Canada

- Yukon(T)
    - Whitehorse
- Northwest Territories(T)
    - Yellowknife
- Nunavut(T)
    - Iqaluit
- British Columbia(P)
    - Victoria
- Alberta(P)
    - Edmonton
- Saskatchewan(P)
    - Regina
- Manitoba(P)
    - Winnipeg
- Ontario(P)
    - Toronto
- Quebec(P)
    - Quebec City
- Newfoundland & Labrador(P)
    - St. John’s
- New Brunswick(P)
    - Fredericton
- Prince Edward Island(P)
    - Charlottetown
- Nova Scotia(P)
    - Halifax

Continents

- North America
- South America
- Europe
- Asia
- Africa
- Antarctica
- Australia

Oceans

- Pacific Ocean
- Atlantic Ocean
- Indian Ocean
- Southern Ocean

- Arctic Ocean

Geotechnology

- The use of advanced technology in the study of geography and in everyday use

GPS and GIS

- GPS, short for Global Positioning System, is a modern geotechnology built upon using satellites to triangulate location data. GPS is a satellite-based system that provides location data
    - GPS devices work by communicating with satellites to triangulate location
    - Three day-to-day applications of GPS are: navigating through an area like a city or town, finding directions, and nearby services.
    - GPS has been used in any commercial GPS system, any app or device that uses location services, used for navigation, and police services.
- GIS is a system designed to gather and analyze similar data of an area. For example, it can be used to examine water quality of a specific area. GIS is a database and software is used to model the data and combine it with GPS to provide more information.
    - A GIS Map is created by using a computer system that assembles and analyzes given data to construct a map.
    - The layers of a GIS Map can be manipulated to see different resources that exist in an area and how they have changed over the years.
    - GIS provides the user a complex analysis of an issue, gathers data, and creates maps
    - Three day-to-day applications of GIS are: finding traffic, examining the water quality of an area, and predicting the climate of a specific region.

Remote Sensing

- When a satellite records data and sends results to a ground station for analysis. Weather events are often recorded like this to take future action, from adapting to a problem to mitigating it by placing flood walls, or evacuating people from an area.

Telematics

- Telematics, short for telecommunications informatics is critical to the Internet of Things, a network that links “things” such as your car to a satellite, or your car to your phone. Telematics makes basic tasks automated, giving more time to focus on plans and action; a weather station can implement telematics to take readings of temperature, humidity, precipitation, etc.

Polar Front

- An area where a polar air mass meets a tropical air mass. The line where they meet can be thousands of kilometers long. As this is a transition zone between cold polar air and warmer tropical air, it stores lots of potential energy that natural disasters can tap into, increasing their severity. Polar fronts are also very, very cold.

Humus

- The part of soil that is made from deceased organic matter such as leaves and other material degraded by microorganisms and decomposers. However, humus doesn't include inorganic elements.

Plate Tectonics

- Plate tectonics is a widely accepted theory about the composition of Earth's crust. This theory states that the Earth's crust is not one solid piece, rather it is made up of pieces called tectonic plates that move in various ways. The theory explains the causes of many natural phenomena which result from the interaction of the rigid lithospheric plates. There are 7 major plates, 8 secondary plates, and over 60 minor plates. The movement of these plates causes natural disasters such as earthquakes and tsunamis, and also causes volcanoes and the formation and destruction of Earth's crust.

Proof of Theory of Plate Tectonics/Continental Drift

- Theory of Plate Tectonics states that the Earth is made of a bunch of plates that are constantly shifting and are responsible for natural disasters.
    - Apparent fit of the continents; observation that continents seem to fit together; the coastlines of the continents seem to fit together such as the eastern coast of South American and the western coast of Africa.
    - Fossil correlation; fossils are found in land masses that are separated by large bodies of water. Mesosaurus fossils were found in rock of both South America and Africa. Since the mesosaurus could not fly or swim, it must have walked over to the other continent before the two broke apart and died once there.
    - Rock and mountain correlation; identical rock and mountain structures have been found on either side of the ocean
    - Paleoclimate data; bituminous coal that forms from tropical plants has been found in cold areas, and warm areas show glacial striations. This means that cold areas today were closer to the equator, and warm areas today were once farther from the equator. Moreover, glacial striations, evidence of glaciation and the area being closer to the poles, have been found in warmer areas near the equator.

Types of Plate Movement

Divergent

- Occurs when two plates move apart, most commonly along a mid-ocean ridge (a feature created by the spreading of the sea floor where two plates are diverging), but it does happen on land as well. When this happens, both plates get larger and new areas of Earth's crust are constantly being made this way along 70,000 kilometers of mid-ocean ridges. The plate divergences are an active volcanic site, with the one along the floor of the Atlantic Ocean known as the Atlantic Ring of Fire

Convergent

- There are two types of convergent plate movement, an oceanic plate converging with a continental plate or two continental plates converging.
    - Oceanic plates are denser than continental plates and so slide underneath continental plates and into the underlying magma. The oceanic plate gets recycled by the intense heat of the magma through a process known as subduction. The crust being melted here balances the new crust forming at a divergent plate boundary. Subduction can happen fairly smoothly when the oceanic plate moves slowly and continuously under the continental plate. These can cause small earthquakes, but they can cause very large and serious earthquakes under specific conditions. These specific conditions are when the plates are locked and build up tension. This tension can get released in only a few seconds and can be devastating, reaching values of 8.0 to 9.0
    - When a continental plate converges with another continental plate, massive layers of rock are folded, broken, and forced upwards by the immense forces caused by one plate being forced under another. This process has created the majority of mountain ranges we know today like the Himalayas

Transform

- Two plates move along a transform plate boundary (conservative boundary), plates are made neither larger or smaller. In these locations, plates move in roughly parallel but opposite directions. This process happens relatively smoothly with many small earthquakes but no catastrophic damage. Sometimes, like with subduction zones, plates lock in and release immense amounts of pressure in the form of earthquakes. Major earthquakes at transform boundaries are generally in the intensity of 5.5 to 7.5

Earthquakes

- Earthquakes are natural disasters where plate movement causes a sudden and violent shaking of the ground, which ranges from a slight tremor to catastrophic destruction. Earthquakes are generally caused by convergent or transform plate boundaries. Convergent plate boundaries generally result in more powerful earthquakes, but plates can get locked in place, pushing on each other for hundreds

of years. Locked plates can cause greater devastation as energy builds up and is often released in a matter of seconds.

Volcanoes

- Volcanoes are natural phenomena where magma spews from Earth through an opening in the Earth's crust. Volcanoes are created from divergent and convergent tectonic plates. In divergent plates, as both plates split along a mid-ocean ridge, magma rises and forms a volcano. This is the cause of the Atlantic Ring of Fire. In converging plates, an oceanic plate slides underneath a continental plate, pushing magma up through the folds and breaks in the continental plate.

Tsunami

- Tsunamis are sets of large ocean waves caused by an earthquake of other powerful disturbance under the sea. A tsunami can cause great destruction when it reaches land.

Rock Cycle

- The rock cycle is a description of how the major types of rock transform into one another. As it is a cycle, there is no beginning or end to the rock cycle, there has simply been enough time for many cycles of rock formation and destruction.

Igneous Rock

- Igneous rock forms from the cooling of magma or lava. Most igneous rock formation occurs at the bottom of the ocean or inside Earth's crust, and the location of the rock's formation can be told by the structure of its crystals. Igneous rocks that form in Earth's crust are intrusive rocks, while rocks that form under the ocean or on the surface are extrusive rocks

Weathering, Erosion, and Deposition

- Weathering, erosion, and deposition is the method in which rocks break down into smaller pieces and then move the particles to a new location. Weathering is the process of breaking down rocks by means of water, wind, chemicals, and living things. Erosion is the process of moving those broken down pieces of rocks, and deposition is the process of the eroded materials building up in a new location. This is important since deposition dictates where the particles build up, and it can create a delta at the mouth of a river, changing drainage patterns. In all cases, the sediment can only form sedimentary rock.

Sedimentary Rock

- Most sedimentary rocks are created after billions of years of compaction and cementation of loose sediments. Compaction occurs as sediment dries or more layers of sediment layer on top, packing the sediment tightly. These sediments eventually cement together because of the minerals deposited between them. Different sedimentary rock forms from different sediment; shale is formed from loose

sediment and clay, while limestone is made from the shells of long dead marine animals.

- Sedimentary rock is generally found in the ocean and three things typically happen to the layers of sedimentary rock on the bottom of the ocean.
    - The layers of sedimentary rock just lay on the ocean floor. This typically means that there are deposits of crude oil and natural gas under those layers of sedimentary rock, making them critical sources of the world's energy supply.
    - The layers of sedimentary rock act as a bumper for when two plates converge. The sedimentary rock gets sandwiched between the two converging plates and gets pushed up as layers of rock break and fold to form mountain ranges. This is why it is common to see fossils of sea creatures kilometers above sea level. A prime example of this is Canada's Rocky Mountains
    - Tectonic forces lift layers of sedimentary rock out of the sea while keeping them horizontal. This creates plains, which is where many people tend to live. An example of this evident in our world is how Ontario was lifted in this way.

Metamorphic Rock

- Metamorphic rock is sedimentary and igneous rock gone through immense heat and pressure. This immense heat and pressure generally comes from magma extruding from the Earth's surface, becoming lava, and flowing through existing rock layers. This metamorphism is critical to the concentration of minerals; the great heat and pressure can cause minerals to concentrate in relatively small areas. Some useful minerals such as iron, gold, or nickel concentrating in one area makes mining a very profitable venture in that region.

Landforms

Canadian Shield

- Mainly composed of igneous and metamorphic rock, formed in the Precambrian Era
- Minerals: gold, nickel, copper, zinc, diamonds, lead
- Industry: Mining, Logging, Pulp and Paper, Tourism
- Little farming because of poor soil, exposed bedrock, and terrible drainage
- Oldest and largest landform
- Covers more than half of Canada, some of Greenland and 2 small areas of United States
- Abundant supply of freshwater from glaciation
- One of the world's most important sources of metallic minerals (Gold, Zinc, Copper, Nickel, Uranium, Diamond, Lead, Iron, Silver)
- Many of its rivers flow into Hudson Bay
- Southern rivers used for hydroelectricity
- Boating, dog sled riding, fishing, hunting, snowmobiling, and cross-country skiing
- Very rocky

Interior Plains

- 17% of Canada's population lives here
- Southern part (Saskatchewan) is one of the most important agricultural areas of Canada, most of food production is exported
- Mainly composed of sedimentary rock; erosion of different rocks created deep and wide river valleys, rolling hills, and slopes from west to east - formed during the Paleozoic Era.
- Oil and Natural gas in sedimentary rock make good resources for mining (Alberta)
- Rounded landscape, lakes, flat plains, gently rolling hills, lowlands, plateaus, foothills, escarpments, and Badlands
- Cattle, Grain, coal, oil, natural gas
- Produces potash, an ingredient in fertilizer
- Two escarpments break up Interior Plains into 3 distinct levels from east to west
- Shallow ponds called sloughs & large areas of marshy wetlands

Great Lakes - St. lawrence Lowlands

- Frontenac Axis - Canadian Shield bisects areas near Kingston
- Sedimentary Rock, formed in the Paleozoic Era
- Rolling hills flattened from glaciation
- Deep river valleys gouged by glaciers
- St Lawrence is a rift valley
- Great Lakes are good for farming and 60% of Canada's population lives here
- Area is slightly less than 2% of Canada
- Together with Interior Plains accounts for 75% of Canada's food production. Food production here is used within Canada
- Great Lakes lowlands formed from sediment from Canadian Shield glaciation
- Escarpment: Steep cliff formed by erosion of sedimentary rocks
    - Niagara Escarpment

Hudson Bay - Arctic Lowlands (Lowland Region)

- Population slightly above 10,000 (0.03%)
- Mainly Aboriginal population
- Hudson Bay region is mainland south of Hudson Bay, while Arctic region is several islands in Hudson Bay
- Used to be a highland region, eroded into a lowland region
- Hudson Bay region is low-lying, very flat, swampy, forested, and has a harsh climate

Appalachian Mountains (Highland Region)

- Oldest highland region
- Most of population lives in narrow coastal regions
- Rolling hills and valleys
- Valuable mineral resources are found in some locations
- Non-metal and metal minerals

- Fishing & tourism
- Extends into the US

Western Cordillera (Highland Region)

- Youngest mountain range
- Extends into the US
- The Rockies are actually the easternmost side of Western Cordillera (Border between Alberta and British Columbia)
- Large population in valleys in British Columbia
    - Vancouver, interior valleys (Okanagan Valley), coastal plains (Victoria)
- Coastal climate is very rainy (Rains a lot on windward side of mountains)
- Plateaus protected by valley walls
- Mountains are very dry on leeward side/rain shadow

Innuitian Mountains/Regions (Highland Region)

- “Forgotten Mountains”
- Glaciers still exist in this area
- Northernmost landform region
- Formed during mid-Mesozoic era
- Made mostly of sedimentary rock
- Permafrost (Permanently frozen ground) makes farming difficult
- Cold winters and short summers
- Short vegetation, goes only to snowline; snow insulates plants

LOWERN (Climate Processes)

Latitude

- The Sun’s light hits Earth equally, but the Earth is spherical, so the light, and by extension heat, is spread out over a greater area as you move closer to the poles. The further you are from the equator, the colder it generally is

Ocean Currents

- At the equator, water gets warmed up and it starts to move towards the poles. The waters that move towards the poles are called ocean currents and are warmer than surrounding waters. Warmer ocean currents make and area warmer, while colder ocean currents make areas colder. An example of this is the warm ocean current from Japan that crosses the Pacific Ocean and splits when it hits North America. A warm North Pacific current moves upward, while a cold California current moves southward. As ocean currents move about, they bring winds that have similar temperatures as the currents with them. These winds warm and cool coastlines.

Winds and Air Masses

- Air masses are large bodies of air that take on the climatic conditions of where they form. Air masses move depending on existing weather patterns and the temperature gradient from the equator to the poles. When an air mass moves from an area of high pressure to that of low pressure, wind is produced. Earth has an established wind movement pattern where air rises and move across the Earth ro fall and then move once again. This pattern repeats three times and then the air masses return to the equator to restart the cycle. Canada experiences the westerlies wind belt.

Elevation

- As you move higher up, there is a lower air concentration because Earth's gravity diminishes as distance increases. The lower air pressure makes the temperature drop, causing colder temperatures at higher elevations. If the air expands without condensation, the air will cool by 1°C for every 100 meters of elevation change. Cooler air cannot hold nearly as much heat, so condensation begins and gives off heat, dropping the temperature to 0.6°C for every 100 meters

Relief

- Relief is the shape of the surface of the land; the windward side of a hill or mountain will receive substantially more precipitation than the leeward side/rain shadow since air masses are pushed up by the hill or mountain. This causes the air mass to expand and condense, resulting in precipitation. As the air mass passes the peak of the hill/mountain, it is dry and results in much less precipitation.

Near Water

- Water acts as a sort of temperature modulator; maritime areas (which are areas close to water) receive upwards of 1000 mm of precipitation a year, but have small annual temperature ranges (under 25°) since the water heats and cools much slower than the land. In continental areas (areas far from water), the land heats and cools faster than water, causing a very large annual temperature range, but little precipitation. Areas that show elements from both continental and maritime climates have modified continental climates.

Climate Regions

- Arctic
- Taiga
- Boreal
- Cordilleran
- Pacific Maritime
- Prairie
- Southeastern
- Atlantic Maritime

Soil

- Soil is loosely packed material capable of supporting life on Earth given the right conditions
- Soil needs MOMA
    - Minerals(Zinc, Calcium, Potassium, Nitrogen, Iron, Aluminum etc) that the plant needs for proper growth
    - Organic matter; humus, roots, and decomposers to enrich the soil
    - Moisture; soils need a very specific amount of water for optimal quality and so that the soil is rich and fertile
    - Air; every soil needs air to support life
- The conditions soils need to support life are that there needs to be a thick layer of loose parent material available from which a fertile soil can develop. A lot of parent material in Canada is sorted and unsorted glacial deposits, but areas where the glaciers dug into the ground and exposed the bedrock like the Canadian Shield, the parent material is often bare rock.The rock weathers into loose material after 100,000 years. Soil also needs to have the right climate to develop into well-developed, fertile soil. The growing season needs to be long enough for rich plant growth in the summer; the plant adds nutrient-rich organic material to the soil in this time. In addition, you need the right amount of precipitation. Too much or too little will result in wet-climate or dry-climate soils respectively, leading to poor drainage and poor soil.
- Wet-climate soil results in nutrients from the A Horizon draining down to the B Horizon and C Horizon, which is known as *leaching*. The soil then loses fertility and tends to be greyish. The topsoil is thin and soluble organic materials are rapidly washed down by the excess rainfall
- Dry-climate soils result in moisture moving up from the parent material and subsoil to the topsoil. This makes the topsoil rich and dark. If there is too little precipitation, the soil will be infertile since the little plant growth decreases the organic material with it. This accumulation of calcium salts is known as calcification.
- A soil profile is the three different layers that exist in the soil beneath the surface of the ground. Each layer has a particular combination of physical, biological, and chemical characteristics.

Vegetation

- Natural vegetation is the product of temperature and climate. It is also the result of plant growth outside the influence of human cultivation.

Regions

- Tundra
    - Few very small trees grow here
    - Small shrubs, flowering plants, mosses, and lichens stick close to the surface for heat to survive the very short growing season
- Boreal and Taiga Forest

    - One of the largest forest regions in the world
    - Growing season gets longer the farther south while precipitation levels are generally higher. This results in more lush forests and a wider range of species farther south than the boreal forest.
    - Winters are long and cold while summers are warm and short.
    - Poor soil conditions with thin, acidic soils, and poor fertility from large amounts of leaching
    - Only the hardiest of coniferous trees like black spruce and balsam fir can survive in the northern parts
    - Hardy deciduous trees like white birch and poplar are common in the southern parts.
- West Coast Forest
    - Enormous trees, more than 50 meters tall, resulting from mild temperatures and abundant precipitation
    - Distinct appearance and importance for forestry separate it from the Cordilleran (wide range of vegetation types in the mountainous area) region
    - Temperate rainforest because of very high precipitation levels
    - Large coniferous species such as Douglas fir, Sitka spruce, and red cedar
- Wide range of vegetation types in the mountainous area
- Grassland
    - Too dry for significant tree growth
    - Trembling aspen, willow, and spruce grow in wetter areas of grasslands region and in river valleys in drier areas
    - Natural grasses grow taller in the wetter areas of the region than in the drier areas. These two areas are called the *tall-grass prairie* and the *short-grass prairie* respectively
    - A transition zone called parkland exists between the tall grasses and boreal forest.
    - Mix of trees and grasslands
- Mixed Forest
    - Wide transition zone between boreal and deciduous forests
    - Mainly boreal in northern areas
    - Mainly deciduous in southern areas
    - Cool winters and warm summers
    - Transitional soils; not as fertile as deciduous soils, but richer than boreal soils
    - Much of the southern part of mixed forest has been cleared out for agriculture of towns and cities
- Deciduous Forest
    - Northernmost tip of deciduous belt in United States
    - Hot summers and mild winters
    - Maple, beech, oak, tulip trees, butternut
    - Almost entire forest has been cleared for farming and urban growth
    - Soils are fertile and not as acidic as soils that develop under coniferous trees

Ecozones

- An area of Earth's surface that has a specific combination of plants, wildlife, climate, landforms, and human activities
- Overlaying soil, landform, and vegetation maps on each other produces 15 ecozones in Canada
- Arctic Cordillera
- Northern Arctic
- Southern Arctic
- Taiga Cordillera
- Boreal Cordillera
- Pacific Maritime
- Montane Cordillera
- Taiga Plains
- Boreal Plains
- Prairies
- Taiga Shield
- Boreal Shield
- Hudson Plains
- Atlantic Maritime
- Mixedwood Plains

Kapuskasing

- Forestry
- Pulp and Paper
- Majority of jobs are in the tertiary sector

Yield Management

Sustained Yield Management

- Managing harvest of a resource so that harvest doesn't cause long-term depletion og the resource

Mining The Resource

- Exploiting a resource in an unsustainable way

Types of Farming

Intensive Farming

- Large amounts of labour are performed on small areas of land near urban areas, supplying the urban centres with products such as milk

Extensive Farming

- Small amount of labour done on a large amount of land with a greater emphasis on products that will be exported

Fishing Practices

- Commercial fishing
    - Fishing is a source of food and a source of income
    - Fish stocks are too often mined(Orange roughy, chilean sea bass)
    - Fishing populations fluctuate so it's difficult to employ sustainable yield management
    - Many reasons for overfishing

Forestry Practices

- Clearcutting
    - Cutting down are removing every tree from an area
- Shelterwood logging
    - The progression of tree-cutting in such a way that the forest is naturally able to produce a new generation of seedlings without human interaction
    - Best form and regenerates faster
- Selective Cutting
    - The practice of harvesting trees that are mature or undesirable to encourage the growth of healthy trees of different ages.
    - Cutting down older trees to plant new trees because new trees produce more oxygen than older trees.

Mining

- Process or industry of obtaining coal and other metallic minerals from a mine
    - Methods of reducing environmental impact include measures such as:
        - Reducing water consumption
        - Reducing waste output
        - Reducing water, air, and soil pollution

Mineral Deposits of Canada

- Copper, Gold, Uranium, Diamond, Lead, Zinc, Iron, Nickel, Silver in the Canadian Shield
- Sandstone, Dolomite, Limestone, Shale, Coal, Gypsum, Salt in Canada's Lowland regions
- Iron, Zinc, and Coal in Canada's Highland Deposits

Population density: the average number of people living in a particular area, and is calculated by dividing the population of a place by the area of the place.

- Canada does not have as many people for such a large country. Canada's relatively small population is dramatically shown by what is called an *isodemographic map*.

Census Metropolitan Area (CMA): an urban area in Canada with a population over 100,000. A CMA is centered around a city and generally extends beyond the borders of the city.

Continuous Ecumene: the part of the country where there is continuous, permanent settlement.

Discontinuous Ecumene: the part of the country where there are significant patches of settlement.

Rural Settlement Patterns

3 important factors affect the pattern of rural settlement in a particular area:

1. The ***nature of the resources*** that attract people to the area in the first place. For example, the settlement pattern in a rich agricultural region will be quite different from the pattern in an area based on commercial fishing.

2. The ***transportation methods*** that were in use when the area was settled. If people traveled by water (or in winter by sled on frozen rivers and lakes), the pattern will be different from that in areas settled later when travel was by the railway or on roads.

3. The ***role of the government*** in determining the pattern. In some areas of Canada, settlement occurred with little, if any, influence by government. People pretty much settled where they wanted, keeping in mind the two factors mentioned above. In some areas, such as Southern Ontario and the southern Prairies, the government imposed a survey system before the settlement occurred. The survey system included a pattern of roads and lots that still exist.

- Populations in rural areas can be described as being dispersed, concentrated, or linear.

Survey System: a grid system used to locate and identify parcels of land and roads.

Dispersed Population: a population spread evenly across the land; common in agricultural areas.

Concentrated Population: a population focused in patches with specific resource industries, such as mines or paper mills.

Linear Population: a population settled along a line, such as a coastline, river, or highway.

Exploring Connections: Landforms, Geology, and Human Activities

- Excellent farmland (called Class 1) is very rare, taking up only 0.5% of Canada's land.
- Good farmland (called Class 2 and 3) makes up 4.5% of Canada's land.

Landform Processing

- Coastal British Columbia is a very beautiful part of Canada. It has Canada's mildest climate and it's mild winters area great for recreational activities (snowboarding, golf, or sailing).
- Not everything about Vancouver is quite rosy, however. One of the effects of Vancouver's popularity for Canadian's and foreign migrants is that an average house costs almost $1 million.
- In addition, Vancouver and other areas of Coastal British Columbia face a potentially devastating natural hazard. Risk of a tsunami and a catastrophic earthquake is very high.

Tsunami: a set of large ocean waves caused by an earthquake or other powerful disturbances under the sea. A tsunami can cause great destruction when it reaches land.

Forces that Shape Earth

- Earthquake risks along with the landforms that we see in all parts of Canada, are the result of the interplay of a number of powerful natural processes. Some of these processes build up the land, while others wear it down.
- When the building-up processes are stronger, the land gets higher.
- When the wearing-down processes are stronger, the land gets lower.

Time Spans

Eons: half a billion years (500,000,000)
Eras: several hundred million years
Periods: many tens of millions of years
Ages: millions of years

ka - thousands of years
Ma - millions of years
Ga - billions of years

Different Eons

- **Hadean Eon:** 4.5 billion until 4 billion years ago (Earth was very hot and new).

- **Archean and Proterozoic Eons:** 4 billion until 500 million years ago (Earth was quiet and tranquil, and peaceful. Small changes happened slowly).

- **Phanerozoic Eon:** 500 million years ago to now (life appears on Earth amidst rapid changes).

Eras of the Phanerozoic Eon

- **Paleozoic Era:** Old life, 544 million years ago (first fishes, first reptiles, large coal swamps)
- **Mesozoic Era:** Middle life, 245 million years ago (first birds, first flowering plants, dinosaurs)
- **Cenozoic Era:** New life, 65 million years ago (dinosaurs are extinct, the age of mammals)

Each era is split into periods such as the Cretaceous, Ordovician, and Cambrian. Each period has their own distinct characteristics that differ them each other.

Precambrian Era: 4.6 billion years ago (Earth formed)

- Evidence of the Precambrian exists in only 9 places in the world, such as the Canadian Shield. Most of the world was formed and shaped in more recent times.

Pangea: was a supercontinent that existed during the late Paleozoic and early Mesozoic eras (about 250 million years ago). The continents were all connected and then they were drifted apart to their locations today due to continental drift.

Plate Tectonics

Plate Tectonics: the theory that Earth's outer shell is made up of individual plates that move, causing earthquakes, volcanoes, mountains, and the formation and destruction of areas of the crust.

- The theory of plate tectonics explains why we have high mountain ranges, majestic plains, and the deepest parts of the ocean.
- The crust of the Earth is actually floating on molten rocks inside Earth.
- The crust is not a single piece. It is made up of dozens of pieces called *plates*
- There are 7 major plates, 8 secondary plates, and more than 60 minor plates
- The movement of the plates has shaped Canada in many ways. For example, the mountain chains on the east and west coasts grew as a result of plates colliding.
- The movement has also played a role in the formation of fossil fuels in Canada.
- Oil, gas and coal formed when Canada's land mass was located in a warmer, tropical climate.

The 7 Major Plates

1. North American Plate
2. South American Plate
3. African Plate
4. Eurasian Plate
5. Australian Plate
6. Antarctic Plate
7. Pacific Plate

<u>Rock Cycle</u>

- ***Igneous rocks*** forms when magma or lava cools. Most cooling happens out of sight, either at the bottom of the ocean or inside Earth's crust. You can tell where an igneous cooled by the structure of it's crystals.

    - **Intrusive Rocks:** forms when magma cools slowly deep below Earth's surface, giving time for large crystals to form. An example of intrusive rock is granite.

    - **Extrusive Rocks:** forms when molten rock, called *lava*, cools on the surface of Earth. These rocks have tiny crystals that are barely visible to the naked eye. An extreme example of extrusive rock is called obsidian. It is blown explosively out of a volcano and cools almost instantly. Crystals do not have time to form, so the rock looks like black glass.

- **Sedimentary rocks** are mostly created after millions of years of *compaction* and *cementation* of loose sediments.
- Compaction occurs as loose sediments become tightly packed from drying or the weight of more layers of sediments on top. Eventually, the sediments become cemented together by minerals deposited between them.
- The type of sedimentary rock that forms depends on the type of sediment.
- For example, shale is made up of fine silt and clay particles, and sandstone is made up of sand.
- Not all sedimentary rocks come from eroded sediments. Limestone, is formed from the shells of tiny marine animals.
- The most important location for the formation of sedimentary rocks is in the ocean next to continents. Three things can typically happen to this sedimentary rock on the bottom of the ocean.

    1. The rock layers just sit on the bottom of the ocean. In many places in the world, sedimentary rocks on the seabed contain deposits of crude oil and natural gas. These deposits are critical sources of the world's energy supply. Examples include Canada's Atlantic Coast, the Gulf of Mexico, the North Sea, and the Persian Gulf

    2. Sedimentary rocks become the "bumper" when two continental plates collide. Canada's Rocky Mountains and Mount Everest are composed of rocks that formed in the sea and were folded and forced up by convergence. It is common to see fossils of sea creatures thousands of metres above sea level.

3. Tectonic forces lft layers of sedimentary rock out of the sea while keeping them more or less horizontal. The result is the creation of plains, on which most of the world's people live.

- Some sedimentary rocks contain deposits of fossil fuels (oil, natural gas, and coal) and are the geologic base of most agricultural regions. Aside from these two benefits, the economic importance of sedimentary rocks is often underestimated. It is hard to imagine what our society would be like without concrete, who's ingredients (lime, sand, crushed stone, and gravel) come from sedimentary deposits.

- **Metamorphic Rocks** are "changed" versions of igneous, sedimentary, and other metamorphic rocks.
- The changes occur when the rocks are exposed to great amounts of heat and pressure, such as when molten rock intrudes into existing rock layers.
- Metamorphic versions of sedimentary rock are much harder than the original. Shale changes into slate, for example, and limestone becomes marble.
- Metamorphism in igneous rocks is important in the creation of mineral deposits, Sometimes, the concentration of iron ore, gold, nickel, and other minerals are rich enough to make mining worthwhile.

Weathering, erosion, and deposition are related processes that break down all types of rock into small particles and then move the particles to a new location.

Weathering: the breaking down of rocks by water, wind, chemicals, and living things.

Erosion: the moving of broken-up pieces of rock.

Deposition: the building up of eroded materials in a new location.

<u>Glaciation</u>

Glaciation: the process of ice advancing and covering large areas of land.

Although glaciation is a much less powerful than plate tectonics, it is still fundamentally important to the creation of the Canadian landforms that we see today. Glaciers advanced across Canada 4 separate times in the last 2.5 million years.

- Geographers in North America call the 4th glacial advance the Wisconsin Glaciation because the ice advanced as far south as that American state.
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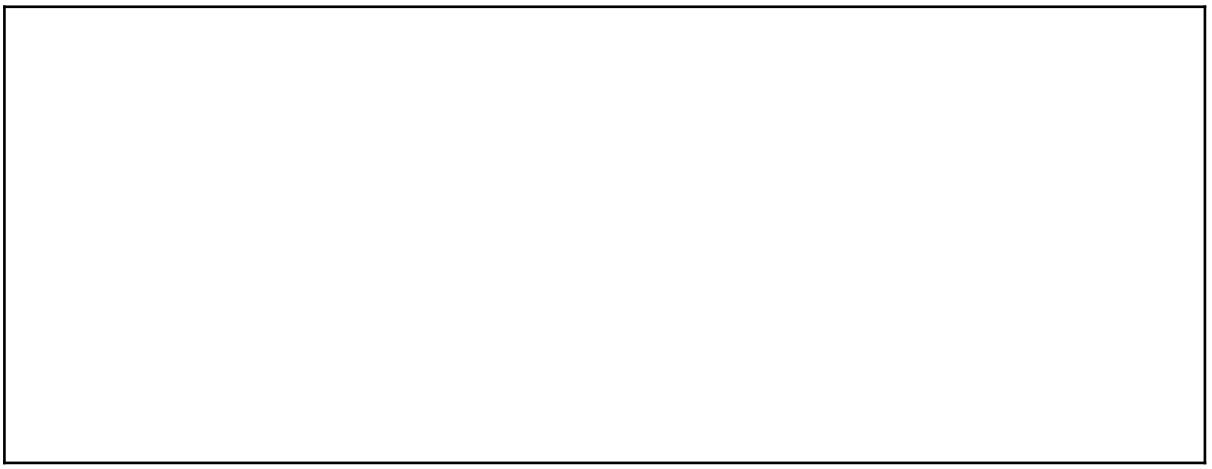


Erosional Effects

1. **Removal of Materials:** glaciers acted as giant-moving machines, scraping away the soil and rocks that covered much of Canada. The result is that much of the country has little or no soil today. Most of the eroded soil is far north.

2. **Changes to Drainage Patterns:** glaciers also completely changed the drainage patterns of rivers, streams, and lakes. In particular, lakes and rivers that had existed in low areas of loose earth materials were destroyed. New lakes formed in rock basins that filled with water as the glaciers melted.

Dispositional Effects

Dispositional effects also falls into two categories: eroded materials deposited directly by ice and those deposited by massive amounts of meltwater.

Deposition By Ice: materials deposited directly by ice **are not sorted by size**. These unsorted materials, a mixture of loose sediments and rocks of all sizes, are called *till*.

3. **Till Plains:** a common feature formed by deposition is a till plain. They are generally rather featureless, with small hills and valleys. They are formed from rock and sediment released from glaciers as they melt.

4. **Moraines:** a very common feature formed directly by ice is a moraine. Moraines are deposits of till that form at the edges (nose and/or sides) of a glacier. The Oak Ridges Moraine, which extends from the Orangeville area to north of Trenton, is an example of the rolling hills and small lakes typical of a moraine.

Deposition By Water: if you start with an immense amount of ice and it warms, either in the summer or as a glacier is melting, you get an immense amount of water.

5. Meltwater moves glacial debris as any river would, but on a much more massive scale. Fast-moving water can move heavy particles like gravel and rocks. As the water slows, it deposits these particles based on weight. First the rocks drop out, then the gravel, and then the sand. The result is that we see materials that have been sorted by size.

6. Meltwater rivers flow into meltwater lakes. In these lakes, where there is very little movement of the water, the lightest materials - silt and clay particles- are deposited. Glacial lakes were much larger than today's lakes, so glacial lake deposits are a common feature in many parts of Ontario and the southern Prairies. These areas tend to be very flat, have deep rich soils, and are often prime farmland.

Landforms caused by glaciers

- **Fjord:** a long, deep, narrow body of water that reaches far inland that are usually found in U-shaped valleys.
- **Kame:** a hill composed of sand and gravel laid down by glacial meltwater.
- **Kettle Lake:** a lake created when a piece of a glacier comes off and creates a hole in the ground. Then the ice melts and creates a lake.
- **Esker:** a long, narrow ridge composed of sediment which is usually deposited by glacial meltwater.

Landform Regions of Canada

Canadian Shield

- Igneous and metamorphic rock.
- Formed in the Precambrian Era.
- Gold, lead, nickel, copper, zinc, diamonds.
- Mining, logging, pulp and paper, tourism.
- Little farming due to the thin and poor soil and exposed bedrock, and poor drainage.
- Glaciers scraped soil away and formed many small lakes.

Interior Plains

- Sedimentary rock.
- Paleozoic Era.
- Erosion of different rocks created deep wide river valleys, rolling hills, slopes from west to east.
- Lakes, flattened land, rounded landscapes, fertile soil.
- Cattle, natural gas, oil, grain growing, coal

St. Lawrence/Great Lakes Lowlands

- Sedimentary rock.
- Paleozoic Era.
- Frontenac Axis bisects Canadian Shield near Kingston, Ontario.
- Rolling hills, very flat due to glaciation, deep river valleys.
- Good land for farming, flat, good soil because of deposits from glaciers.

- National Capital - Ottawa
- Newfoundland and Labrador - St. John's
- Nova Scotia - Halifax
- P.E.I. - Charlottetown
- New Brunswick
- Ontario - Toronto
- Quebec - Quebec
- Manitoba - Winnipeg
- Saskatchewan - Regina
- Alberta - Edmonton
- British Columbia - Victoria

- Nunavut - Iqaluit
- Northwest Territories - Yellowknife
- Yukon - Whitehorse

- North America, South America, Europe, Africa, Asia, Australia, Antarctica
- Pacific Ocean, Atlantic Ocean, Indian Ocean, Southern Ocean, Arctic Ocean

Polar front: a transition area where cold polar air mass meets warm tropical air masses. Thousands of miles long. The temperatures of the two air masses are very different. The Arctic air mass is much colder than the tropical air masses that have moved up from tropical regions. The boundary between the two air masses is stationary.

Humus: dark, organic material that forms in soil when plant and animal matter decays.

GPS (Geographic Positioning System): a satellite-based system that provides location data.

GIS (Geographic Information System): computer system that manages and analyzes geographic information. It can show be used to examine water quality in a particular area. GIS and GPS are combined in navigation systems and are combined in most smartphones. The GPS part provides location movement data while GIS is a database of information. All of these data have gone through a process called georeferencing, which is linking geographic data to a particular area.

Remote Sensing: seeing or measuring something from a considerable distance, often from a satellite.

Telematics: any technology that involves the long distance transmission of digital information.

Population density: the average number of people living in a particular area, and is calculated by dividing the population of a place by the area of the place.

- Canada does not have as many people for such a large country. Canada's relatively small population is dramatically shown by what is called an *isodemographic map*.

Rural Settlement Patterns

3 important factors affect the pattern of rural settlement in a particular area:

1. The ***nature of the resources*** that attract people to the area in the first place. For example, the settlement pattern in a rich agricultural region will be quite different from the pattern in an area based on commercial fishing.

2. The ***transportation methods*** that were in use when the area was settled. If people traveled by water (or in winter by sled on frozen rivers and lakes), the pattern will be different from that in areas settled later when travel was by the railway or on roads.

3. The ***role of the government*** in determining the pattern. In some areas of Canada, settlement occurred with little, if any, influence by government. People pretty much settled where they wanted, keeping in mind the two factors mentioned above. In some areas, such as Southern Ontario and the southern Prairies, the government imposed a survey system before the settlement occurred. The survey system included a pattern of roads and lots that still exist.

Survey System: a grid system used to locate and identify parcels of land and roads.

Dispersed Population: a population spread evenly across the land; common in agricultural areas.

Concentrated Population: a population focused in patches with specific resource industries, such as mines or paper mills.

Linear Population: a population settled along a line, such as a coastline, river, or highway.

Exploring Connections: Landforms, Geology, and Human Activities

- Excellent farmland (called Class 1) is very rare, taking up only 0.5% of Canada's land.
- Good farmland (called Class 2 and 3) makes up 4.5% of Canada's land.

Landform Processing

- Coastal British Columbia is a very beautiful part of Canada. It has Canada's mildest climate and it's mild winters area great for recreational activities (snowboarding, golf, or sailing).
- Not everything about Vancouver is quite rosy, however. One of the effects of Vancouver's popularity for Canadian's and foreign migrants is that an average house costs almost $1 million.
- In addition, Vancouver and other areas of Coastal British Columbia face a potentially devastating natural hazard. Risk of a tsunami and a catastrophic earthquake is very high.

Tsunami: a set of large ocean waves caused by an earthquake or other powerful disturbances under the sea. A tsunami can cause great destruction when it reaches land.

E**arthquake**: the shaking and vibration of the Earth's crust due to movement of the Earth's plates (plate tectonics). Earthquakes can happen along any type of plate boundary. Earthquakes occur when tension is released from inside the crust.

Volcano: an opening in Earth's crust that allows molten rock from beneath the crust to reach the surface. This molten rock is called magma when it is beneath the surface and lava when it erupts or flows from a volcano. Volcanoes form at the edge of tectonic plates.

Forces that Shape Earth

- Earthquake risks along with the landforms that we see in all parts of Canada, are the result of the interplay of a number of powerful natural processes. Some of these processes build up the land, while others wear it down.
- When the building-up processes are stronger, the land gets higher.
- When the wearing-down processes are stronger, the land gets lower.

<u>Time Spans</u>

Eons: half a billion years (500,000,000)
Eras: several hundred million years
Periods: many tens of millions of years
Ages: millions of years

ka - thousands of years
Ma - millions of years
Ga - billions of years

- **Hadean Eon:** 4.5 billion until 4 billion years ago (Earth was very hot and new).

- **Archean and Proterozoic Eons:** 4 billion until 500 million years ago (Earth was quiet and tranquil, and peaceful. Small changes happened slowly).

- **Phanerozoic Eon:** 500 million years ago to now (abundance of life appears on Earth amidst rapid changes).

Eras of the Phanerozoic Eon

- **Paleozoic Era:** Old life, 544 million years ago (first fishes, first reptiles, large coal swamps)
- **Mesozoic Era:** Middle life, 245 million years ago (first birds, first flowering plants, dinosaurs)
- **Cenozoic Era:** New life, 65 million years ago (dinosaurs are extinct, the age of mammals)

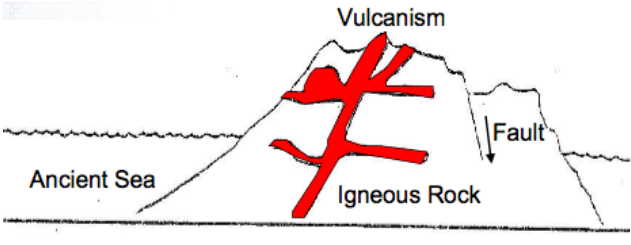
Each era is split into periods such as the Cretaceous, Ordovician, and Cambrian. Each period has their own distinct characteristics that differ them each other.

Precambrian Era: 4.6 billion years ago (Earth formed)

- Evidence of the Precambrian exists in only 9 places in the world, such as the Canadian Shield. Most of the world was formed and shaped in more recent times.

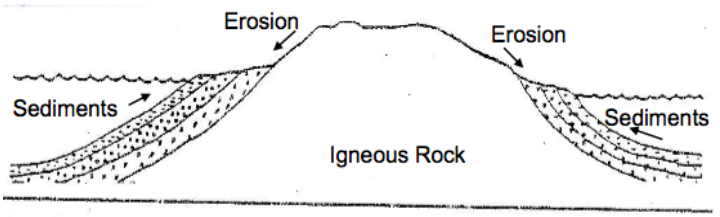
<u>Canada's Mountain History</u>

Precambrian Era - 4.6 billion years ago



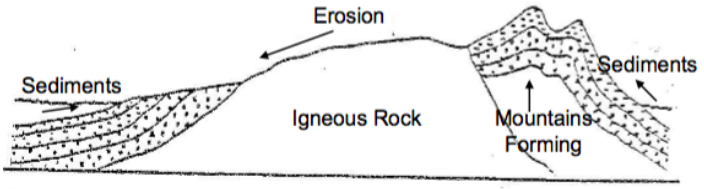
- Vulcanism
- Fault Lines
- Igneous Rock (surrounding the magma in the volcano)
- Ancient Sea (surrounding the volcano)

Paleozoic Era - 544 million years ago



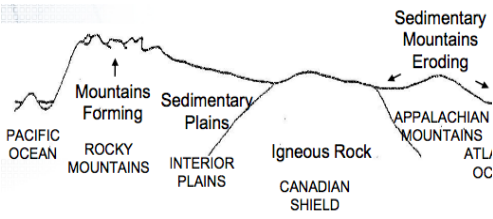
- Igneous Rock (not a volcano anymore)
- Erosion of volcanoes (due to the sea)
- Igneous rock sinking into the sea
- Sediments rising from the sea

Mesozoic Era - 245 million years ago



- Erosion of volcanoes
- Igneous rock
- Sediment rising from the sea to form mountains
- Mountains begin forming

Cenozoic Era - 65 million years ago



- Mountains forming next to the Pacific Ocean (Western Cordillera)
- Sedimentary plains next to mountains (Interior Plains)
- Interior plains are created when sediments from the Shield and the Rocky Mountains were deposited in shallow inland seas and compressed into layers of sedimentary rock.
- The eroded igneous rock becomes the Canadian Shield.
- Sedimentary mountains eroding next to igneous rock (Appalachian Mountains)
- Atlantic Ocean next to eroding mountains

Pangea: a supercontinent that existed during the late Paleozoic and early Mesozoic eras (about 250 million years ago). The continents were all connected and then they were drifted apart to their locations today due to continental drift.

<u>Proof of the Continental Drift Theory and Pangea</u>

The Apparent Fit of the Continents: The coastlines of the continents seem to fit together like one big puzzle. It has been noted that the coastlines of South America and the western coastline of South Africa seem to match up.

Fossil Correlation: There are various examples of fossils found on separate continents and in no other regions. Let's take a look at the mesosaurus. The mesosaurus is an ancient species that only lived in shallow freshwater. There are only 2 places where we can find remains of this fresh water creature - the eastern coast of South America, and the western coast of Africa. It is impossible that they swam or flew across from continent to continent. This indicates that these continents had to be once joined together because the extensive oceans between these land masses act as a type of

barrier for fossil transfer. There are 3 more notable fossil examples which include the Cynognathus, Lystrosaurus, and Glossopteris.

Rock and Mountain Correlation: Mountain ranges from different continents lineup and have same age and type of rock as each other. The mountain ranges in the north eastern United States and Northern Europe match up, meaning they are composed of the same type of rock and the same age of rock. These mountains must have been connected and were ripped apart as the continents drifted away. Glaciers from long ago leave Glacial striations on the rock below them as they slowly move over them. Similar glacial striations are found on the bedrock of the African and South American tropical rainforests. Glaciers only form in cold areas suggesting that these rainforest used to be in cold areas, but drifted near the warm equator later on.

Paleoclimate Data: Bituminous coal is created from dead tropical vegetation after millions of years of pressure. This coal is found in parts of Antarctica and Northern Russia, which don't have tropical climates. This shows that a long time ago, those areas were once tropical areas located near the equator. After millions of years, the continents must have drifted apart to where they are right now, but still had the fossilized tropical vegetation that later on turned into Bituminous coal.

Plate Tectonics

Plate Tectonics: the theory that Earth's outer shell is made up of individual plates that move, causing earthquakes, volcanoes, mountains, and the formation and destruction of areas of the crust.

- The theory of plate tectonics explains why we have high mountain ranges, majestic plains, and the deepest parts of the ocean.
- The crust of the Earth is actually floating on molten rocks inside Earth.
- The crust is not a single piece. It is made up of dozens of pieces called *plates*
- There are 7 major plates, 8 secondary plates, and more than 60 minor plates
- The movement of the plates has shaped Canada in many ways. For example, the mountain chains on the east and west coasts grew as a result of plates colliding.
- The movement has also played a role in the formation of fossil fuels in Canada.
- Oil, gas and coal formed when Canada's land mass was located in a warmer, tropical climate.

The 7 Major Plates

1. North American Plate
2. South American Plate
3. African Plate
4. Eurasian Plate
5. Australian Plate
6. Antarctic Plate
7. Pacific Plate

Types of Plate Movement

- **Divergent:** this occurs when 2 plates move apart. This most commonly happens along a mid-ocean ridge, although it does happen on land too. When this happens, both plates get larger. New areas of Earth's crust are constantly being created in that way along 70,000 kilometres of mid-ocean ridges. Most of the world's volcanoes occur along divergent plate boundaries.

Mid-ocean Ridge: a feature created by the spreading of the sea floor where 2 plates are diverging. The best-known example runs through the Atlantic Ocean from north to south.

- **Convergent:** this occurs when 2 plates move toward each other. There are 2 types of convergence, depending on the kinds of plates that are colliding.

    - **Continental plate meets oceanic plate**: the rocks that make up deep-ocean plates are denser than those that make up continental plates. As a result, a heavier oceanic plate slides underneath a continental plate. This is known as ***subduction.*** Note that the existing crust is "recycled" by subduction. The crust being melted here balances the new crust forming at a divergent plate boundary.

Subduction: the process in which one plate slides underneath another. The **subducted plate** moves into Earth's interior and is "recycled" (it melts).

Subduction can occur fairly smoothly when the oceanic plate moves slowly and continuously under the continental plate. As it does, there are many small earthquakes that cause no damage, and might not even be felt by people. However, in some places, the plates do not move and they push against one another, locking up and causing tension to build up for centuries. Eventually this tension is released in only a few seconds. This result can be a catastrophic 8.0 - 9.0+ quake.

- **Continental plate meets continental plate:** when two continental plates run into each other, massive layers of rock are folded, broke, and forced upward by the immense pressures of the collision. This process created many of the world's most important mountain ranges. The Himalayas began forming when the Indian secondary plate collided with the Eurasian plate. This process started about 55 million years ago and continues today, rising higher and higher.

- **Transform:** along a transform plate boundary (also called a conservative boundary), plates are made either larger nor smaller. In these locations, plates move in roughly parallel, but opposite, directions. As with subduction, the process often happens fairly smoothly, but again, the plates could lock up and release enormous amounts of energy, resulting in a damaging earthquake. Earthquakes at transform plate boundaries tend to be less severe than ones near subduction zones. The intensity level of quakes at transform boundaries range from 5.5 to 7.5.

Divergent	**Convergent: Continental meets Oceanic**	**Convergent: Continental meets Continental**	**Transform**

Rock Cycle

- ***Igneous rocks*** forms when magma or lava cools. Most cooling happens out of sight, either at the bottom of the ocean or inside Earth's crust. You can tell where an igneous cooled by the structure of it's crystals.

    - **Intrusive Rocks:** forms when magma cools slowly deep below Earth's surface, giving time for large crystals to form. An example of intrusive rock is granite.

    - **Extrusive Rocks:** forms when molten rock, called *lava*, cools on the surface of Earth. These rocks have tiny crystals that are barely visible to the naked eye. An extreme example of extrusive rock is called obsidian. It is blown explosively out of a volcano and cools almost instantly. Crystals do not have time to form, so the rock looks like black glass.

- **Sedimentary rocks** are mostly created after millions of years of *compaction* and *cementation* of loose sediments.
- Compaction occurs as loose sediments become tightly packed from drying or the weight of more layers of sediments on top. Eventually, the sediments become cemented together by minerals deposited between them.
- The type of sedimentary rock that forms depends on the type of sediment.
- For example, shale is made up of fine silt and clay particles, and sandstone is made up of sand.
- Not all sedimentary rocks come from eroded sediments. Limestone, is formed from the shells of tiny marine animals.
- The most important location for the formation of sedimentary rocks is in the ocean next to continents. Three things can typically happen to this sedimentary rock on the bottom of the ocean.

    1. The rock layers just sit on the bottom of the ocean. In many places in the world, sedimentary rocks on the seabed contain deposits of crude oil and natural gas. These deposits are critical sources of the world's energy supply. Examples include Canada's Atlantic Coast, the Gulf of Mexico, the North Sea, and the Persian Gulf

    2. Sedimentary rocks become the "bumper" when two continental plates collide. Canada's Rocky Mountains and Mount Everest are composed of rocks that formed in the sea and were folded and forced up by convergence. It is common to see fossils of sea creatures thousands of metres above sea level.

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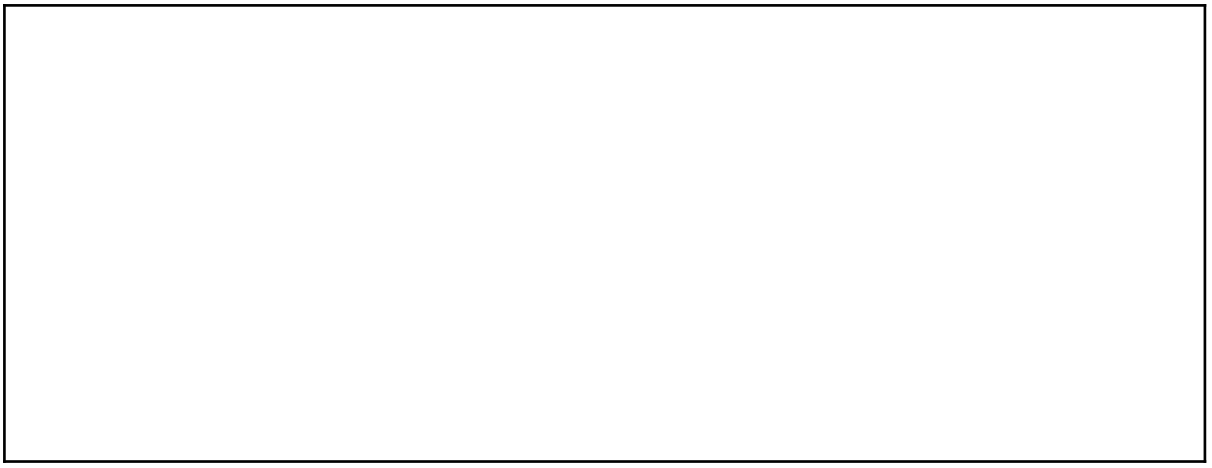

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Landforms

Fjord: a long, deep, narrow body of water that reaches far inland that are usually found in U-shaped valleys.

Kame: a hill or hummock composed of sand and gravel laid down by glacial meltwater.

Kettle Hole/Lake: a lake created when a piece of a glacier comes off and creates a hole in the ground. Then the ice melts and creates a lake. Don't have any tributaries. Will eventually evaporate

Esker: a long, narrow ridge (often curvy/sinuous) composed of stratified sediment and making the former location of a glacial tunnel.

Misfit Stream: a river that is either too large or too small to have eroded the valley in which it flows.

Crevasse: large crack in glacier formed by tearing of glaciers that gets larger and larger when meltwater falls down the crack.

Crevice: narrow opening in the earth/rock.

Escarpment: an area of the Earth where elevation changes suddenly. Caused by faulting and erosion.

Moraine: produced from an accumulation of sediment deposited by a glaciers

Oak Ridges Moraine

- Rain and snow that fall onto the Oak Ridges Moraine soak into the ground to replenish large reservoirs of groundwater that supply drinking water for over 200 000 people.
- This is because moraine sands and gravels allow water to infiltrate more rapidly and in much greater amounts per unit area than the surrounding, less permeable till plains.
- In addition, depressions called kettles capture water rather than allowing it to run off over the surface. Hence, there are few flowing streams on the moraine.
- Instead, water seeps into the depths of the moraine until it reaches a less permeable layer. It then begins to move sideways to emerge as springs or wetlands along the lower slopes. These springs are the headwaters of over 60% of the watersheds in the GTA.
- Stretches 160km from the Niagara Escarpment to the Trent River.
- About 65% of it is within the GTA.

Niagara Escarpment

- A prominent rock ridge that spans nearly 1600 km across Great Lakes region and the United States
- Forms the ancient "backbone" of North America.
- Over millions of years, sediments compressed into rock.

Landform Regions of Canada

Canadian Shield

- Igneous and metamorphic rock.
- It is of Precambrian age.
- Covers more than half of Canada.
- Important source of metallic minerals and diamonds; gold, lead, nickel, copper, zinc, diamonds.
- Mining, logging, pulp and paper, tourism.
- Little farming due to the thin and poor soil, exposed bedrock, and poor drainage.
- Abundant supply of freshwater.
- Glaciers scraped soil away and formed many small lakes.
- More than 1 billion years ago, it had many huge mountains, but most of them have eroded away.
- Tundra in the north, boreal forest in the south.
- The geological foundation of Canada and is, by far, its oldest and largest landform region.
- Many rivers flow into Hudson Bay. Rivers in the south part of the Shield are used for hydroelectricity.

Canada's Lowland Regions

Interior Plains

- Sedimentary rock from the Paleozoic Era.
- Created from the sediments of the Shield and the Rocky Mountains that were deposited in shallow inland seas and compressed into layers to form sedimentary rock.
- Erosion of different rocks created deep wide river valleys, rolling hills, slopes from west to east.
- Deep, flat, fertile soil.
- Lakes, flattened land, rounded landscapes, fertile soil.
- Cattle, natural gas, oil, grain growing, forming, coal.
- Known as the "Bread Basket"
- This region is the world leader in the production of potash, a major ingredient in fertilizer.

St. Lawrence/Great Lakes Lowlands

- Sedimentary rock from the Paleozoic Era.
- A narrow band on the Canadian Shield, called the Frontenac Axis, separates the GL and SL into two parts.
- Rolling small hills, very flat due to glacial deposits, deep river valleys.
- Smallest landform region.
- Good land for farming, flat, good soil because of deposits from glaciers.
- St. Lawrence=A rift valley (a linear-shaped lowland between several highlands or mountain ranges created by the action of a geologic rift or fault).
- Almost 60% of Canada's population lives here.

Hudson Bay-Arctic Lowlands

- Hudson Bay Lowlands consists of a layer of sedimentary rock that rests on top of the Shield.
- Very flat, low lying area dotted with ponds, lakes, and streams.
- Swampy forests.
- Harsh climate.

- Arctic Lowlands consists of Paleozoic sedimentary rock.
- Series of islands, low-lying barren of islands with coastlines ranging from extensive lowlands to spectacular cliffs.
- Ground is mostly composed of permafrost.

Canada's Highland Regions

Appalachian Mountains

- Over 300 million years old, was created by folding and faulting during the Paleozoic Era.
- Oldest highway region, created when the North American the Eurasian plates collided about 300 million years ago.
- Erosion has rounded the mountains overtime, creating rolling hills, rolling peaks, and rolling mountains.
- Non-metallic minerals such as coal and salt, are found in the plateaus of sedimentary rock.
- Metallic minerals such as iron and zinc can be found in igneous and metamorphic rock as well..
- A "Drowned coastline" is where a coastline has been pressed down (or sank) or eroded by a mass of ice.
- Characterized by a wealth of large, beautiful deciduous hardwood trees**.**
-

Western Cordillera

3 Divisions of Western Cordillera

1. Rocky Mountains and Columbia Mountains (East) – 2 major mountain ranges that are separated by a large deep valley.

- Formed 65 million years ago - beginning of cenozoic era.
- Rocky Mountains created by folding and faulting
- Rocky Mountain Trench=created by erosion, is 10 km wide
- Columbia Mountains made of sedimentary rock and metamorphic intrusions with minerals.

2. Interior Plateaus (Centre) – Made of metamorphic and igneous rock due to volcanic activity.

- It has metallic minerals such as copper, gold and zinc.
- Major rivers have created deep valleys.
- Glacial and river deposits have made the land good for farming.

3. Coast Mountains (West) – Divided in 2 ,Coastal Mts Range (Mainland), Island Mt Range (Offshore), by deep trough (Pacific ocean).

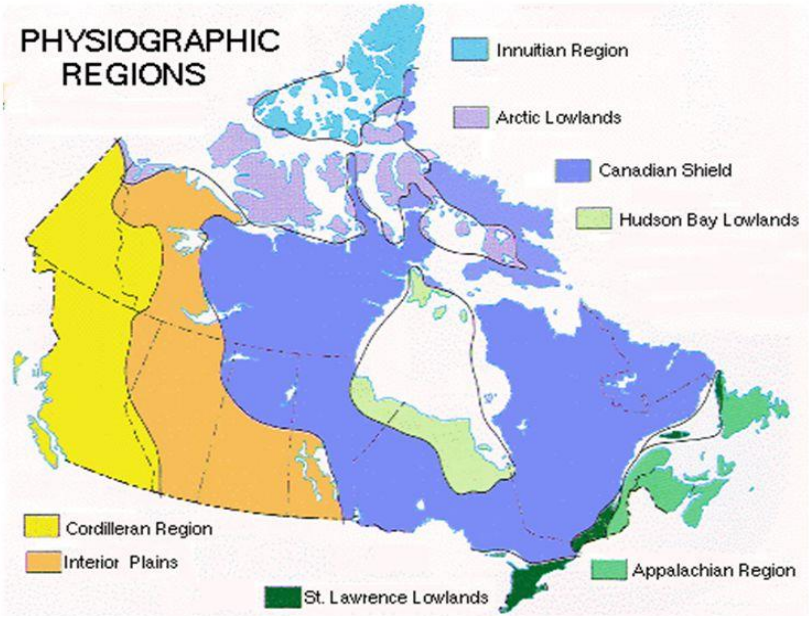
- Created by plate action and pressure.

- Made of Igneous and metamorphic rock.
- Today, plates continue to move=many earthquakes.
- The area is characterized by fjords.

- Economy in Western Cordillera is based on Tourism, Mining, and Farming.
- Rich in minerals and timber.
- Sharp-peaked mountains.
- Tall, rugged mountains due to the interactions between the North American and Pacific Plates.
- All of sedimentary, igneous, and metamorphic rock.
- Herbs, lichens and shrubs at higher elevations and various types of coniferous forest and grasslands at lower elevations.

Innuitian Region

- This mountain region was formed in the mid Mesozoic era.
- Made mostly of sedimentary rock.
- Cold winters and short summers.
- There are large areas covered by snow and permafrost.
- Largely unexplored due to hostile climate. Canada's most remote region.
- This region is younger than the Appalachians, so erosion has not yet rounded them significantly.
- No full-time population.



Permafrost: Permafrost is a permanently frozen layer below the Earth's surface. It consists of soil, gravel, and sand, usually bound together by ice. Innuitian Region and possibly Arctic Lowlands.

Natural Vegetation: the plants that would grow in an area with no human interference.

Weather: day to day condition of temperatures and precipitation (and wind speed, air pressure, barometric pressures, and several other factors). Examples: Temperatures, humidity, precipitation, wind speed, cloud cover.

Climate: the long term patterns of temperature and and precipitation. Examples: continental climate, maritime climate, arid climate

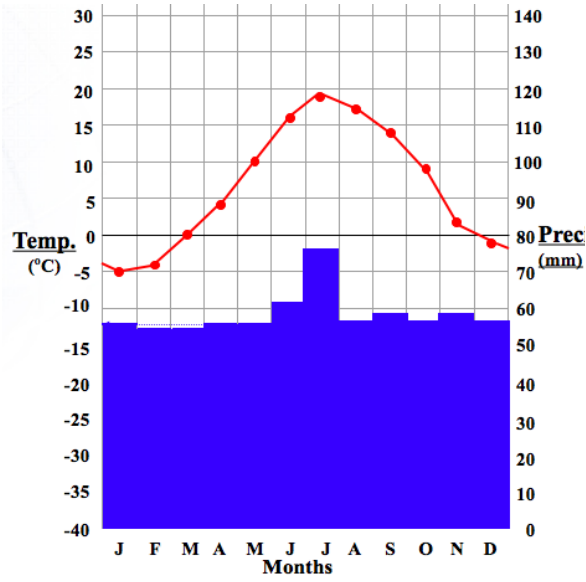
Maritime Climate: climate in areas near an ocean. Higher precipitation, lots of rain, air masses travel across the ocean and pick up moisture, air will rise and won't be able to hold onto the moisture any longer, will drop the mass of moisture along the coastlines. Has a small temperature range, UNDER 25℃ in annual temperature range and OVER 1000 mL in precipitation.

Continental Climate: climate in areas far from the ocean. More extreme temperatures, less precipitation because no moisture. The annual temperature range is MORE THAN 25℃ and the annual temperature range and the precipitation is LESS THAN 1000℃ mL.

Annual Temperature Range: temperature of the warmest month minus the temperature of the coldest month.

Climograph

- We can illustrate climate and compare climates from different locations easily using a climograph.
- X-axis = months
- Y-axis = temperature (line graph), start with 0℃ in the middle of the axis
- Precipitation with bar graph, precipitation value is on the opposite side of x-axis, start with 0℃ on the bottom
- Equal intervals
- Include a title.



Factors That Affect Climate

LOWER Near water

- **L**atitude
- **O**cean currents
- **W**ind, air masses, and jet streams
- **E**levation
- **R**elief
- **Near Water**

Latitude: distance north or south of the equator.

- The Sun's energy is concentrated on a small area near the equator.
- The farther you are from the equator, the less direct sunlight you recieve.
- The Earth's curvature causes the sun's energy to be less concentrated and to spread out near the poles.

Ocean Currents

- An ocean current moving away from the equator is relatively warmer than the surrounding water.
- An ocean current flowing toward the equator is cooler.
- For example, the Gulf Stream brings warm water from the tropics to the coast of Atlantic Canada.

- Winds moving across an ocean current are warmed or cooled, again depending on the relative temperature of the water.
- Warm currents warm air masses while cooler currents will cool down air masses.
- Winds bring that temperature to land areas they cross.
- Salt water holds heat better than fresh water.
- Warm water pushes cold water.
- Ocean currents affect precipitation.

Wind and Air Masses

- An air mass is a large volume of air that takes on the climatic conditions of the area in which it forms.
- For example, an air mass that forms over an ocean contains moist air, while one forming far from the ocean has very dry air.
- Air masses move depending on the particular weather patterns that exist at any given time.
- This means that the area where you live may experience one air mass for several days, followed by several days with an air mass that has completely different characteristics.
- Think of a hot humid day followed by a cool, sunny day. The hot air mass from the Gulf of Mexico must have pushed north while a cold and dry air mass must have moved south from Northern Canada.
- Air/wind moves over Earth's surface from areas of higher air pressure to areas of lower air pressure.
- The most important wind belt for most of Canada is the westerlies (the winds from west to east).

Air Mass: A large volume of air with the same temperature and moisture throughout. It takes on the climatic conditions of the area in which it forms.

Front: The boundary between two air masses of different temperature and moisture content.

Cold Front: the leading edge of a cold air mass.

Warm Front: the leading edge of a warm air mass.

Prevailing Winds: winds that blow in a constant direction at these altitudes.

Jet streams: currents of air high above the Earth. They move from west to east at altitudes of about 8 to 15 kilometers and at speeds around 400 km/h. They form where large temperature differences exist in the atmosphere.

Coriolis Effect: a natural phenomenon that causes fluids, like water and air, to curve as they travel across or above the Earth's surface. The result of Earth's rotation (faster near the equator) on weather patterns and ocean currents. The Coriolis effect makes storms swirl clockwise in the Southern hemisphere and counterclockwise in the Northern Hemisphere. This is why we have westerlies.

Elevation: refers to how high or low we are on the earth's surface.

- As elevation increases, it gets colder and colder.
- At a higher elevation, air is forced to rise because of the structure of mountains.
- The pressure decreases because there is less air sitting on top of the air.
- The air becomes less dense.

- As a result, the air expands and cools, and heat is lost.
- Without condensation, air cools by 1℃ for every 100 metres of elevation change.
- Cooler air cannot hold as much moisture, so condensation eventually starts to happen.
- Condensation gives off heat so that the rate of cooling drops to 0.6℃ for every 100 metres.

Relief: the shape of the surface of the land.

- Important factor in determining the amount of precipitation that the area gets.
- Places on the *windward side* of a height of land (the side facing the wind) get substantially more rain and snow than places on the *leeward side/rain shadow* (the opposite side, away from the winds direction).

Near Water

- Places that are close to an ocean have what is called a *maritime climate*.
- Winter temperatures are relatively mild, while summers never get too hot.
- The bodies of water act as regulators of temperature.
- As a result, the annual temperature range is quite small.
- For example, Vancouver has a maritime climate and has an annual temperature range of only 14.4℃.
- The proximity to a major body of water means that precipitation is quite high.
- Vancouver receives 1189 mL of precipitation, which is fairly typical for its climate.

- Places far from the ocean have a *continental climate*.
- Land heats and cools much more quickly than water, so extreme temperatures are the norm.
- Regina has a continental climate. It has an annual temperature range of 31.1℃, which is more than twice that of Vancouver. No nearby source of moisture is available, so precipitation is low - only 390 mL.

- Areas near the great lakes are a special case.
- They are far enough away from the ocean that they should be continental, but because they are so large, the Great Lakes provide a partial maritime influence.
- They moderate the temperatures somewhat and provide a source of moisture, as long as they are not frozen.
- This type of climate is called *modified continental*.

Types of Precipitation

1. Relief Precipitation
    - Hot air mass from water moves to land
    - The hot air is blocked by the mountain so it loses density and moves upwards
    - When moving upwards, it cools and condenses to create precipitation
    - Precipitation leads to the formation of vegetation on that side of the mountain
    - The other side of the mountain doesn't get any precipitation so it has cold and dry air
    - Affected by relief, near water, air masses/wind, and latitude
2. Convectional Precipitation
    - On a flat surface of land
    - When hot air mass rises due to low density

    - And precipitation falls when it cools and condenses
    - Affected by relief and latitude

3. Cyclonic Precipitation

    - Cyclonic/Frontal Precipitation
    - When a hot air mass and cold air mass and moving towards each other above water
    - The hot air mass moves upwards since it has less density
    - The hot air mass cools and condenses and becomes a cold air mass
    - Cycle repeats
    - Affected by air mass, near water, ocean current, latitude

Soil: a naturally occurring, unconsolidated or loose material on the surface of the earth, capable of supporting life

Soils is made up of 4 components

1. Minerals
2. Organic Material
3. Moisture
4. Air

Soil Profile: the 3 different layers that exist in the soil beneath the surface of the ground. Each layer has a particular combination of physical, biological, and chemical characteristics.

1. A Horizon (topsoil)
2. B Horizon (subsoil)
3. C Horizon (parent material)

- Soil that has a thick, dark *A horizon or topsoil* layer
- Such rich soils exist in areas where the right combination of geology, climate, and vegetation are found.

Geology

- There must a thick layer of loose parent material available from which a fertile soil can develop.
- In much of Canada, the parent material is unsorted or sorted glacial deposits.
- In the rest of the country, where glacial erosion was the more powerful force, the parent material is often bare rock.
- The soil formation process has barely begun in these areas (100,00 years but 11,000 years has gone by)

Climate

- Two climatic processes are important.
- The growing season has to be long enough for rich plant growth in the summer.
- This plant growth adds nutrient-rich organic material to the soil.
- You also need the right amount of precipitation.
- Too much rainfall, water moves downward throughout the soil.
- This process is called leaching, removes nutrients that are important for plant growth.

- These nutrients are mineral compounds of nitrogen, phosphorus, potassium, and other chemical elements that dissolve in water.
- If leaching occurs, the soil loses fertility.
- You can identify these severely leaching soils easily because they lack the dark brown, fertile topsoil.
- Instead, they tend to be greyish.
- We call these type of soils wet climate soils.

Wet-climate Soils: soils that develop where leaching is dominant soil-forming process.

Dry-climate Soils: soils that develop where calcification is the dominant soil-forming process.

- In areas that are drier, moisture tends to move upward from the parent material and subsoil, bringing valuable plant nutrients with it.
- The rich, dark topsoil layer, where plants grow stands out.
- If climate is too dry, the soil will be infertile, there is little plant growth, so the amount of organic material in the soil is low.
- The soils of southern Saskatchewan provide good examples of dry-climate soils.
- The soils in the southeastern part of the province, slightly higher precipitation, has produced exceptionally rich soils that are the basis of the region's productive grain and oilseed farms.
- Father west, where rainfall amounts are lower, the soil does not contain a rich layer of organic material.

Calcification: process in dry climates where water carrying dissolvable minerals moves upward through the
soil. At the surface, water evaporates, leaving the minerals behind.

Soil Patterns

- A wide range of soil exists in the Western Cordillera because of that region's varied relief and climate patterns.
- The harsh climate of the tundra soils region makes the formation of proper soil horizons difficult.

Tundra

- Tundra soils tend to be very rich in old plant material that cannot decompose because it is too cold.
- Permafrost exists in these areas.
- The top mertre of the tundra soil that thaws in the summer is called the active layer.
- The frozen lower layer prevents water from draining away.
- The result is that the land becomes waterlogged, with many swampy areas.

Natural Vegetation Processes and Patterns

- Natural vegetation in any given location is mainly a product of the particular combination of temperature and precipitation.
- There are 6 natural vegetation regions in Canada, not including the Cordillera region.
- There is a transition zone between each vegetation region, an area where the vegetation changes gradually
- The Cordilleran vegetation zone is not uniform.

- A windward slope can have lush forest while a nearby valley can be dry grassland area.
- Can change from lush to barren, treeless slope.
- Wetter climates=boreal forests (both coniferous and deciduous).
- Drier climates (deserts or grasslands).
- Warmer climates= deciduous forests and mixed forests
- Cooler climates=Tundra or Taiga forests or Boreal Forets

Vegetation Region	**Location**	**Description**
Tundra	Pretty much all of Nunavut Northern tips of Quebec and Newfoundland. The northern part of Canada.	- Due to Arctic climate, small, few trees - Small shrubs, mosses, and lichens grow close to the surface, - Near the surface to absorb maximum heat in the short growing season
West Coast Forest	On the west coast -- where else	- Basically Canada's rainforest - Enormous trees, >50m - Mild temperatures, abundant precipitation - Large coniferous trees - Temperate rainforest -- lots of rain, but not so hot temperatures (mild)
Boreal and Taiga	- Basically most of Canada - Northwest territories - Northern parts of all other provinces apart from maritime ones including B.C	- One of the largest forest regions in world - The more south, the more lush and longer growing season - Tin,acidic soils with poor fertility -- leaching - Only hardy trees can survive - North = Coniferous Trees - South = Deciduous Trees - Long, cold winters - Warm, short summers
Mixed Forest	- Transition zone between deciduous and boreal - Southern Quebec, Ontario - All of New Brunswick, Nova Scotia and PEI	- More south, the better the soil and more deciduous trees - More north, the worse the soil and more coniferous trees - It's transitional, so it's conditions aren't as bad as the boreal forest but not as good as the Deciduous Forest - Much has been cleared for agriculture or growing towns and cities
Deciduous Forest	- Canada's deciduous forest is in southwestern Ontario and is the northernmost tip of the very large deciduous belt in the U.S.	- Fertile soils - Wide variety of species - Hot summer, mild winters - Most of the land has been cleared for farming and urban usage
Grasslands	- Prairies	- Too dry for significant tree growth -- rain shadow from cordillera - Certain trees can grow in the wetter areas of grasslands

		- Various different grass species - There are taller grasses in wetter areas (tall-grass prairie) and shorter grasses in drier areas (short-grass prairie) - The transition zone between grassland and boreal forest is called parkland. - It has a mix of grasses and trees
Mountainous area	Basically the western cordillera without west coast forest	- Similar to the climate of the cordillera, there isn't uniform vegetation - All sorts of different types of dry and wet climate soils.

	Coniferous (also called evergreen, needle-leaved, softwood)	Deciduous (also called broadleaf, hardwood)
Canadian Examples	White spruce, black spruce, balsam fir, red pine, white pine	Sugar maple, beech, hickory, poplar, red oak
Special Features	• Able to survive in areas with poor quality soils. • Their sticky sap acts like antifreeze, stopping needles from freezing in cold winters. • Waxy needles and thick bark preserve moisture during dry conditions. • Needles and flexible branches shed snow, preventing damage to the tree.	• No leaves in the winter lessens the snow load on the branches. • Dormant in the winter, but sap flows strongly as spring warms. • Most deciduous trees need at least 5 months with average temperatures above 10 degrees C.

- Mixedwood Plains
- Atlantic Maritime
- Pacific Maritime
- Prairie
- Boreal Shield
- Taiga Shield
- Hudson Bay Plains
- Boreal Plains
- Taiga Plains

- Boreal Cordillera
- Taiga Cordillera
- Montane Cordillera
- Arctic Cordillera
- Northern Arctic
- Southern Arctic

The Canada Land Inventory is a comprehensive multidisciplinary land inventory of rural Canada, covering over 2.5 million square kilometers of land and water. Land capability for agriculture, forestry, wildlife, recreation, wildlife (ungulates and waterfowl) was mapped.

Types of Farming

1. **Arable:** Crops
2. **Pastoral:** Animals
3. **Mixed:** Crops and animals
4. **Subsistence:** Grown just for the farmer and his family
5. **Commercial:** Grown to sell
6. **Intensive:** High inputs of labour or capital usually small areas of land, located near large urban areas, dairy products
7. **Extensive:** Low inputs of labour or capital, large areas of farmland, wheat and cooking oil
8. **Sedentary:** Permanently in in one place
9. **Nomadic:** The farmers move around to find new areas to farm

Total Stock: all parts of the natural environment including energy, living organisms, and non-living materials. For example, sunlight, trees, and water are all part of the total stock.

Resource: anything that can be used to produce goods and services, such as raw materials, workers, money, and land.

Natural Resources: things found in the total stock that people find useful.

Renewable Resource: a resource that can be regenerated if used carefully.
- Soil, forests, fish stocks

Non-Renewable Resource: a resource that is limited and cannot be replaced once they are used up.
- Fossil fuels, minerals

Flow Resource: a resource that is replaced by natural actions and must be used when and where they occur or be lost.
- Sunlight, wind, water currents

Other Resource: a resource that does not fit into the other 3 categories
- Rocky Mountains, Niagara Falls (attract tourism business so it’s considered a resource.

Mining the Resource: exploiting a renewable resource in an unsustainable way.

Sustained Yield Management: the process of managing a renewable resource to ensure that the amount harvested does not cause long-term depletion of the resource. The harvest is equal to or less than the amount replenished each year.

Farming

- Soil is the renewable resource on which farming relies. While a relatively small part of Canada's land is used for commercial agriculture, it is a vitally important resource for supplying food to Canadians and for export.

Resources Needed: a suitable climate (temperature measured in number of growing degree-days; sufficient precipitation) and deep, fertile soils

Problems: Soil deterioration. Bad farming practices can result in soil being eroded into rivers or fertility being washed out of the soil. Urban growth reduces the amount of farmland available. Changes in temperature and rainfall patterns could have a major impact on where forming is possible.

Forestry

- Trees are obviously the the renewable resource used in forestry. Wide swath across Canada is covered with forests and is used for forestry. Forests are important in most countries for producing lumber, paper, and firewood.

Resources Needed: A climate and soils that are appropriate for the type of tree. Existing forests provide seeds for new generations of trees.

Problems: The size and borders of forest regions will change due to climate change. There could be an increased risk of forest fires and other types of forest damage.

Commercial Fishing

- Naturally occuring fish stocks are required.

Problems: Fish stock are too often mined. Pollution of the ocean can reduced the number of fish and make the fish dangerous to consume. Since oceans are warming, fish populations move. Example, the Pacific salmon is moving northward.

Fracking: the process of drilling down into the earth before a high-pressure water mixture is directed at the rock to release the gas inside.

Reserves: how much of a resource is thought to be in the ground, based on exploration date.

Production: how much of a resource is being taken from the ground each year.

    - Extraction
        - The process of extracting raw resources from the natural environment
    - Production
        - The process of making or growing something for sale or use
    - Distribution
        - The process of distributing the goods to the consumers
    - Consumption
        - The process of consumers using the resource
    - Disposal
        - The process of throwing away or getting rid of something
        - Great Pacific Garbage patch due to ocean currents

R/P Ratio: the number of years the reserve of a non-renewable resource will last at current rates of production.

Oil Sands/Tar Sands: deposits of sand containing heavy form of crude oil called bitumen.

Metallic Mineral: a mineral that yields a metal when melted. It mostly comes from igneous and metamorphic rock.

Raw Material: a substance used in the manufacture of a product.

Primary Industry: an industry that focuses on producing or extracting natural resources. This sector includes forest industries, agriculture, mining, and fishing.

Secondary Industry: an industry that focuses on making things using the products of primary industries. The sector includes manufacturing, construction, and the utilities.

Tertiary Industry: an industry that focuses on providing services. This sector includes "everything else" that is not included in the primary and secondary industries.

Quaternary Industry: The use of modern technology in research and development to train and provide information to other industries.

Location Factors of Manufacturing

1. Location of customers
2. Proximity to Raw Materials
3. Availability of Freshwater and Power
4. Labor Supply
5. Transportation
6. Political Factors
7. Circumstance

- **Magna International** is an auto parts company that started in Toronto and was found by Frank Stronach.

Multilateral Aid: assistance provided by governments to international organisations like the United Nations, World Bank, and International Monetary Fund (IMF). These organisations seek to reduce poverty in developing nations. In 2013-14, the Australian Government provided approximately $601.2 million in ODA to United Nations agencies, and $483 million to the World Bank Group.

Free Trade: international trade without tariffs or other barriers to trade.

Tariff: a tax applied to imported goods that is designed to protect domestic manufacturers by making foreign goods more expensive.

Basic Industry: an industry that brings money into the economy.

Non-Basic Industry: an industry that circulates money within an economy.

Multiplier Effect: the increase in total wealth or income that occurs when new money is injected into an economy. It's the measure of how often any new money gets spent and re-spent in a community before it leaks out. The amount of the multiplier effect varies but it's about 3:1 in general. This means a new dollar will be spent 3 times. It also means for one basic job, there will be 3 non-basic.

Branch Plant: a plant or factory in Canada belonging to a company whose headquarters are in another country.