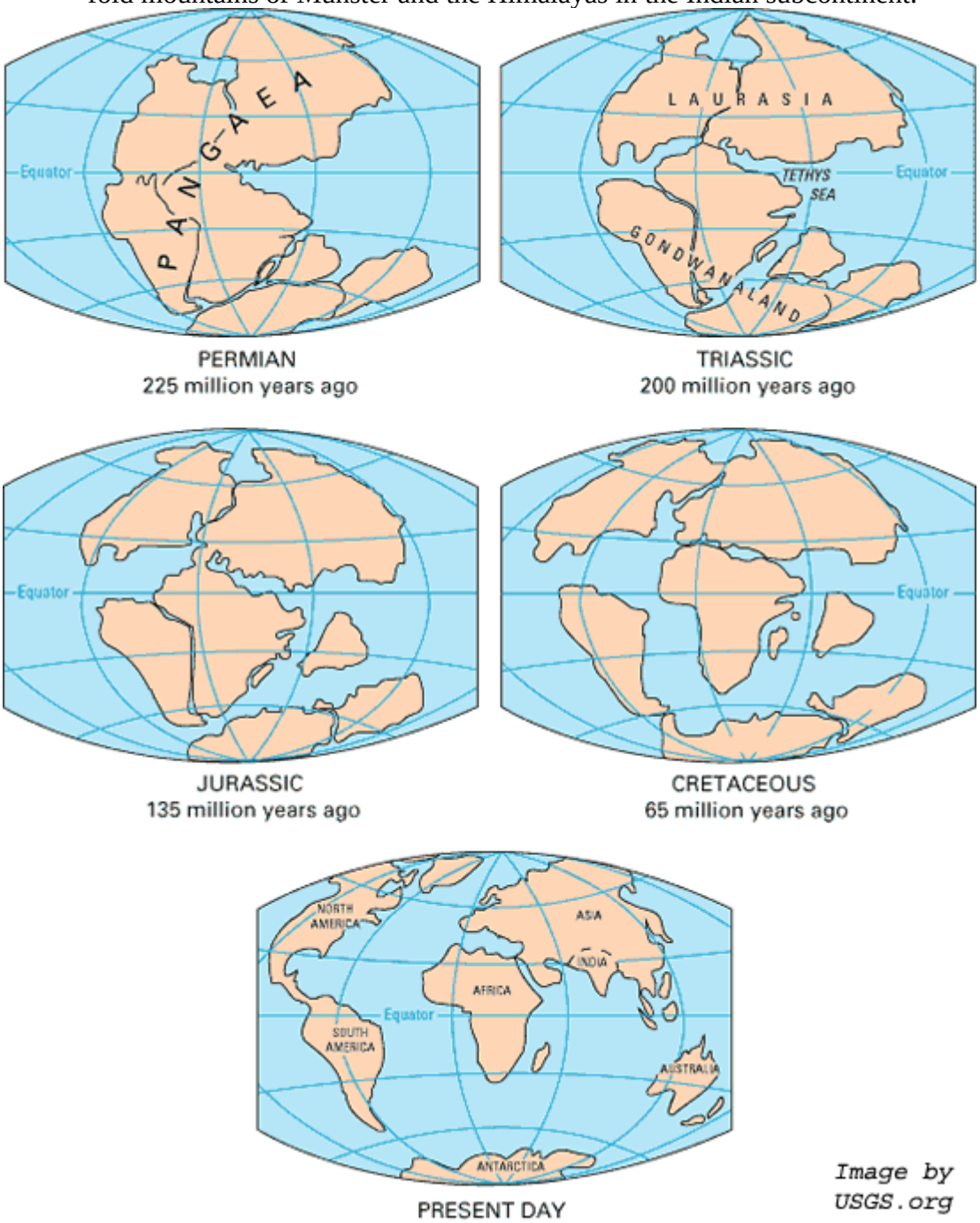


Image by USGS.org

CONTINENTAL DRIFT

- Over the past Two billion years the continents of the earth have been moving about and constantly changing their position on the earth.
- During this process they continents have collided and separated many times. The last time they came together the continents collided to form a single, huge continent called Pangaea.
- Pangaea was surrounded by a single ocean called Panthalassa.
- Then Pangaea initially split into two continents called
  (1) Gondwanaland (2) Laurasia
- Gondwanaland then broke apart forming Africa, Antarctica, South America and the Indian Subcontinent. Laurasia split into Eurasia and North America.

PROOFS OF CONTINENTAL DRIFT

- Matching rocks found on continents that are thousands of miles apart.
- Matching fossils that are found in precise locations where the continents were once joined together.
- Matching edges of continents along the edges of the continental shelves, fitting together like a jigsaw puzzle.

THEORY OF SEA FLOOR SPREADING

- The theory of SEA FLOOR SPREADING suggests that ocean floors widen as new rock is formed along mid-ocean ridges where continents were split apart originally.

➢ *PROOFS OF SEA FLOOR SPREADING*

- The existence of mid-ocean ridges
- The varying ages of the sea floor. The age of the sea floor is youngest where new rock is formed along mid-ocean ridges, and oldest along continental edges.
- Glacial deposits of similar types and ages are found in the areas where continents were attached.

Tomorrow's world

- Scientists believe that the Earth's crust has been undergoing these transformations for most of it's 4.6 billion year history. Two hundred million years from now a new Pangaea will be formed when all lands again converge. Then, inevitably, another break-up will ensue as our restless planet continues to reform and reshape itself.

Sea Floor Spreading... ...
It's tearing me apart .. ...
HELP!!

CORE TOPIC 3 – PLATE BOUNDARIES

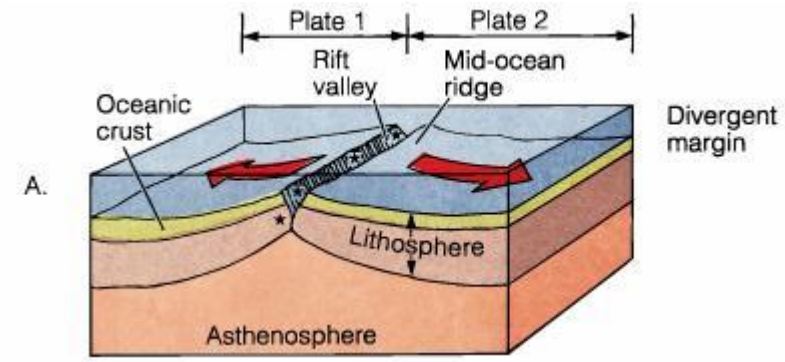
- New ocean floor is formed at boundaries of construction, where plates separate. To balance this so that the earth's size does not increase, old ocean floor at the opposite side of the globe is sucked into the mantle and is destroyed. Most of this destruction occurs along the Pacific Ring of Fire along the edges of the Pacific Ocean.

  - *THERE ARE 3 TYPES OF PLATE BOUNDARY:*

    - Boundaries of construction
    - Boundaries of destruction
    - Passive boundaries

BOUNDARIES OF CONSTRUCTION

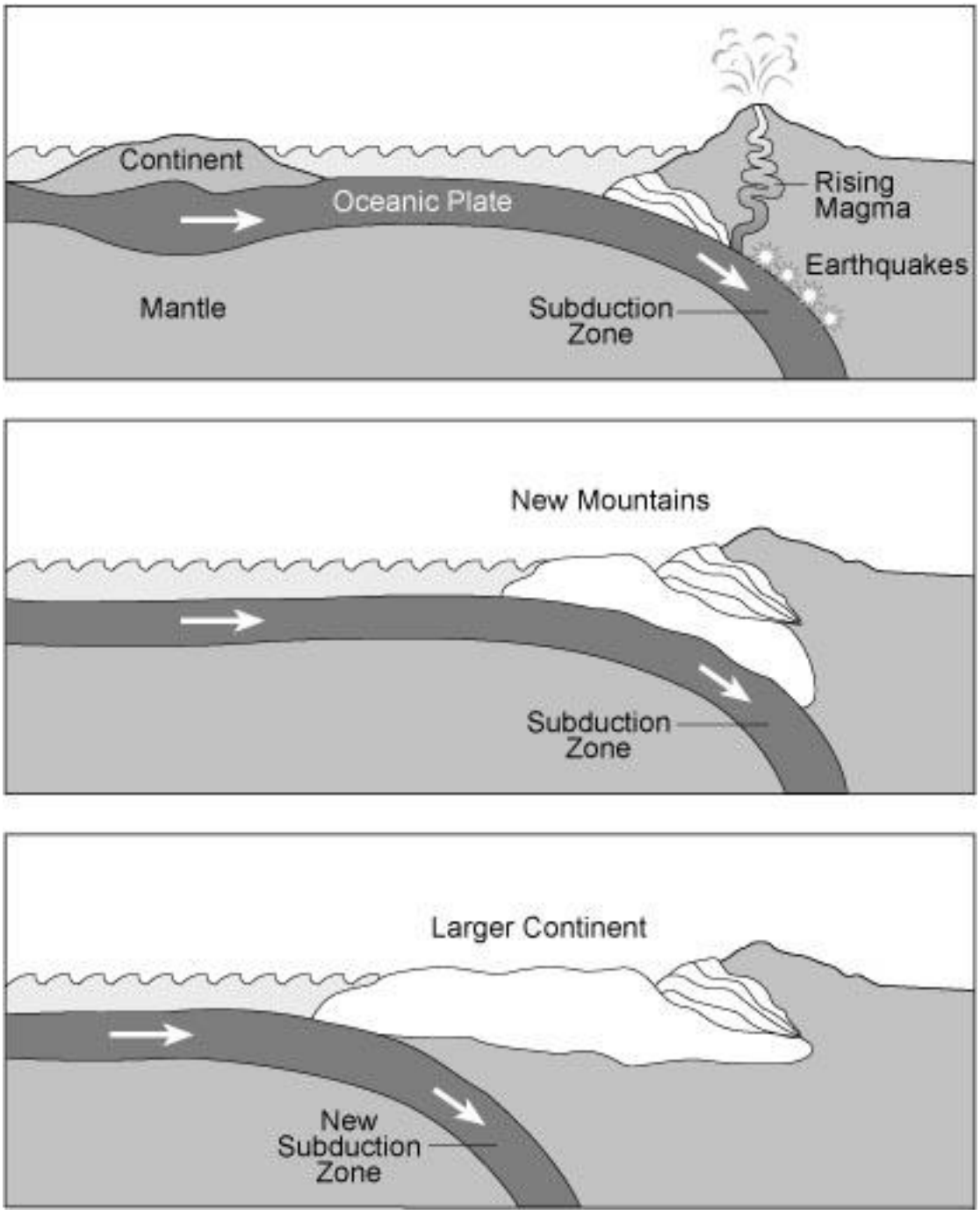
- New sea floor, new oceans and mid-ocean ridges form at boundaries of construction.
- A rising current of magma from the mantle splits the continent into two smaller continents.
- As these smaller continents move apart, sea water rushes in to fill the new valley.
- A mid-ocean ridge forms directly above the rising current of magma.
- Many volcanoes form along the mid-ocean ridge.
- Some land, such as Iceland, may appear above the sea surface.



BOUNDARIES OF DESTRUCTION

- Boundaries of destruction are places where old ocean floors sink into the mantle and are destroyed. This must happen so that the earth does not get bigger because of increased amounts of new sea floor rock that are formed at mid-ocean ridges.
- Sea floors along the edges of the Pacific Ocean sink into the mantle. This process is called subduction. As the plates descend(move downwards);

  - they melt into the mantle creating magma that forms curved lines of volcanoes, called volcanic arcs, at the surface.
  - They become stuck, forming earthquakes along the line of the sinking plate.
  - They create deep ocean trenches that form the deepest parts of the ocean, e.g. the Mariana Trench.
- This zone, where the greatest amounts of subduction, volcanoes and earthquakes occur, is called the Pacific Ring of Fire.



SUBDUCTION OCCURS IN THREE TYPES OF LOCATION

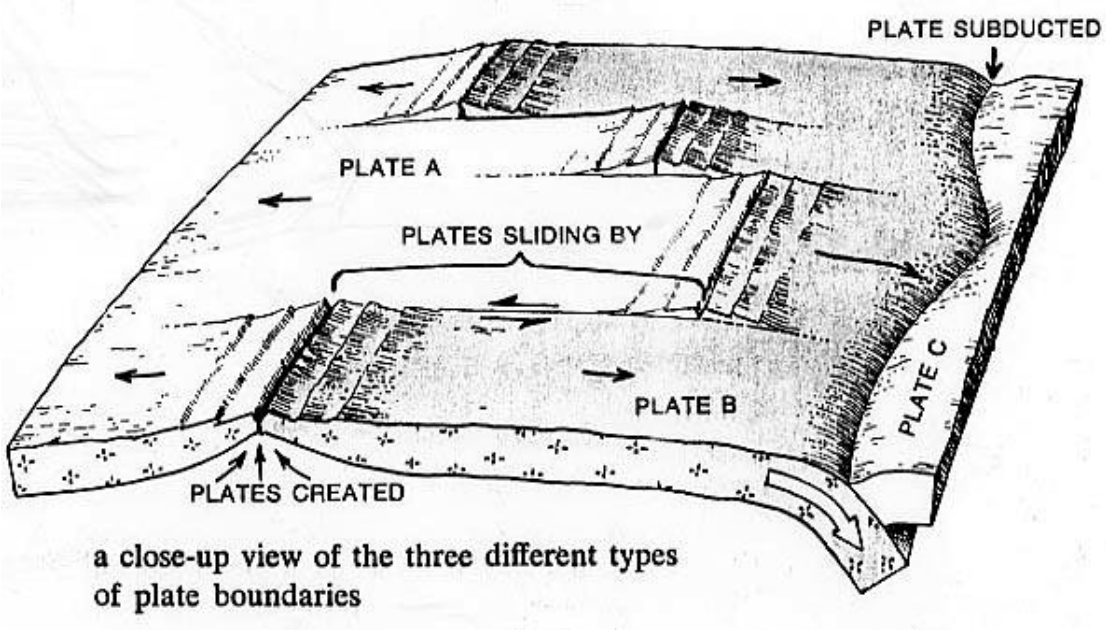
1. Where two ocean plates collide
    - One ocean plate sinks under the other
    - The sinking plate melts as it descends to form magma, which then rises to form a curved line of volcanoes called an island arc.

2. Where an ocean plate and a continent collide
    - The heavier ocean floor sinks into the mantle.
    - It buckles the land along the edge of the continent, forming fold mountains.
    - It pushes, buckles and destroys islands and underwater plateaus and extinct volcanoes against the continent's edge, so making the continent wider.
    - The descending plate melts to form magma, which then rises through the folded rock to form volcanoes within the fold mountains at the surface.

3. Where two continents collide
    - As two continents approach each other, the intervening ocean plate sinks under one or both of the continents.
    - Finally, all the sea floor and intervening islands and underwater plateaux are destroyed, and the continents collide to form high fold mountains such as the Himalayas.

PASSIVE BOUNDARIES

- Passive boundaries occur where plates slide past each other.
- Most of these boundaries occur along the edges of mid-ocean ridges.
- Some occur on dry land, such as the San Andreas Fault in California.
- Rock is neither created nor destroyed at these boundaries.
- Many earthquakes occur along these fault lines.



a close-up view of the three different types of plate boundaries

CORE TOPIC 4 – VOLCANOES, EARTHQUAKES & LANDFORMS

VOLCANOES AND EARTHQUAKES ARE LOCATED WHERE PLATES SEPARATE AND COLLIDE; BUT EARTHQUAKES ALSO OCCUR WHERE PLATES SLIDE PAST EACH OTHER. THE REMAINDER OF EARTHQUAKES OCCUR ALONG FAULT LINES THAT ARE LOCATED AWAY FROM PLATE BOUNDARIES.

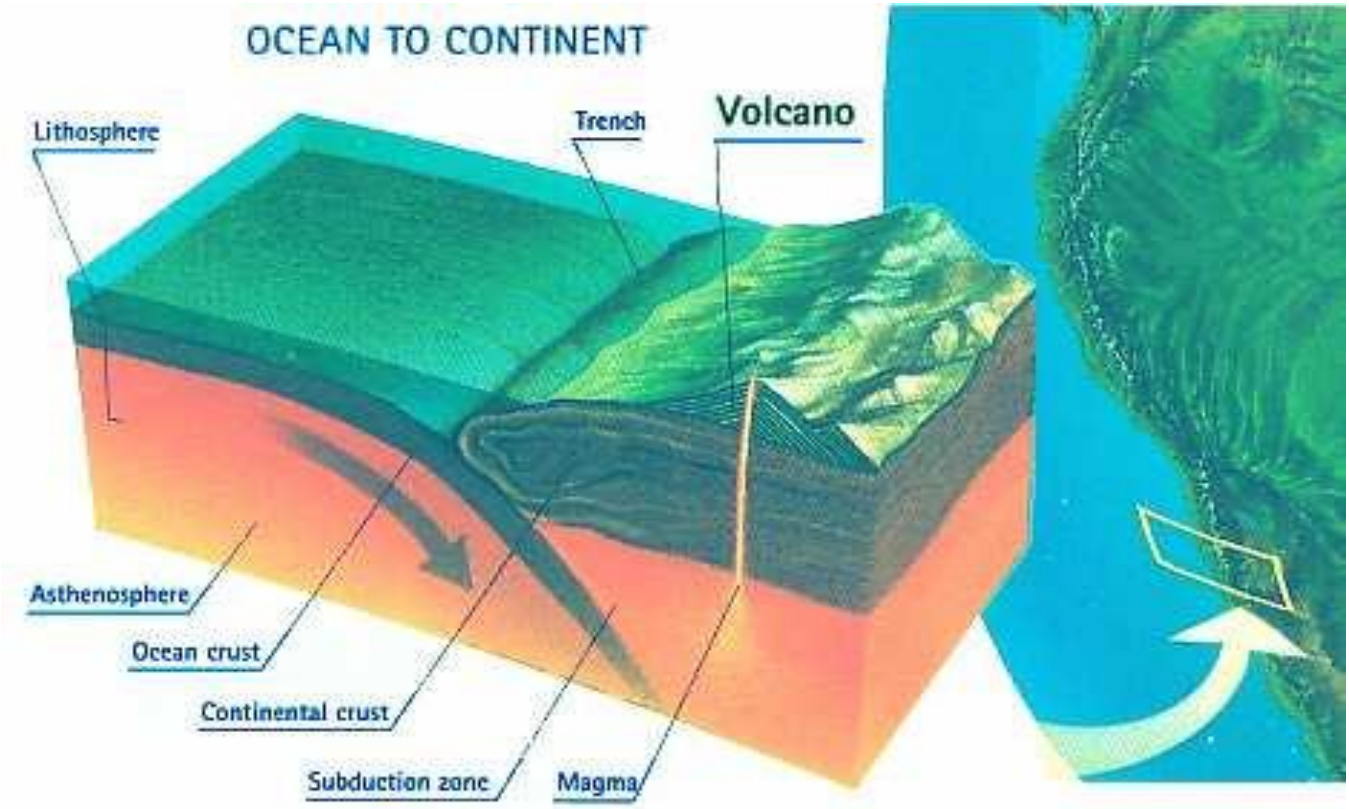
QUESTION: Why do most earthquakes and volcanoes occur along the Pacific Ring of Fire?

ANSWER: The Atlantic Ocean has a Mid-Atlantic Ridge that creates new land on its seabed. This also happens in the Indian Ocean and in the Pacific Ocean. To balance this, there are corresponding locations where old land is being recycled and sucked into the mantle. Most of this recycling, called subduction, occurs around the edges of the Pacific Ocean where ocean plates and continents meet.
As the ocean plates sink into the mantle they melt to form volcanoes at the surface and they get stuck to form earthquakes.

QUESTION: Why has Plate Tectonics revolutionised our understanding of earthquakes and volcanoes? OR Explain why earthquakes and volcanoes regularly occur at similar locations.

ANSWER: Both earthquakes and volcanoes occur at constructive and destructive plate boundaries.

1. Where two ocean plates collide is a destructive plate boundary.
    - Ocean plates are heavy because they are formed of thick basalt rock and they are saturated with water. When two ocean plates meet one of them sinks under the other and slides into the Earth's mantle. As the ocean plate sinks into the mantle it sometimes gets stuck, and pressure is built up until it is suddenly released. This sudden release of energy causes earthquakes that occur near the surface of the seabed. These are called shallow earthquakes.
    - As it sinks further into the mantle the moisture in the rock causes melting, which leads to intermediate earthquakes. The melting also creates magma that rises through the overlying rock of the other ocean plates and creates explosive volcanoes at the surface.
    - These volcanoes create volcanic island arcs on the sea bed – such as Japan and the Philippine islands. When it sinks even further some of its minerals break up, causing deep earthquakes. All the earthquakes occur along the line of the sinking ocean plate. This line is called the Benioff Zone.

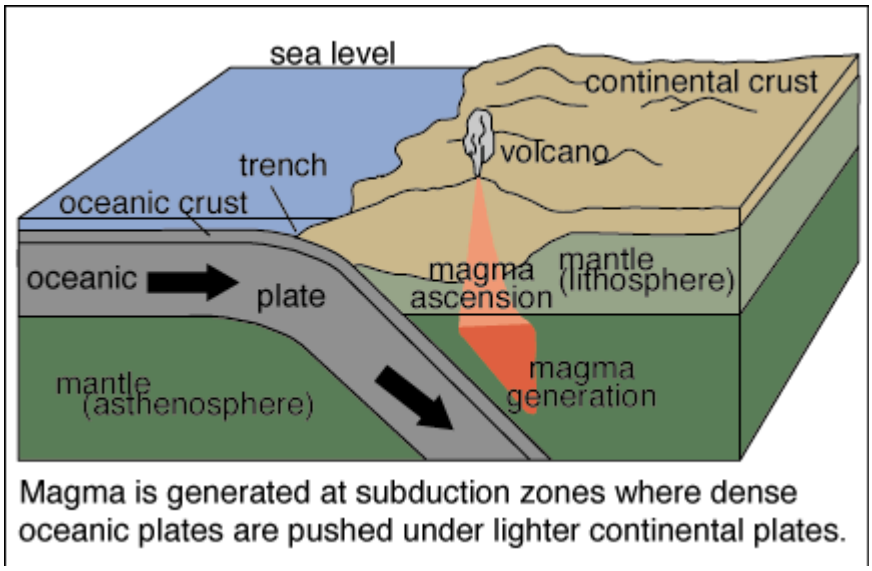


When a plate with thin ocean crust meets a plate with thicker continental crust, the thinner plate subducts. Magma rises to the surface and forms a line of volcanoes such as these on the west coast of South America.

2. Where an ocean plate meets a continental plate, or where two continental plates collide, is a destructive plate boundary

- The ocean floor is covered with thousands of metres of sediment that settled out of the sea water. As water-saturated ocean plates sink into the mantle at subduction zones under the plate, this thick sediment is scraped from the ocean floor. It is squeezed into layers of sedimentary rock and metamorphic rock that over millions of years is buckled and bent up into fold mountains.
- As the plate sinks it becomes stuck, just as before; strain is built up and finally the rock snaps, creating earthquakes.
- When the sinking plate reaches a depth of about 100 kilometres it water content causes surrounding rock to melt, creating magma and earthquakes. This magma rises through the buckled rock and some of it reaches the surface, creating highly explosive volcanoes. As the magma rushes to escape at the surface it also creates many earthquakes.

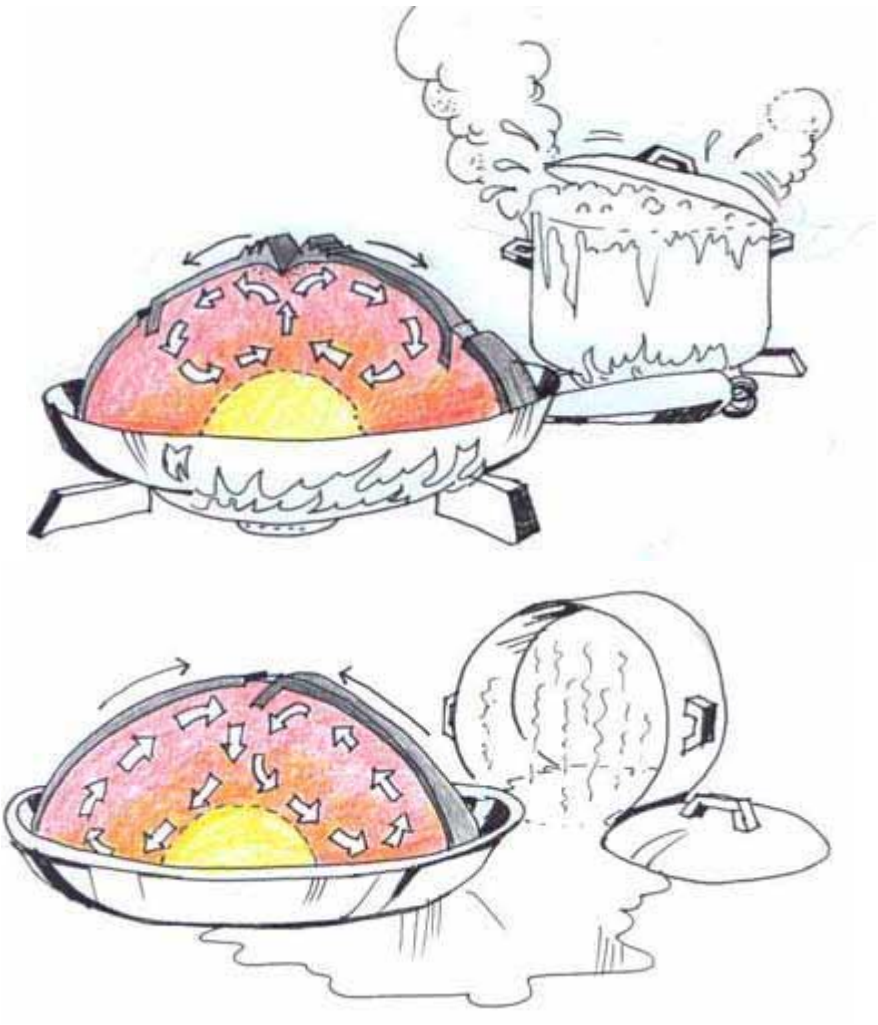
- Most of the world's earthquakes occur along the Pacific Ring of Fire, where ocean plates sink under continental plates: for e.g., in the Rockies in North America and in the Andes, in South America.
- When two continental plates approach each other the intervening ocean plate sinks under each continental plate, until the two plates collide.



Magma is generated at subduction zones where dense oceanic plates are pushed under lighter continental plates.

3. Where a mid-ocean ridge creates new rock is a constructive plate boundary

- Many earthquakes and volcanoes occur at mid-ocean ridges. As ocean plates separate, convection currents from the earth's mantle bring magma to the surface to fill the empty space on the sea floor. When this magma, at 800°C to 1,000°C, meets the cold ocean water it instantly becomes solid and forms new basalt rock.
- This new rock then splits, creating earthquakes, with one half attaching to each separating plate. This new rock is not able to withstand much strain – it splits easily – just as new home made bread would break much more easily than stale bread. So these earthquakes are generally small.
- Some places along mid-ocean ridges are hotter than others; they are called hot spots, where large volumes of magma pour onto the sea bed. Generally this magma forms wide flows that build up into islands. Volcanoes also occur at these locations, such as Iceland. Many earthquakes and volcanoes occur along the Mid-Atlantic Ridge.



4. Volcanoes do not occur where plates only slide past each other. These are passive boundaries.

- Only earthquakes occur where plates slide past each other. These are called transform faults. Most transform faults occur on the sea floor, but a major one occurs on land at the San Andreas fault in California. They are the means by which new rock that is created at mid-ocean ridges is carried to destructive boundaries, where plates sink into the mantle.
- While sliding past each other they sometimes become jammed. Strain is built up until the jamming point is unable to resist the pressure, and then the plates suddenly snap and jump forward. This sudden movement creates an earthquake – foreshocks and aftershocks. The strain is then transferred to the next jamming point and the process repeats itself again and again.
- Due to the fact there is no subduction, this means there is no melting of plates and as such no magma exists to create volcanoes.

THE HUMAN COST OF EARTHQUAKES IS INFLUENCED BY SOCIO-ECONOMIC FACTORS.

1. COUNTRIES OF THE DEVELOPED WORLD

(A) WELL CONSTRUCTED BUILDINGS

- Research into the way buildings move during earthquakes has led to new designs in building construction. Rich countries have the resources to invest in such research, because quality of life and safety matter are major issues during political elections. Buildings, especially tall ones, simultaneously bend and twist during earthquakes; therefore new structural engineering designs have been created so that these buildings will withstand the destructive power of reasonably severe earthquakes. New materials, such as special steel products, help to offset some damage.
- Some buildings are built on 'roller' foundations, which allow the ground itself to move substantially while the building itself remains quite undisturbed, almost detached from the movement.

(B) EDUCATION

- Continuous education in schools on earthquake drill makes children, and later adults, aware of ways to remain reasonably safe during earthquakes. Children practice these exercises regularly in places that are especially prone, such as in Japan and California.
- Fire prevention officers and specially trained civilians in key jobs are also trained in how to reduce the risk of serious injury during earthquakes.
- Fire extinguishers are positioned in key locations such as kitchens, hallways and elsewhere, and automatic electric trip switches switch off current when some leakage occurs on electric lines.
- Modern medical help and procedures also reduce death tolls in rich countries. Emergency plans that are practiced under simulated conditions. Emergency plans that are practiced under simulated conditions greatly help in regions of large populations, such as major industrialised cities of the developed world that are located close to earthquake zones.

(C) MODERN TECHNOLOGY

- Specialised equipment such as seismometers are strategically placed in regions of high earthquake risk. These instruments record foreshocks that indicate a major earthquake or volcanic eruption may be imminent. In such instances warnings are given to radio and television stations, so that people can be least somewhat prepared for the unknown.
- Tsunami warning stations have been set up for the Pacific Ocean region, where the most earthquake-prone cities in the world are located. This Tsunami warning station is located in Hawaii, centrally located in the Pacific region and a state of the richest nation of the world, the USA. Early warning can be relayed to areas at high risk of a tsunami that may result from an earthquake on the sea floor. When a warning is given, people in coastal regions may have time to evacuate coastal areas to avoid being killed.

2. *DEVELOPING COUNTRIES*

(A) POOR BUILDINGS

- Most residential buildings in developing countries are constructed of relatively loose materials such as mud bricks. They lack any structural fittings that are designed to resist earthquake damage and would reduce the risk of death or serious injury. During earthquakes, such buildings collapse on the occupants, killing most of them.
- Many severe earthquakes are occurred in places such as India, Pakistan and Afghanistan, where as many as 50 to 60,000 people have been killed in a single town during a single earthquake.
- Outside help is difficult to reach, as telecommunications are often poor or non-existent. In addition, many people live in large cities built close to major earthquake zones. Indonesia and India are located close to major fault lines that regularly cause earthquakes.

(B) LACK OF INFORMATIONS SYSTEMS

- The lack of a tsunami warning system in regions such as the Indian Ocean has been directly influenced by a lack of resources being allocated to essential services. While many undeveloped countries have invested hugely in military equipment, they have neglected to invest in life-saving equipment and education for their coastal populations. This fact was directly responsible for the deaths of over 250,000 people during the tsunami disaster of 2004. In addition, the lack of coordinated information systems prevents local people from being made aware of impending disaster.

HOW VOLCANOES AND THEIR EFFECTS MAY BE PREDICTED

- Types of material that form a volcano can indicate the power and explosive nature of a volcano.
- The dating of volcanic materials can create a timing pattern for eruptions.
- The distribution pattern of volcanic materials can suggest the area likely to be affected by a future eruption.
- Numerous small earthquakes near a volcano may suggest a larger eruption is about to occur.
- Changes in types and amounts of gases escaping from the sides or crater.
- Changes in local ground water, temperature and composition.

- (1) Nuee Ardente: Generally volcanoes that occur at destructive boundaries are highly dangerous, because the magma contains a high proportion of silica and this prevents gases from escaping freely. Pressure builds up and finally the whole mountain top is blasted into the sky. Such volcanic explosions give rise to Nuee Ardentes, which are clouds of poisonous gases, hot ash and rocks that rush down the volcano sides killing and destroying everything in their path.

- (2) Lahar: These are mud flows created by the sudden melting of ice by hot ash and lava on the sides of a volcano.

- (3) Past volcanic eruptions: The study of past volcanic eruptions in an area can help to prepare people for future eruptions.

ICE AGES

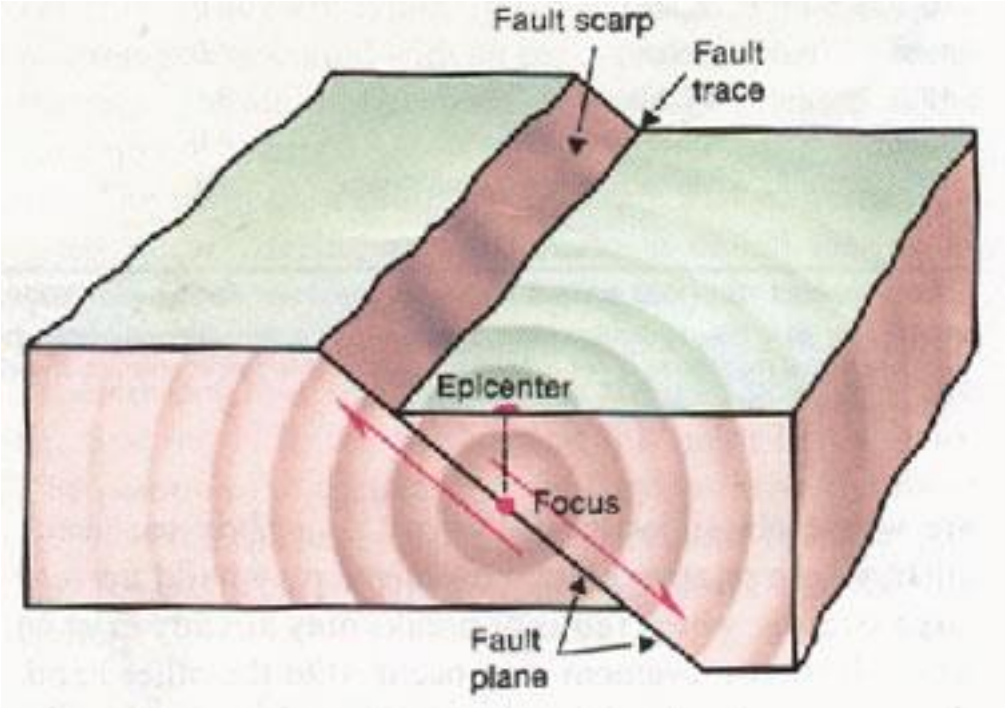
Thousands of metres of ice pressed down the land surface. When the ice sheets melted at the end of the Ice Age, the land gradually bounced back to its original level. This change still causes earthquakes from time to time.

ANCIENT FAULTS

Plates move along ancient faults that lie buried deep beneath the surface.

EARTHQUAKE FACTS

- A seismologist is a person who studies earthquakes
- A seismograph is an instrument that records and measures earthquakes.
- Earthquake strength is measured on the Richter scale from 0 upwards.
- Earthquake magnitude is also measure on the Mercalli scale.
- The focus is the spot where an earthquake occurs.
- The epicentre is a spot on the earth's surface directly above the focus.



HOW EARTHQUAKES AND THEIR EFFECTS MAY BE PRECDICTED.

SCIENTIFIC INSTRUMENTS

Instruments are placed in regions that are liable to earthquakes. These regions include;

- Fault lines
- The sides of active volcanoes

The instruments measure any change in the tilt or movement of the earth's surface, or a movement of rocks relative to one another.

SEISMIC GAPS

Places that have not had an earthquake for a long time but are bordered by areas of recent earthquake activity are the most likely spot for future earthquakes.

DATING PATTERN

By establishing a pattern of past earthquake activity, one can predict the likelihood of a new earthquake.

EFFECTS OF EARTHQUAKES

- They can cause vertical and sideways displacement of parts of the earth's crust.
- The can cause the raising or lowering of parts of the sea floor.
- They can cause the raising or lowering of coastal regions, as in Alaska in 1899, when some coastal rocks were lifted 15m (50 feet).
- They can cause landslides, as in the loess country of north China.
- If shocks are experienced in densely populated and heavily built-up areas, the results can be disastrous. Some of the worst earthquakes include those of San Francisco in 1906 and Tokyo-Yokohama in 1923; the latter killed 100,000 people. In October 1989 Los Angeles suffered a severe earthquake centred on the San Fernando valley. Roads and buildings collapsed, and twenty-two people were killed.
- Some gaping holes, cracks or subsidences are formed, railways and water pipes are cut and bridges collapse, causing massive structural damage and loss of life. Fires result from leaking gas pipes, while disease may occur in some areas from a combination of burst sewerage mains and high temperatures.
- Where an earthquake affects the ocean floor, great waves, known as seismic waves or tsunamis, may spread outwards across the ocean at speeds of 500-800 km/h (300-500 miles per hour) and can cause great damage and a high death toll in coastal areas. Upon entering shallow coastal waters these destructive waves are slowed, and the water begins to pile up to heights that occasionally exceed 30m (100 feet).

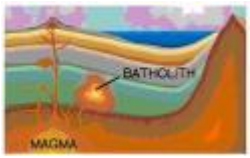
CORE TOPIC 5
Folding, Rocks and Landforms

The Caledonian Foldings;

- The ancient ocean, the Iaepetus ocean, which lay between the Eurasian plate and the American plate, started to get smaller when these two plates moved towards each other.
- As they got close, small pieces of crust, called terranes, were squashed together to create the island of Ireland.
- At this stage Ireland was located about 30º south of the equator, at about the same latitude where south Africa is today.
- As these terranes made contact with each other, the ones that formed the west and north-west of Ireland moved sideways, creating thrust faults that separate them today.
- Then the American and Eurasian plates collided about 400 million years ago to form one huge continent.
- The in-between ocean floor was subducted under both continents and the seafloor sediments were buckled up to form the sedimentary rocks of the Caledonian Fold Mountains.
- The Connemara and Wicklow Mountains, the Scottish and Scandinavian Highlands and the Appalachians in North America were once part of this huge mountain range.

Rocks of the Caledonian Fold Mountains

- The subducted ocean floor melted under the mountains and then rose up through the buckled rock layers to form masses of magma.
- This magma cooled slowly to form **batholiths** of an igneous rock called **granite**. Granite has large crystals of **mica**, **feldspar** and **quartz**.
- The heat from the magma in the batholiths changed (metamorphosed) the sandstone into quartzite.
- Since then both the granite and the quartzite rocks have been exposed to form very different landscapes and landforms.
- Layers of shale that was heated under pressure changed (metamorphosed) to slate or schist.



Landforms of the Caledonian and Amorican Foldings

- The batholiths of granite now form **granite landscapes** of rounded hilltops, with blocks of granite in some places forming **tors** on top. These were formed when the overlying rock layers were eroded by weathering and erosion.
- The quartzite forms quartzite landscapes with very pointed sugarloaf peaks due to frost action. These include the Great and Little Sugar loafs in Wicklow, the Twelve Bens in Connemara, Croagh Patrick in Mayo and Mount Errigal in Co. Donegal.
- Tors and granite landscapes also formed in Devon and Cornwall in Southern England during the Armorican (Variscan) Foldings about 300 million years ago.
- Granite batholiths were formed in the folds of the sedimentary rocks in Devon and Cornwall because here the folding was intense, far greater than it was in Munster.

FORMATION OF IRELAND'S SEDIMENTARY ROCKS

- Once the Caledonian fold mountains with their sedimentary rocks, their metamorphic rocks and their igneous rocks had been formed, they came under severe erosion from weathering and other erosion processes.
- The mountains became worn down and the various rocks were broken up into particles that were washed down and deposited to form new sedimentary rocks of various types in a hot, desert environment that was prone to flash floods.

CONGLOMERATES

- Conglomerates were formed near the mountains. Large pebbles of quartz, quartzite, feldspars, shales and slates were washed down gullies and deposited in alluvial fans and screes to form conglomerates.
- Millions of years later at the end of the last ice age, large moraines and eskers of boulders, gravels and sands were also cemented together to form conglomerates.

SANDSTONE: LOCATION 30º SOUTH OF THE EQUATOR

- Large quantities of quartz grains from the weathered granite in the Caledonian mountains were washed into the lowlands during flash floods to form sheets of sand. Later these quartz grains were cemented together to form fine sandstone.
- All these sandstones are called Old Red Sandstone.
- They were formed in hot desert conditions.

SHALE

- Shales and mudstones formed far from the mountains in delta and seabed areas because they are formed of the lightest particles, which are transported by river waters. They formed clays out of the weathered feldspars from the granite in the mountains.

LIMESTONE: AT THE EQUATOR (350 MILLION YEARS AGO)

- Limestone was formed when Ireland was at the Equator.
- Limestone of many types were formed either in deep oceans or shallow seas. The limestone were formed from great thicknesses of broken shells, fossils, coral or lime mud. They were cemented by a lime mud.

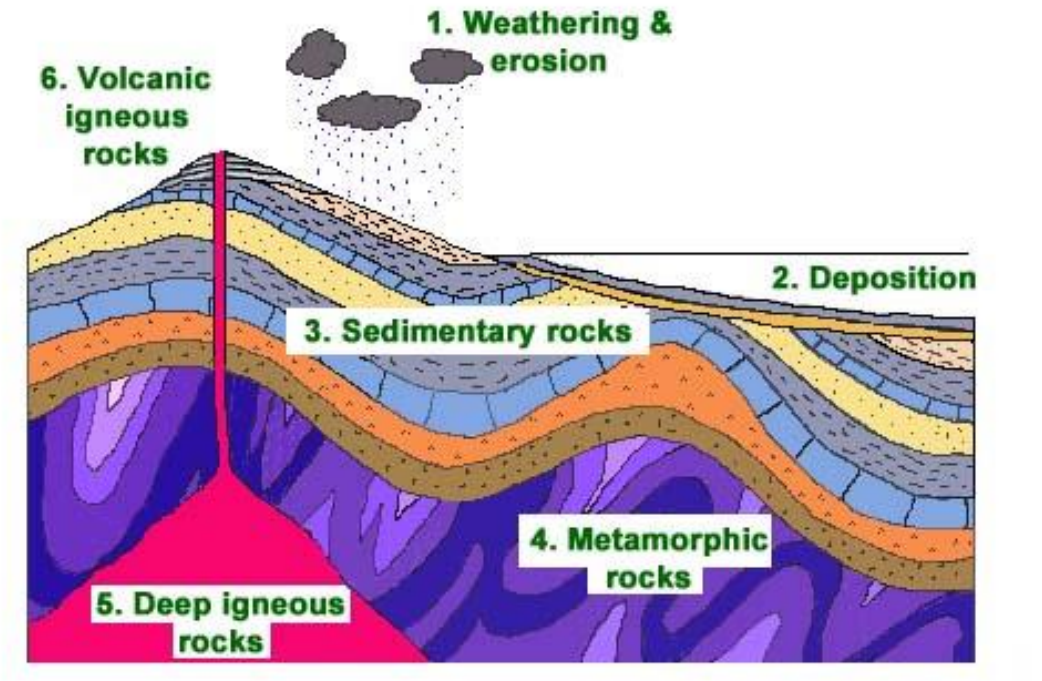
CHALK: NORTH OF THE EQUATOR

- Chalk was formed from billions of shells called coccoliths, when Ireland was north of the Equator in a warm sea. It was a clear sea with little sediment being brought from land, so chalk is pure white.
- It is found in Antrim.

LANDFORMS OF SEDIMENTARY ROCKS

THE DARTRY-CUILCAGH UPLANDS AND BEDDING PLANES

As Ireland was moving close to the Equator it experienced times when it was lowered below sea level to varying depths. Alternate layers of sandstone, shale and limestone were laid down on top of one another, each separated from the next by a bedding plane.



RIDGES AND VALLEYS IN MUNSTER (300 MILLION YEARS AGO)

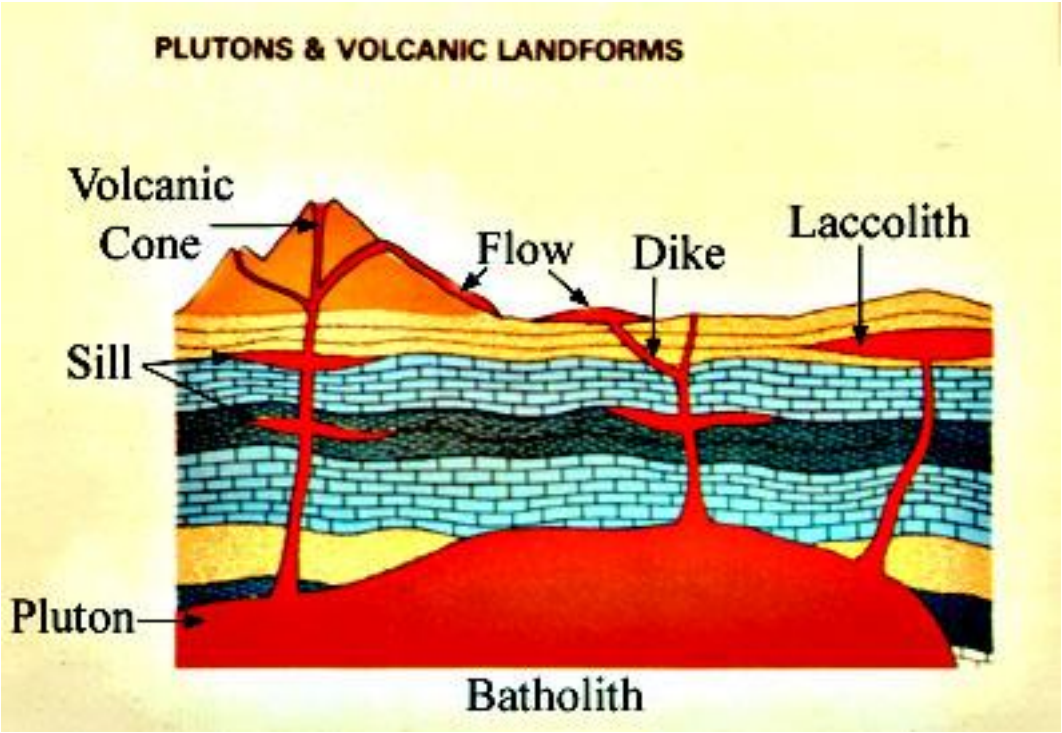
- During the Armorican (Variscan) foldings sedimentary rocks in Munster were folded to form ridges of sandstone and valleys of limestone.
- These ridges and valleys run west to east across Munster as do the rivers that flow in them.
- Limestone rock layers in the valley floors are younger than the sandstone layers on the ridges.
- Each rock layer is separated from the next by a bedding plane.

IRELAND'S BASALT ROCK & ITS LANDFORMS (65 MILLION YEARS AGO)

Basalt is a fine-grained igneous rock.
It was formed when lava cooled quickly on the Earth's surface about 65 million years ago.
It forms six-sided columns and is found in the Giant's Causeway in Antrim.

LANDFORMS

- The Antrim Plateau is its largest landform.
- It forms volcanic plugs, sills, dykes and laccoliths.
- The Giant's Causeway in Co. Antrim



LANDFORMS OF THE ALPINE FOLD MOVEMENT (37 MILLION YEARS AGO)

- The Alps are the youngest fold mountains. They were formed about 37 million years ago when the African Plate pushed into the Eurasian Plate.
- The Apennines were formed because the local sea floor sinks under the leg of Italy.

The Paris Basin

- Layers of Sedimentary rock were slightly folded by the same earth movement that formed the Alps. The basin is dish-shaped, level at its centre and with steep slopes called scarps at its eastern edges.

The Weald

- A dome created in the Weald in Southern England by folding. Weathering and erosion of the youngest rocks have exposed the older rocks in the centre.

HOW PEOPLE INTERACT WITH ROCKS

IN IRELAND

Quarrying:

Quarrying is the process whereby rock is blasted from quarry faces or excavated from the ground and prepared for the construction Industry.

Sands and gravels are excavated from ridges, called eskers, and deltas of sands and gravels that were laid down by rivers that flowed at the end of the Ice Age. They are generally mixed with cement to make mortar and concrete.

Limestone and sandstone are blasted from quarry faces. They are then broken down into smaller particles of stone of various sizes called aggregates. These are used:

- To make concrete and concrete products, such as concrete blocks and roofing tiles.
- For road surfacing
- As filling for passages and driveways
- Limestone in powdered form, lime is used as a fertiliser.

Gypsum is quarried at Kingscourt, Co. Cavan. It is used to make plaster slabs for house construction.

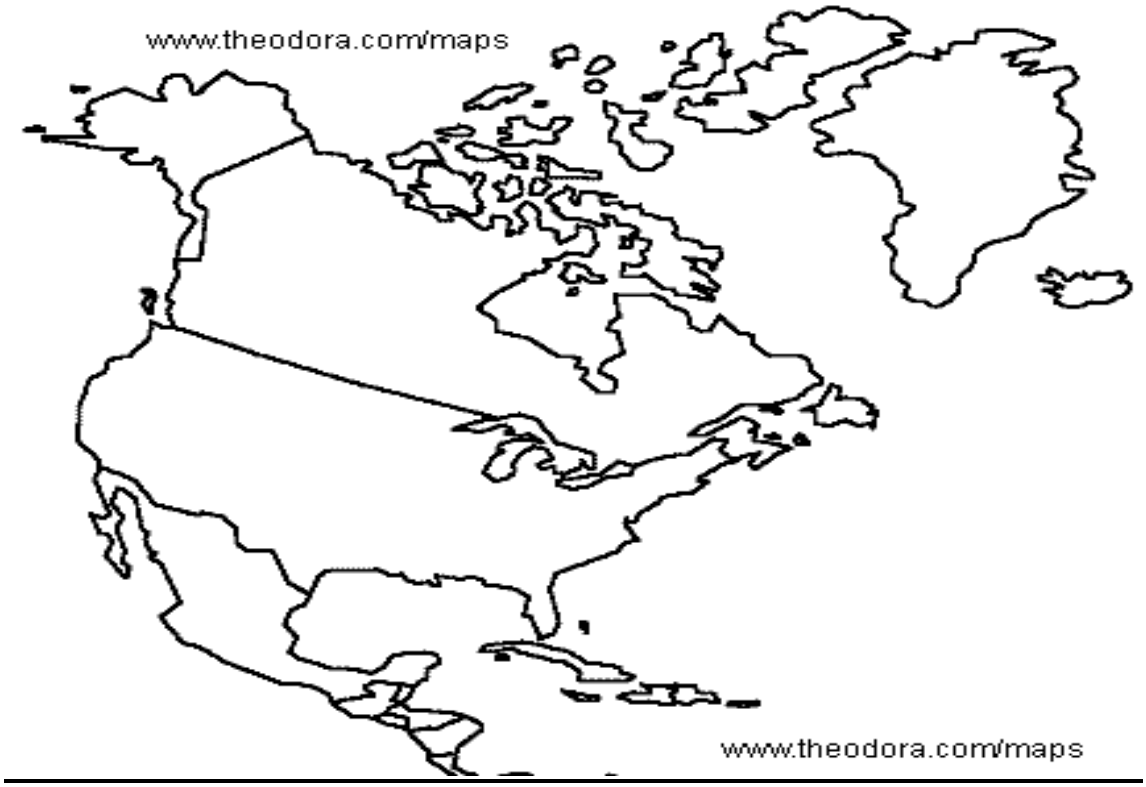
Zinc is mined from limestone at Lisheen, Co. Tipperary, Galmoy, Co. Kilkenny and Navan, Co. Meath. It is used for weatherproofing metals for the construction Industry, e.g. zinc-coated iron is called galvanised iron. It is used for roofing sheds and haybarns.

Marble is quarried in Connemara and Kilkenny. The term marble is widely used to mean any polished rock. However, pure marble forms from metamorphosed limestone.

IN ITALY

Marble is quarried at Carrara in Tuscany. In its purest form it is white. It is used for flooring, wall tiles and fireplaces. Marble from these quarries was used by sculptors such as Michelangelo Buonarroti during the Renaissance.

CORE TOPIC 6 – AMERICA'S ACTIVE & PASSIVE PLATE MARGINS



AMERCIA'S WEST COAST

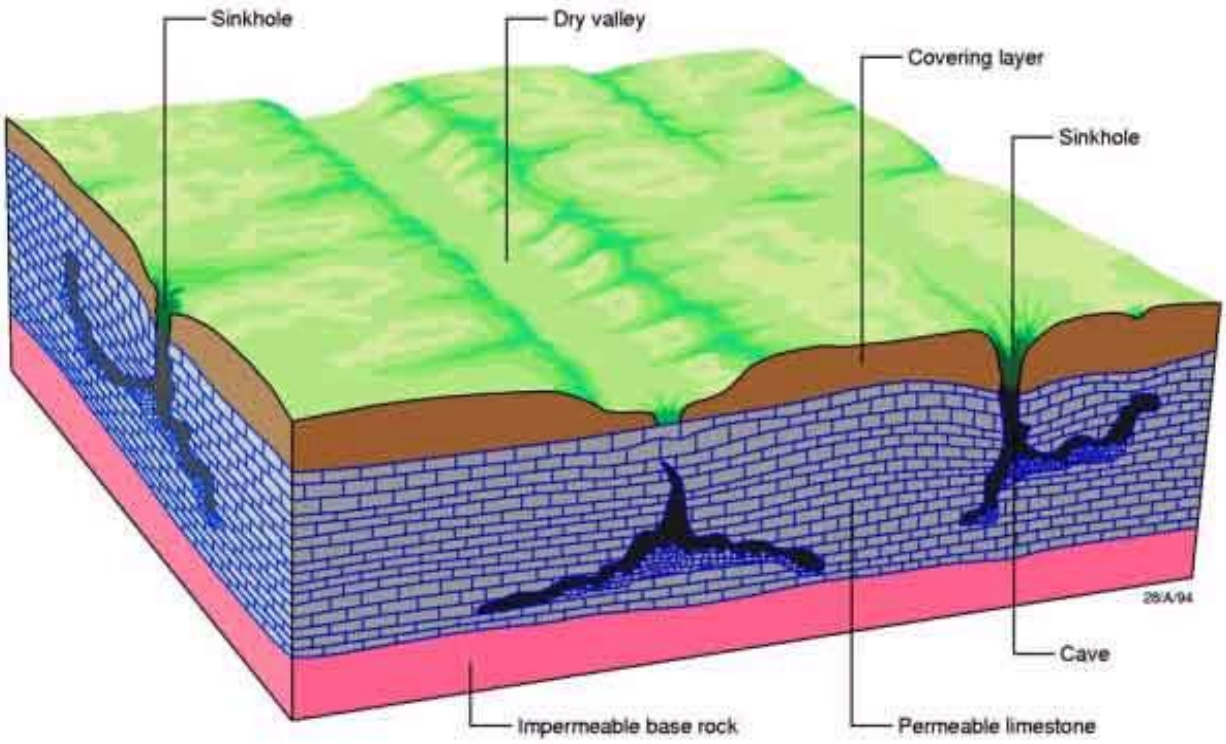
- The Pacific Ocean floor is sinking under the American continent so this is an active plate margin.
- Rocks are buckled along this edge.
- Rising magma forms batholiths of igneous rocks.
- The heat from the batholiths forms marble, quartzite and slate.
- Most of America's newest igneous and metamorphic rocks are located along this edge.
- The Juan de Fuca plate sinks under the American plate.

AMERICA'S EAST COAST

- This is America's trailing plate margin
- Sediments are being deposited by rivers on this continental edge
- Thousands of meters of these sediments form all types of sedimentary rock, such as sandstone and shales.
- Limestone is also formed.

CORE TOPIC 7 – LANDFORMS OF LIMESTONE ROCK

- Karst is a term used to describe large regions where bare limestone rock is exposed at the surface. Examples are:
  - The Burren, Co. Clare
  - The Marble Arch Uplands
- A Limestone pavement is a large, bare, limestone region with grikes and clints formed by solution.
- Sinkholes/swallow holes/slugga: A sinkhole is an opening in the bed of a river where its water disappears underground.
- A cavern is a huge underground chamber formed by solution and erosion by rivers.
- Dripstone is calcite deposited in underground caverns. It forms stalactites, stalagmites, pillars and curtains.
- Tower Karst is a limestone landscape of steep, tower-like hills formed when all the surrounding caverns collapse. River deposits then create an alluvial flood plain.



CORE TOPIC 8 – SURFACE PROCESSES

N.B. STUDENTS STUDY ALL SURFACE PROCESSES

PROCESSES OF MASS MOVEMENT

SOIL CREEP

Soil creep is the movement of soil particles downslope. It occurs due to the influences of:

- Gravity; which pulls soil particles downslope.
- Solifluction; which involves the swelling of some soil particles because they absorb ground water. This swelling causes neighbouring particles to move away from each other.
- Frost Heave; which involves the movement of soil particles by ice crystals that form under stones and moves them to the surface.

Gravity: This pulls large rocks, boulders and soil downslope to create rockfalls and landslides.

Earthflows: These occur when soil is saturated with water on gentle slopes.

Lahars or Mudflows: Lahars occur when enormous amounts of soil, rock, trees and other debris move rapidly downslope. They are triggered when large masses of ice melt owing to volcanic mountains.

Slumping: This happens when cliff edges collapse; as they slip downwards there is a rotational movement of the falling material.

GLACIAL PROCESSES

PLUCKING:
Plucking involves water from melting ice trickling into cracks at the base of a glacier and then freezing. The glacier becomes attached to the rock under it, and then when the ice moves rock particles are plucked from the ground.

ABRASION:
This involves the use by the glacier of these plucked rocks to erode the base and sides of valleys, making them deeper. It also involves the scouring of lowland areas, leading to the removal of soil in some regions.

Basal Slip: The sliding movement of a glacier over its rock floor.

Freeze-thaw: Freeze-thaw is what happens when by day melt-water seeps into cracks in rock and at night this water freezes and expands, breaking up the rock.

RIVER PROCESSES

Hydraulic action: Hydraulic Action is the breaking up of rock caused by the force of moving water.

Corrasion/Abrasion: Corrasion is the use by a river of its load to erode the banks and bed of the river.

Cavitation: Cavitation occurs when bubbles of air collapse and form tiny shock waves against the outer bank of a river.

Deposition: Eroded material is dropped on the bed or flood plain of a river when the slope, the speed or the volume of a river is reduced.

Attrition: Fragments of stone are rounded and made smaller by hitting off each other.

Slumping: This is rotational movement of a collapsing river bank as it is undermined by a river.

COASTAL PROCESSES

Abrasion: Abrasion occurs when boulders, pebbles and sand are pounded by the waves against the coastline.

Hydraulic Action: The direct impact of strong waves on a coast.

Compression: Compression breaks up rock by air being squeezed in cracks and caves.

Attrition: Fragments of stone are rounded and made smaller by hitting off each other.

Longshore Drift: This is a zigzag movement of material along a shore. It builds up bars, spits and lagoons and leads to the development of salt marshes.

CORE TOPIC 9 – SURFACE PROCESSES, PATTERNS AND LANDFORMS

NB Students should be able to identify all surface landforms by name from a diagram.

STUDY ONLY ONE OF THE FOLLOWING IN DETAIL
- Mass Movement, Processes, Patterns and Landforms
- Glacial Processes, Patterns and Landforms
- River Processes, Patterns and Landforms
- Coastal Processes, Patterns and Landforms

RIVER PROCESSES, PATTERNS AND LANDFORMS

RIVER PATTERNS
A basin is the area drained by a river. The pattern of drainage in a basin may be:

- dendritic; when the tributaries form a pattern like the branches of a tree.
- trellised; when tributaries run parallel to each other towards the main course and meet the main river at right angles.
- radial, when streams flow downhill, radiating from a central hilltop or mountaintop.

River Processes

Hydraulic Action:

Corrasion/Abrasion:

Cavitation:

Deposition:

Definitions:

Source: the place where a river begins

Tributary: a river that joins a larger one

Confluence: The place where a river enters a sea or lake

Estuary: That part of a river's course that is tidal

Basin: The entire area drained by a river and its tributaries.

Watershed: The high ground that separates one river basin from another.

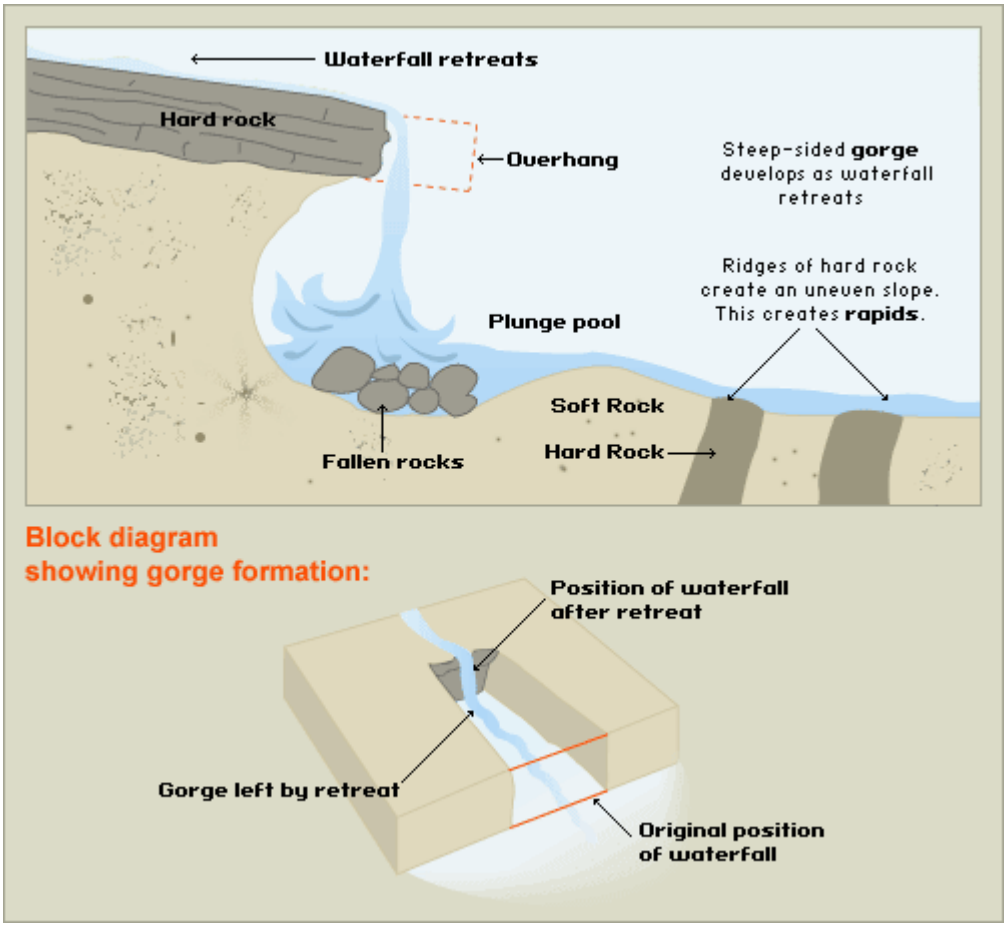
LANDFORMS OF RIVER ACTION

Landform: **Waterfall**
Landform of Erosion; can be found in the Upper Course
Processes: Hydraulic Action, corrosion, eddying, solution, rejuvenation
Examples: Asleagh Falls on the Erriff River; Torc Waterfall, Killarney.

Formation

- When waterfalls occur in the upper course of a river, their presence usually results from a bar of hard rock lying across the valley of the river. If this band of rock is horizontal or slightly inclined, a vertical fall in the river results.
- The scouring action of the falling water and the river's load at the base of the fall cut into the underlying soft rock, creating a plunge pool.
- Two processes are involved in creating the plunge pool;
  Hydraulic Action and Corrasion.

- Hydraulic Action is caused by the force of the falling water; by rushing into cracks, the water can help to break up solid rock. Corrasion is the use by the river of its load to erode the side and bed of the river. At the base of a waterfall, turbulent water and eddying by the river and its load erode the bed to form a plunge pool. Undermining causes an overhanging ledge of hard rock, pieces of which break off and collect at the base of the waterfall. As the fall recedes upstream, a steep-sided channel is created downstream of the falls. The feature is called a gorge.
- If a waterfall appears elsewhere in the course of a river, it may be the result of rejuvenation. This may be caused by a fall in sea level, a local uplift of land, which causes a steeper slope and a greater river speed and so renews downcutting or vertical erosion. This produces a new curve or profile of erosion that intersects with the old curve at the knickpoint. Rivers in Co. Donegal have been rejuvenated, and many flow over waterfalls before they enter the sea.

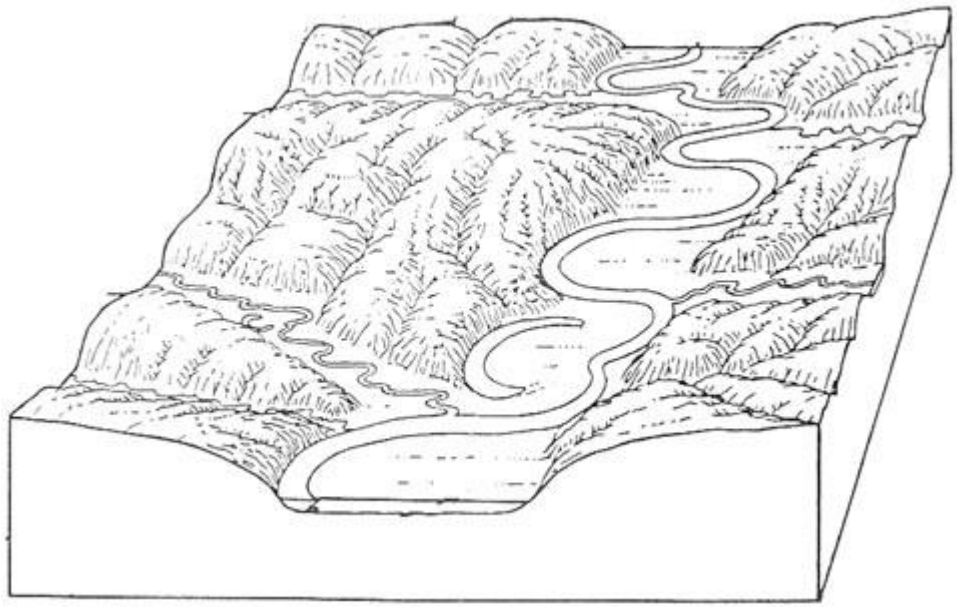


Landform: **Flood Plain**

Landform of erosion and deposition; middle and lower course
Processes: Undercutting, divagation, deposition
Example: River Shannon, Midlands; Blackwater Valley near Fermoy, Co. Cork

Formation

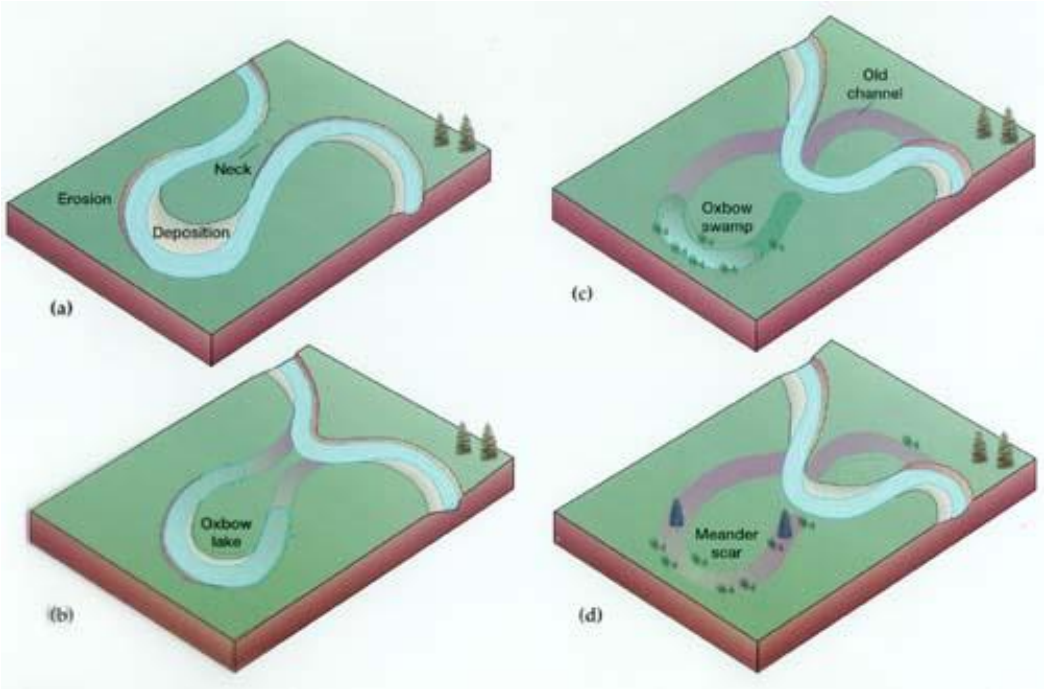
- When meanders migrate downstream, they swing to and fro across a valley. As a result the river swings from side to side. As the water flows around a bend, it erodes most strongly on the outside, forming a river cliff.
- Undercutting of the bank takes place. There is little erosion on the inside of a bend, but deposition often occurs, causing a gravel beach or slip-off slope. The valley had been straightened at this stage, with interlocking spurs removed by the lateral erosion of the meanders (divagation), and a level stretch of land is created on both sides of the river. This is called a flood plain.
- During its upper and middle stages, a river flows quickly and is able to transport a large amount of material, called its load, by the processes of solution, suspension and saltation. However, in the lower stages the speed of a river is reduced, because of the gentler slope of the valley floor. At this stage the river is able to carry only the smallest particles of silt and clay, collectively called alluvium.
- A flood plain is a wide and flat valley floor that is often subjected to flooding during times of heavy rain. When this occurs, the river spreads across the flat flood plain and deposits a thin layer of alluvium. Alluvium is fine material consisting of silt and clay particles and is rich in mineral matter, transported by a river and deposited at places along the flood plain. This deposit enriches the soil and leads to the creation of fertile farmland.



Landform: **Ox-Bow Lake**
Landform of erosion and/or deposition; middle and lower course
Processes: Hydraulic Action, Corrasion, Cavitation, deposition.
Example: River Shannon at Leitrim Town and Ballymoreustace, Co. Kildare

Formation

- As meanders move downstream, erosion of the outside bank leads to the formation of a loop in the river's course, enclosing a peninsula of land with a narrow neck. Three main processes of river erosion act together to create the Ox-Bow lake.
- Hydraulic Action is caused by the force of the moving water. By rushing into cracks and by direct contact with the river banks, it can help to break up solid rock and undermine the banks.
- Corrasion is the use by the river of its load to erode, in this case, the river bank. Along the side of the outer bank turbulent water and eddying (swirling movement) by the river and its load to create a river cliff. Erosion also occurs when bubbles of air collapse and form shock waves against the outer bank. Loose clays, sands and gravels are quickly worn away by this type of process.
- Finally, during a period of flood the river cuts through this neck and continues on a straight and easier route, leaving the river loop to one side. Deposition occurs at both ends of this loop to form an Ox-Bow Lake.
- After a long time these Ox-Bow Lakes become filled with silt from flood water and finally they dry up. At that stage they are called meander scars or mort lakes.



Landform: **Delta**
Landform of deposition; can be found in the lower course
Processes: Deposition
Example: Roughty River, Co. Kerry; the Cloghoge river Delta in Lough Tay in Co. Wicklow.

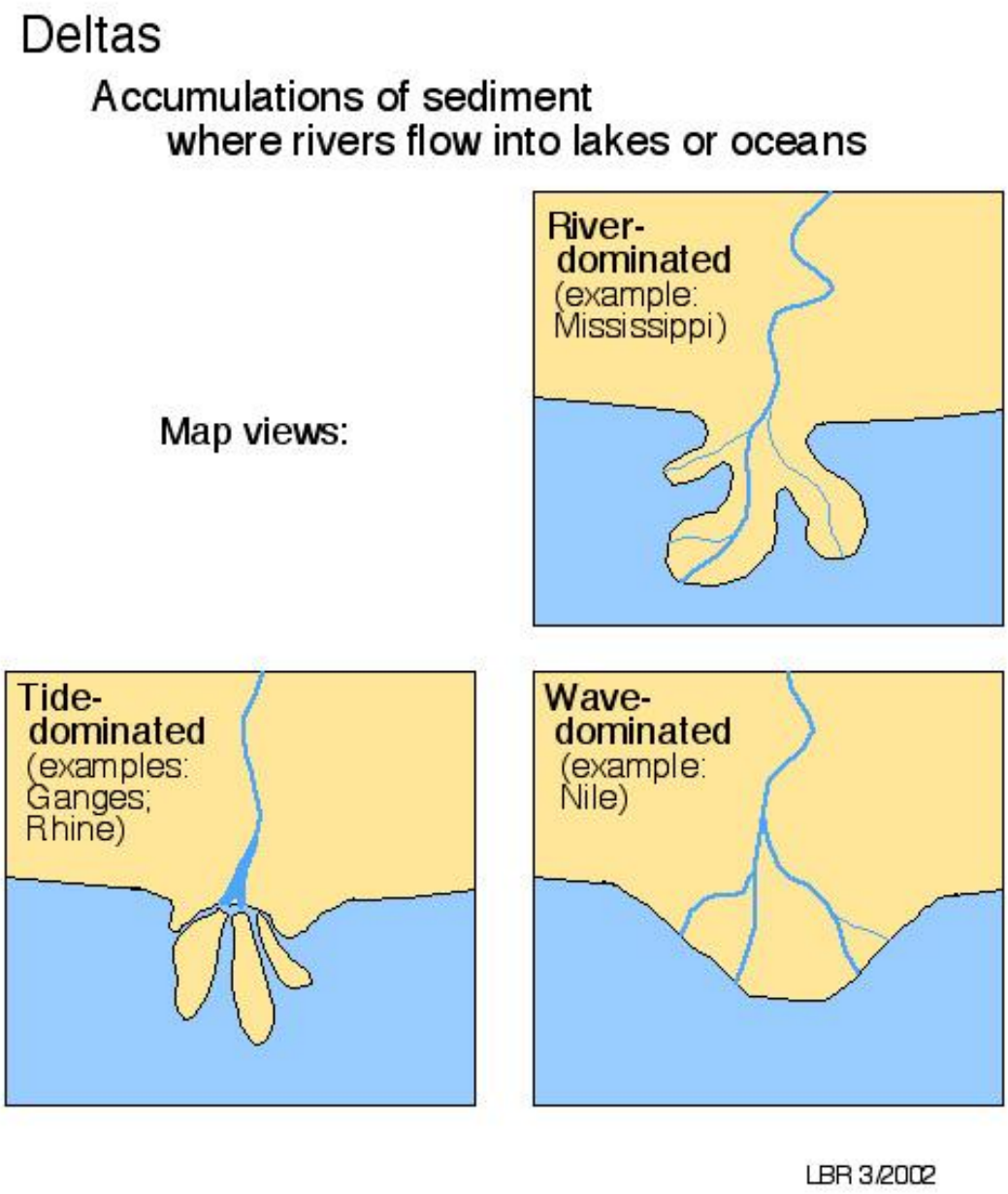
Formation

- The materials deposited in a delta are classified into three categories.

1. Fine particles are carried out to sea and are deposited in advance of the main delta. These are the bottom-set beds.
2. Coarser materials form inclined layers over the bottom-set beds and gradually build out, each one in front of and above the precious ones, causing the delta to advance seawards. These are the fore-set beds.
3. On the landward margins of the delta, fine particles of clays, silts, and muds are laid down, continuous with the river's flood plain. These are the top-set beds.

When a river carries a heavy load into an area of calm water, such as an enclosed or sheltered sea area or a lake, it deposits material at its mouth. This material builds up in layers called beds to form islands, which grow and eventually cause the estuary to split up into many smaller streams, called distributaries. Should this occur in a lake, it is called a lacustrine delta (e.g. Glendalough, Co. Wicklow). If it occurs at a coast, it is called a marine delta (e.g. the Roughty River in Kenmare Bay, Co. Kerry). The material that builds up to form the delta is composed of alternate layers of coarse and fine deposits, which reflect times of high and low water levels, respectively, in the river. Mountain streams flowing into glaciated valleys often build deltas in ribbon lakes. This causes a

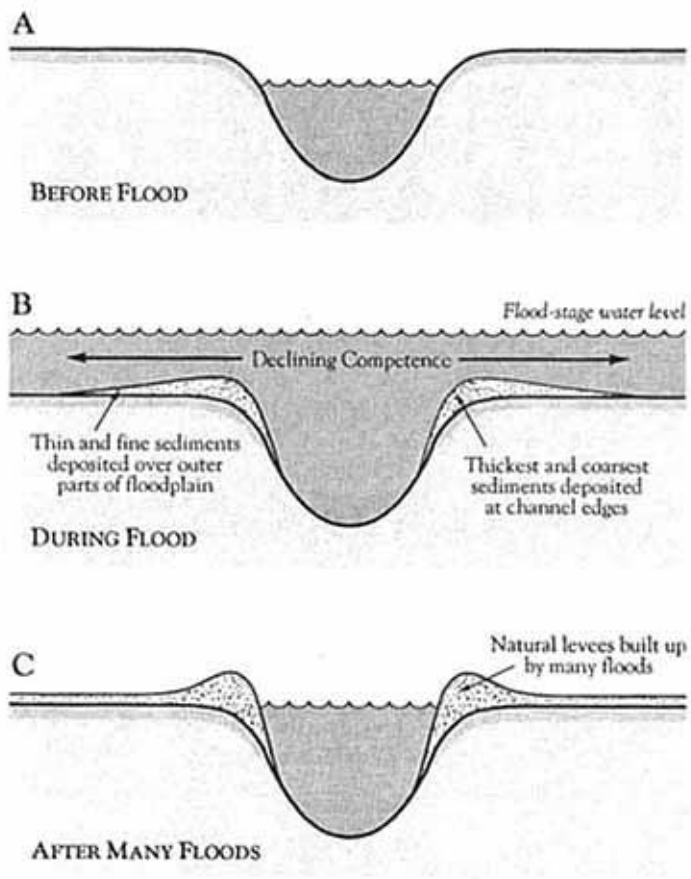
filling-in of the lake, reducing its length over time or dividing ribbon lakes into separate lakes.



Landform: **Levees**
Landform of deposition; occurs in the lower course
Processes: Deposition
Example: Mulkear River, Co. Limerick

Formation

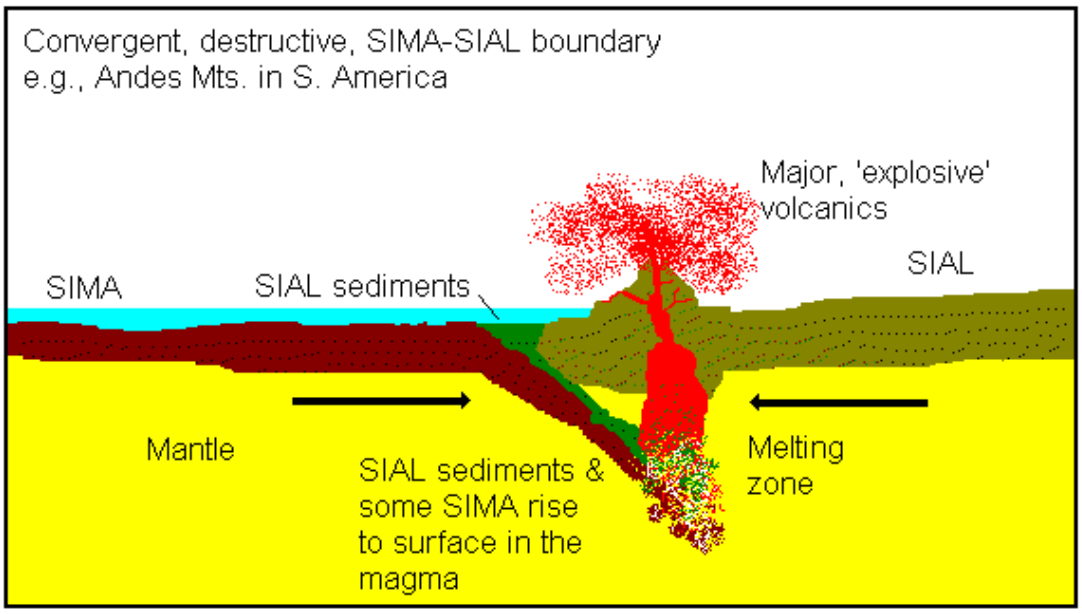
- Levees are high banks along a river's edge in its lower course. They form naturally or can be man-made to retain flood waters and prevent flooding of the surrounding low flood plain. They generally form along the edges of silt-laden rivers as the rivers slowly wind their way across to flat flood plains to the sea. The best known levees are found along the Yangtze Kiang river in China, on which many villages are built.
- As sediment-laden flood water flows out of its completely submerged channel during a flood, the depth, force and turbulence of the water decrease sharply at the channel margins. This decrease results in a sudden dropping of the coarser materials, usually fine sand or silt, along the edges of the channel building up a levee.
- As a levee increases in height it will eventually retain all floodwaters and prevent the river from overflowing it banks onto the flood plain.
- Man made levees are also constructed to prevent flooding and damage to villages and towns, especially where large populations live on floodplains.



CORE TOPIC 10 – THE PROCESS OF ISOTASY AND LANDFORMS

The earth's crust is made up of rocks of differing densities

- The continents are made up of light rocks called SIAL
- The ocean floors are made up if dense rocks called SIMA. A continent floats on a layer of sima that runs under the continents and along the floors of the oceans.
- When erosion of continents occur sediment is deposited in lowlands, increasing weight in this area – so they are pressed down.
- This action also reduces weight in mountain regions, so the mountain regions float higher on the sima layer. Together these actions cause a levelling of the landscape. This process is called ISOTASY.



LANDFORMS CAUSED BY CHANGES IN SEA LEVEL

- The process of isotasy causes raising and lowering of land relative to the level of the sea. This can lead to some landforms being drowned or partially drowned, by the sea.
- On other occasions landforms may be raised above sea level, when they were once either at sea level or below it. Earth movements can also create these landforms.

Emerged Coastal Features

Raised Beaches and Wave-Cut Platforms

- The sea level, relative to the land, changes over time. If the level of the sea falls or the land rises, then coastal features such as beaches or wave-cut platforms may now be well above sea level.
- Step-like terraces may also form when sea levels change.

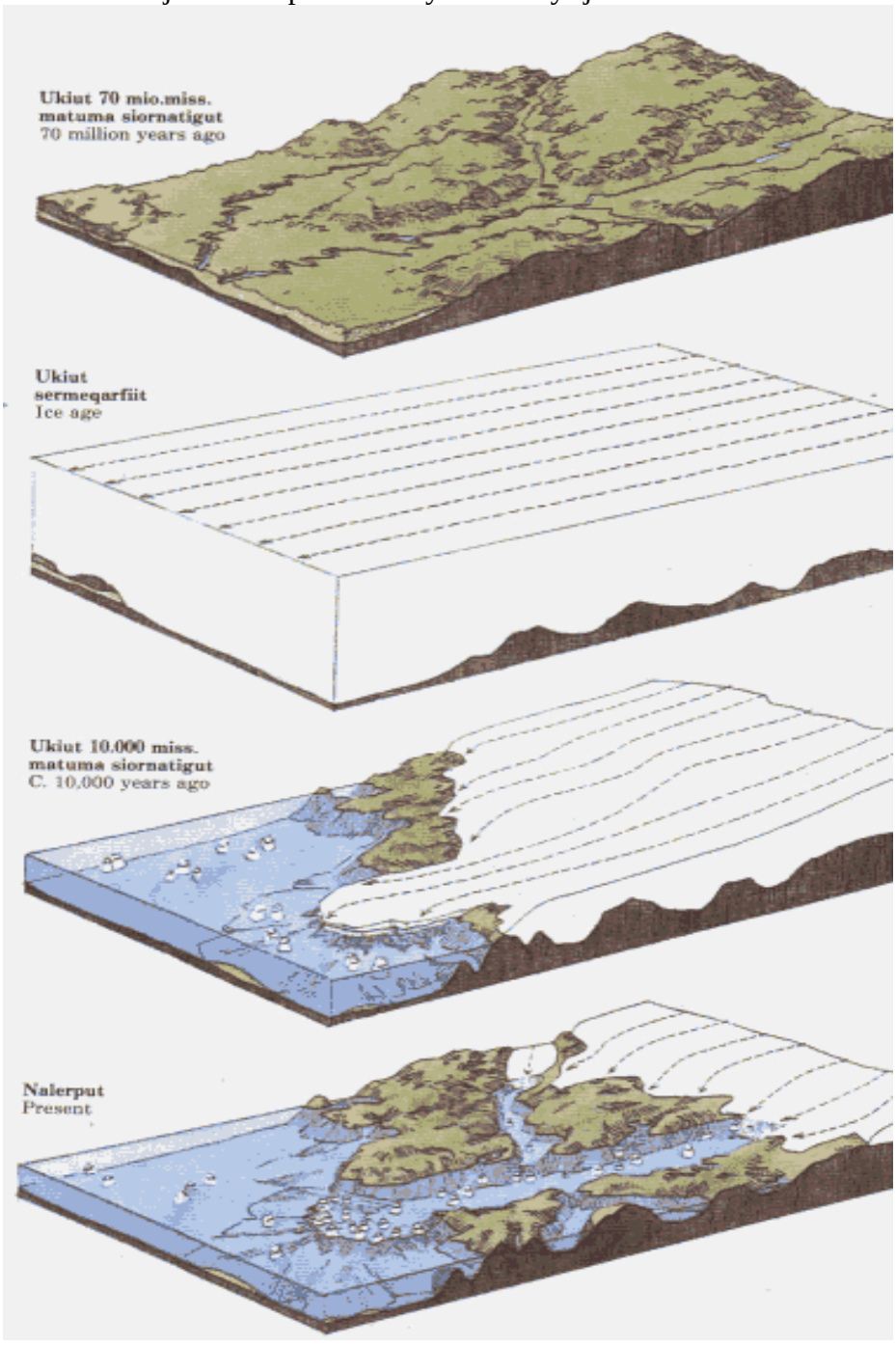
Submerged Coastal Features

<u>Rias</u>

- Rias are submerged river valleys. They occur in South-West Ireland; Dingle Bay and Bantry Bay are Rias.
- As the American plate moved away from the Eurasian plate, the west coast of Ireland lost it support, tilted seawards and was drowned by the sea. This process created the rias of the south-west.

Fjords

- During the last ice age, glaciers carved deep U-shaped valleys in coastal mountain ranges. When the Ice Age ended the water stored in the ice flowed back into the sea, causing the sea level to rise.
- The rising sea filled the deep valleys, forming fjords. Killary Harbour is Ireland's best fjord example. Norway has many fjords.



ADJUSTING TO BASE LEVEL

- When earth movements raise land, the rivers in that region will erode to create a new curve or profile. Rivers began cutting their new curve or profile from their estuaries upstream.
- This process is called rejuvenation
- Waterfalls or rapids on a river near to it estuary indicate that uplift has recently taken place. In Co. Donegal in Ireland, the rejuvenation was caused by loss of weight on the landscape when the Ice Age ended.
- Waterfalls occur where the old profiles and new profiles meet. This is called the knickpoint.

CYCLE OF LANDSCAPE EVOLUTION

- As new, level landscapes are exposed to weathering and erosion, they come under attack from rivers, wind, rain, frost and mass movement.
- The rivers open up channels and the other processes combine to divide the original level land into separate ridges and valleys.
- These ridges gradually get worn down until they are just barely visible as raised land separating valleys that are in their lower stages of development.
- These almost perfectly flat landscapes are called peneplains.Example: South Cork

CORE TOPIC 11 – PEOPLE'S INTERACTION WITH SURFACE PROCESSES

NB: STUDENTS SHOULD ONLY STUDY ONE OF THE FOLLOWING:

Mass Movement Processes
River Processes
Coastal Processes

RIVER PROCESSES

The impact of Hydroelectric Dams

- Hydroelectric dams are built across river valleys to dam up water for the purpose of electricity generation; but this process interferes with the natural processes of river action. Rivers are forced to deposit sediment in the reservoir lake behind the dam. Eventually the dam becomes filled with sediment that should otherwise have been washed to the middle and lower stages, providing gravel, sand and alluvium supplies.
- Farmland behind the dam is likely to be flooded and farmers' homes are submerged by rising reservoir waters.
- If a delta did exist at the river estuary before dam construction, it will now be prone to erosion due to loss of alluvial soils in the reservoir lake upstream.
- Natural vegetation in regions behind dams is lost as the reservoir waters rise.
- Villages with all their historical character may be flooded and lost under the reservoir water. This has occurred at the Three Gorges dam project in China.

The impact of Canalisation

The diversion of fresh water from rivers for the purpose of irrigation can impact on natural processes in the following ways

Increased Salt Content:

- Many minerals are dissolved in river water; we call them salts. When salt content increases, either in the soil or in water, it can have serious effects.
- Some seas may be inland seas and are just huge, freshwater lakes.
- These inland seas, such as the Aral Sea, need a constant supply of fresh water to counteract evaporation.
- Evaporation creates a build-up of salts.
- This changes the seas' ecosystems, leading to fish species and natural vegetation being lost.

Improved Agricultural Output

With increased water supplies through irrigation from reservoirs, local regions that would otherwise be desert may become major farming regions, such as central and southern California.

Loss of Fresh Water

-Rivers that once flowed strongly to the sea may now be just a trickle.
-This causes tidal waters to reach farther up their estuaries than before dam construction. Ecosystems may be wiped out in their estuaries.

Flood Control Measures

Levee Construction

- Levees are high banks of clay and stone, built parallel to a river's channel to contain flood waters.
- Floodwaters no longer spread across a river's flood plain during times of heavy rain. This process naturally provided flood plain with minerals needed by grasses to grow naturally and healthily. Levees deny a flood plain's natural mineral supply, which must now be provided by farmers themselves.
- Wildlife that once lived in marsh or wetland sections of the flood plains must find other nesting places.
- The bursting of levees can lead to severe loss of life.