12 Canada's Landform Connections

Key Ideas

This chapter helps you investigate these questions:

- How do landforms differ in various parts of Canada?
- What forces are responsible for these differences?
- How are the characteristics of the landform regions related to how people use the land?

Key Terms

landform
drainage
meltwater
topography
shield
highlands
lowlands
bedrock
impervious
differential erosion
escarpment
rift valley
lignite
plateaus

The Canadian Landscape

Artists show us the world through their eyes. In a country as vast as Canada, with such a great diversity of landscapes, it is not at all surprising that many Canadian artists have focused on the land in their work. Art historians feel that a distinctly Canadian tradition in art began shortly before World War I with the works of members of the Group of Seven and artists such as Tom Thomson and Emily Carr. Today, their work is highly prized and very valuable.

A.J. Casson and Arthur Lismer, two Canadian artists whose works appear in this chapter, were members of the Group of Seven.

Paintings go beyond what photographs are capable of showing because the artist **interprets** the landscape for the viewer. In this section, we look at four famous Canadian landscape paintings from the perspective of a geographer. In particular, we will consider the two factors most responsible for the appearance of all **landforms** in Canada:

(1) the underlying geology, and

(2) the impact of glaciation.

interprets
paints in a way that conveys personal ideas or feelings about the landscape

The underlying geology is vitally important because it determines a region's landform, e.g., mountains or plains. Glaciation is important because it happened so recently in geologic terms: virtually all of Canada was still covered by ice only 15 000 years ago. If geology provides the structure for a region, glaciation provides the details, for example, the amount of soil, the **drainage** pattern, and whether there are hills or flat land.

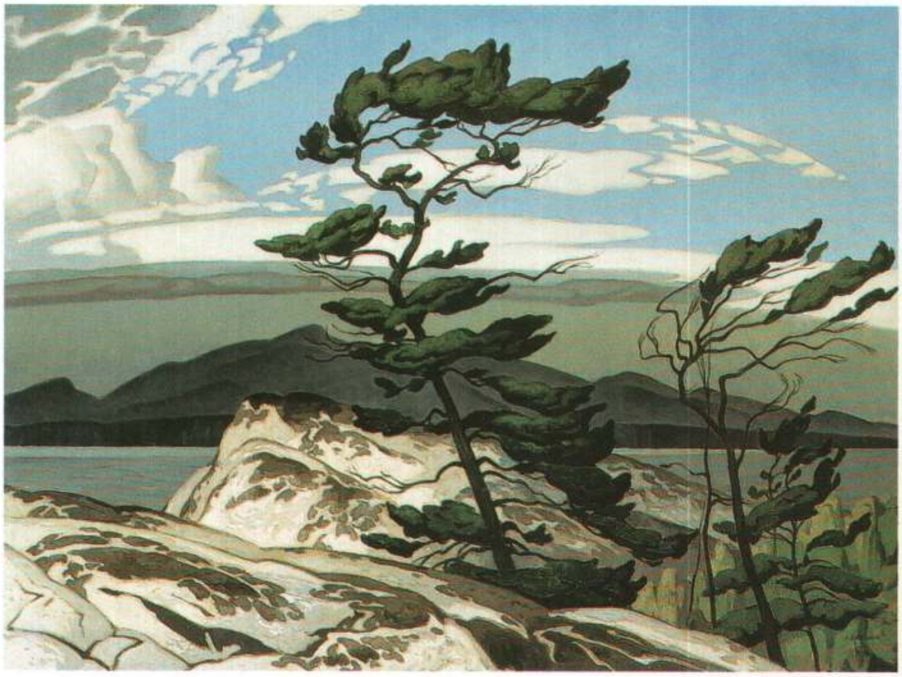


Fig. 12-1 ▶
White Pine was painted by A.J. Casson

perception
interpretation; impression

- ***Viewer's Perception of the Scene:*** This is one of the most famous of all Canadian paintings. It shows wind-bent pine trees on the rocky shore of a lake somewhere on the Canadian Shield. How we feel about the image likely depends on whether we have any experience with this part of Canada. If we have no personal knowledge of it, we may find it wild and beautiful, but a little intimidating too. If we have hiked or travelled by canoe in such an area, we may find ourselves very much attracted to the scene.
- ***Geology:*** The painting shows the eroded mix of igneous and metamorphic rock that is common on the Shield. The landscape is particularly rugged.
- ***Glaciation:*** The last period of glaciation in Canada began about 100 000 years ago and ended less than 15 000 years ago. Two effects of this glacial activity can be seen in this painting. The connection of one of these to glaciation is more obvious than the other. Bare rock exists because the glaciers stripped away the existing soils. This has made many parts of the Canadian Shield more attractive for tourists (and painters!) but useless for farming. The lake shown is typical of the vast number of lakes on the Canadian Shield. Many of these lakes were created because the glaciers destroyed most of the drainage system and created depressions within which water could gather. It will be many thousands of years before a fully mature drainage system is re-established.

No one knows exactly how many lakes are on the Canadian Shield, but the number is likely to be in the hundreds of thousands.

◄ **Fig. 12-2** William Goodridge Roberts painted *Hillside, Lake Alphonse.*

- ***Viewer's Perception of the Scene:*** The place shown is in Quebec, but it just as easily could be in southern Ontario, parts of the Maritimes, or the Prairies. Again, different viewers probably have different perceptions of this scene. Urban residents may look at it and dismiss it as a fairly uninteresting place. Farmers, on the other hand, would look at the knobby hills and rocky soil and feel sympathy for anyone trying to make a living off this land.
- ***Geology:*** Because of the surface materials covering the land, the underlying geology is not obvious. Since we know where this painting was done, however, we know the underlying rocks are likely to be horizontal layers of sedimentary rock formed millions of years ago under ancient seas.
- ***Glaciation:*** The landform features and rocks we can see in the soil are all the result of materials deposited by glaciers. Moving ice acts like a bulldozer—scraping, pushing, and mixing materials of all sizes. These materials likely came from places like that shown in Fig. 12-1. They are deposited at the edge of the ice, often in forms such as we see here.

GeoLit Reminder

When reading a painting:

- How is this painting different from a photograph?
- What does the artist want to draw to your attention?
- How does the painting make you feel?
- Describe the landform features illustrated in Fig. 12-2 and in the other paintings in this chapter.

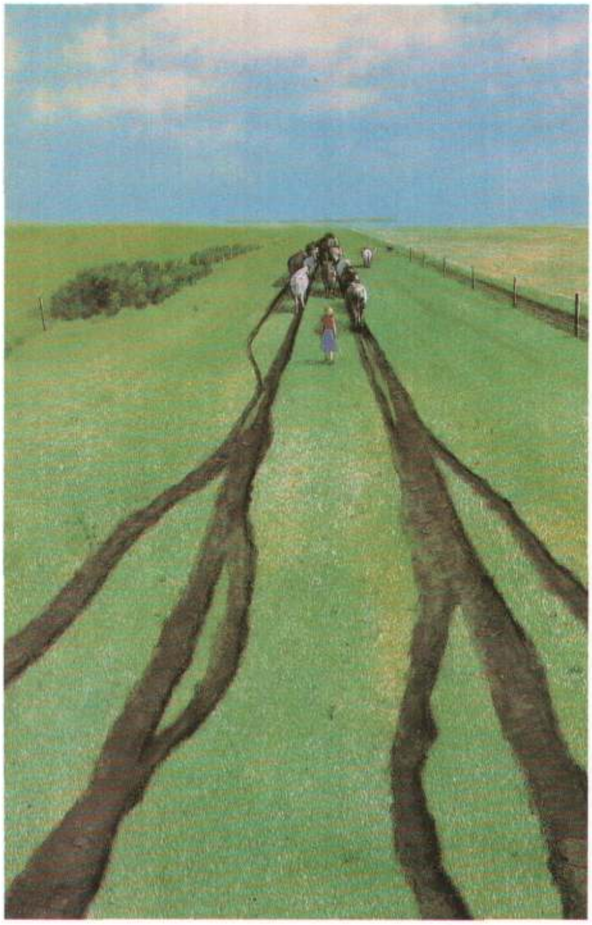
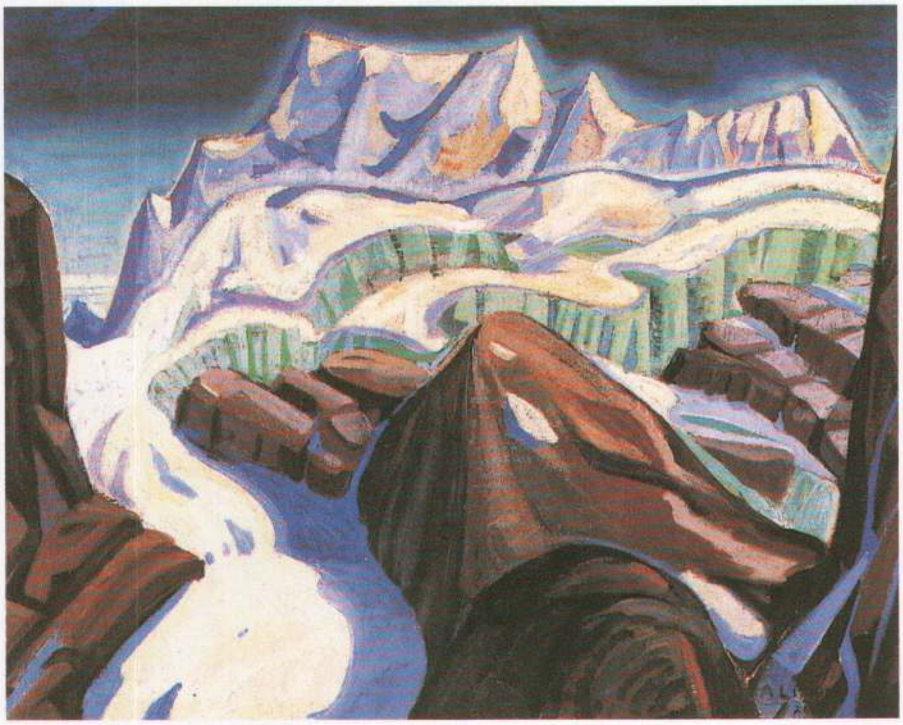


Fig. 12-3 ▶ William Kurelek painted *No Grass Grows on the Beaten Path.*

This technique illustrates the way in which an artist can focus the viewer's eye on a particular feature.

- ***Viewer's Perception of the Scene:*** This painting reflects what many people in eastern Canada think the Prairies look like—entirely flat and featureless. In fact, Kurelek has chosen to paint the horizon farther back than it really is to exaggerate the flatness.
- ***Geology:*** The sedimentary rocks under the land here are horizontal or close to horizontal.
- ***Glaciation:*** Most of the Prairies south of the Canadian Shield are *not* like this. Some parts of the Prairies are more rolling, like Fig. 12-2, because the land was covered by soil materials that were deposited directly by ice. Areas such as the one shown in the painting were created where a rich layer of sorted, finer soil materials were deposited under a glacial lake. These lakes formed near the fringes of melting continental ice sheets where there were vast amounts of **meltwater**. Such lake plains can also be found in southern Ontario, for example, near Windsor and Chatham and along parts of the Lake Ontario shore as well as in southern Manitoba and southern Saskatchewan.



◀ **Fig. 12-4** *The Glacier* was painted by Arthur Lismer.

- ***Viewer's Perception of the Scene:*** Here we actually see a glacier, although it is a mountain (or alpine) glacier rather than the vast continental ice sheet that covered almost all of Canada 20 000 years ago. Most people who look at a scene such as this would like to visit it. Many tourists travel to the mountains of western Canada to see such beautiful scenery. Unfortunately, few people are able to visit the massive glaciers of extreme northern Canada because of their remoteness and the high cost of getting there.
- ***Geology:*** Neither the painting itself nor its title tells us where these mountains are. There are glaciers in the Western Cordillera and in the Innuitian mountains of the northernmost part of Canada. You cannot tell from the painting whether these mountains were created by the folding of sedimentary rocks or from volcanic activity. What you do know is that they were created because of active tectonic activity, likely in the Cenozoic era, because they have not been significantly eroded.
- ***Glaciation:*** Glaciers are obviously an active force in the creation of this landscape. They are carving deep U-shaped valleys (under the ice) and eroding the mountains so that they become more rugged and scenic.

Do you like Lismer's work? You will have to stick to reproductions—some of his paintings have sold for more than a million dollars.

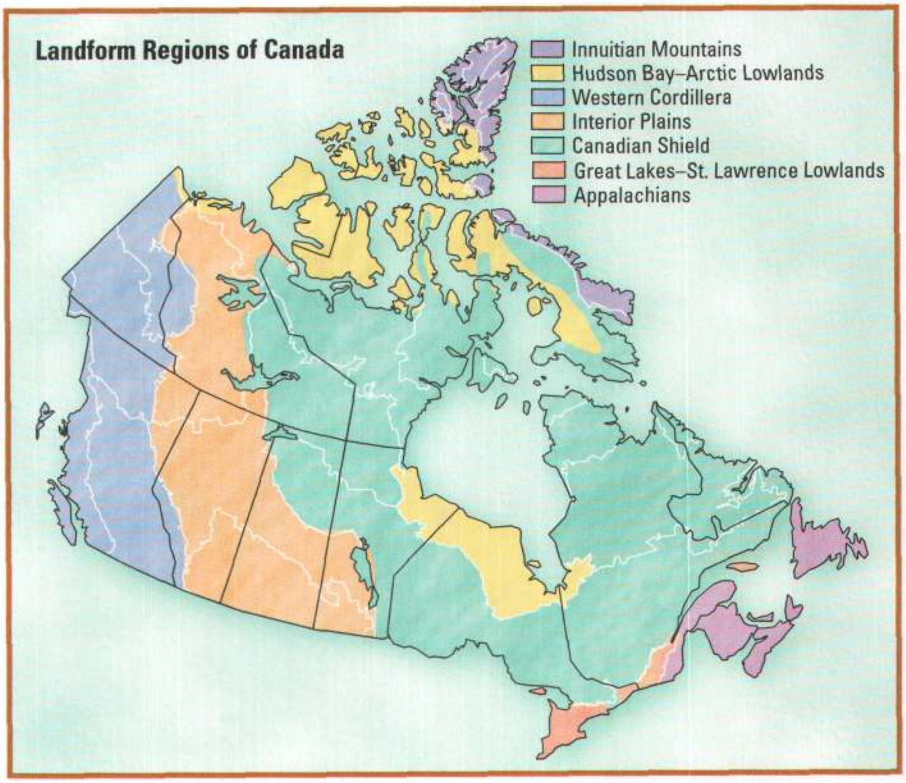


Fig. 12-5 ▶
The white lines indicate ecozone boundaries, which are discussed in Chapter 15.

INTERNET

To learn more about Canada's landforms, check the link at www.pearsoned.ca/makingconnections2.

Canada is a land of great physical diversity. Perhaps this is not surprising since it is the world's second-largest country, and has a very long coastline. We can study Canada's **topography** by focusing on landform regions.

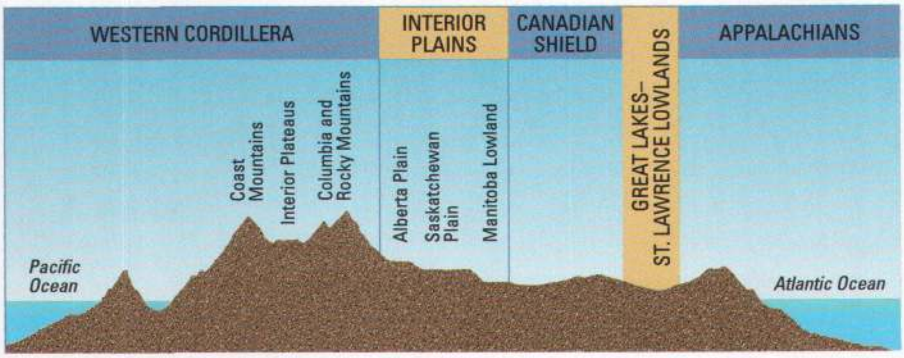
Fig. 12-5 shows Canada's landform regions on a map.

1. What is a landform region? Use your own words.
2. How many landform regions are there in Canada?
3. Which landform region is the largest? Which one is the smallest?
4. a) In which landform region do you live?
   b) Describe the landforms in the region in which you live.

Canada is made up of three distinct types of landforms—**shield**, **highlands**, and **lowlands**. The highlands and lowlands are further subdivided into the regions shown in Fig. 12-6.

The Canadian Shield

The Canadian Shield is the geologic foundation of Canada. The Shield underlies much of Canada and two small parts of the United States. More than half of Canada, about 4 800 000 square kilometres, is covered by the Shield (Fig. 12-5). Some of the world's oldest rocks (3.96 billion years old)



◀ **Fig. 12-6** Profile of southern Canada's landform regions

are located in the Shield near Great Slave Lake. Today, most of the Shield consists of rounded hills of rock that are actually the roots of ancient mountains. The Shield has been eroded for billions of years so it is relatively flat compared with the Appalachian Mountains or the Western Cordillera.

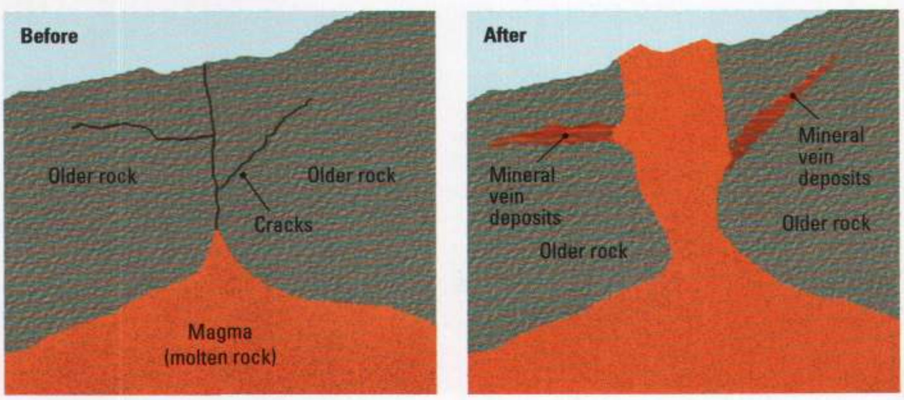
Two types of rock, igneous and metamorphic, form most of the Shield. They contain valuable minerals in great quantities. Because of its vast deposits of lead, gold, nickel, copper, zinc, and other important metals, the Canadian Shield is often called the storehouse of Canada's **metallic minerals**. In addition, rich diamond deposits have recently been found where ancient volcanoes once existed. The Precambrian rocks of the Canadian Shield do not contain fossil fuels (coal, oil, and natural gas). The life forms that produced these products did not exist at the time the Shield was created.

The Canadian Shield is sometimes called the Precambrian Shield because it was formed during the Precambrian era.

See Case Study on diamond mining in Chapter 26.

How were mineral deposits formed in the rock of the Shield? Minerals were present in molten rock, or magma, beneath Earth's crust. As the magma rose toward the surface, it **intruded** into cracks and cavities in the Shield rock. It took thousands or even millions of years for the magma to rise slowly toward the surface. Then, as it cooled, the minerals present in the magma became part of the newly formed igneous rock. Other deposits were formed when very hot water containing dissolved minerals was forced deep into the cracks in the surrounding Shield rock (Fig. 12-7). This process deposited minerals in high enough concentrations to make mining worthwhile.

intruded
forced molten rock into an existing rock formation



◀ **Fig. 12-7** Mineral deposits formed when magma and very hot water, both containing dissolved minerals, intruded into existing rock. Sometimes the minerals separated into layers within the rock according to their density, and at other times they formed throughout the rock mass.

A simple experiment will show you how liquids can separate into layers.

1. Put 20 mL of vinegar and 60 mL of vegetable oil into a jar with a lid.
2. Shake well and let stand. What happens? Why?
3. Add appropriate spices and salt, shake it again, and pour it on a salad!

smelted
minerals are extracted from ore by melting

In Sudbury, Ontario, large deposits of nickel and copper are mined.

As the minerals in the Shield rock slowly cooled, they separated into layers according to their densities. The lighter ones floated to the top and solidified above the heavier ones. Those that had similar densities floated to the same level. Because nickel and copper have similar densities, they are often found together.

The Shield attracts mining companies because of its abundance of metallic minerals. Many cities and towns on the Shield, including Sudbury in Ontario, Thompson in Manitoba, and Yellowknife in the Northwest Territories, rely on the mining industry for jobs. Some of these jobs are in smelters where the mineral ores are **smelted** to separate the minerals from waste materials. The concentrate minerals are shipped to factories in Canada and other parts of the world where they are used to manufacture products we use every day.

Not much farming takes place on the Shield because most areas have very thin soil. The exceptions are northeastern Ontario and adjacent areas in Quebec where glacial lakes have left thick deposits of clay. However, the Shield is ideal for recreation because of its scenic rivers, waterfalls, lakes, rock outcrops, and vast forests. People visit the Shield to canoe, fish, hunt, and "get back to nature." The tourism industry is very important to the towns and cities in the southern parts of the Shield.

The action of the glaciers affected the drainage of the Shield. The scraping and gouging action of the ice created depressions in the **bedrock**. These depressions filled with water to form the hundreds of thousands of lakes that now dot the Shield (Fig. 12-8). Because the bedrock is **impervious**, water does not pass through it. The glaciers

▼ **Fig. 12-8** The Canadian Shield. Notice the many lakes and the exposed bedrock.

deposited sand, gravel, and clay, which dammed rivers or forced them to flow in different directions. The result is a disorganized drainage pattern of winding rivers, lakes, and swamps. In time, a new, more organized and complete drainage system will develop. There has not been enough time since the retreat of the glaciers for this to happen.

The Shield's plentiful lakes and rivers have made it an excellent source of water-generated energy. The centre of the Shield is much lower than its outer portion. This gives it the appearance of a saucer, with Hudson Bay occupying the low-lying centre. As a result, most of the rivers of the Shield flow toward its centre and into Hudson Bay. This pattern of drainage determines the location of hydroelectric generating stations. These stations have been built where the rivers tumble from the Shield onto the Hudson Bay Lowlands. The energy they produce is transmitted by power lines to cities and towns both on and off the Shield.

Glaciers removed enormous amounts of soil, clay, rock, and gravel from the Shield. Today, most of the Shield is covered by only a thin layer of soil, and the bedrock is visible in many places.

These rivers and swamps are breeding grounds for billions of blackflies and mosquitoes.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. a) What types of rock make up the platform on which most of the rest of Canada is built?
   b) What is the topography of the Shield like?
   c) What geologic processes created this topography?
2. Why is the Canadian Shield also referred to as the Precambrian Shield?
3. a) Why is the Shield called Canada's storehouse of metallic minerals?
   b) Using your own words, describe how mineral deposits form.
   c) Why are nickel and copper often found together?
4. Describe the effects of glaciers on the following:
   a) the land's surface material, such as soil, rocks, and gravel
   b) the drainage of the Shield

THINKING

5. The natural beauty, the minerals, the rivers, and the forests are the economic backbone of the Shield. How have these resources aided in the economic development of this region?

COMMUNICATION

6. a) Review the paintings on pages 126–129. For each painting, write a paragraph in which you provide
   i. a brief description of the geology of the area
   ii. the effects of glaciation
   iii. your reaction to the painting

APPLICATION

7. a) On an outline map of Canada supplied by your teacher, draw the borders of the Canadian Shield.
   b) On your map, locate and label the major cities (population over 100 000) on the Shield. Consult your atlas for this information. Save this map for another activity later in this chapter.
   c) How many major cities are there?
   d) Discuss the following questions in a small group:
   i. Why are vast areas of the Shield sparsely populated?
   ii. Could this change in the future? Explain.

The Lowlands

Three lowland regions surround the Shield: The Interior Plains, the Great Lakes–St. Lawrence Lowlands, and the Hudson Bay–Arctic Lowlands (Fig. 12-5). The bedrock under these lowlands is formed mainly of sediments eroded from the Shield. The sediments were laid down in the seas that existed around the Sheild at various times millions of years ago. As the sediments collected, the weight of the upper layers compressed the lower layers into sedimentary rocks.

INTERIOR PLAINS

The Interior Plains of Canada are part of the Great Plains of North America that stretch from the Arctic Ocean to the Gulf of Mexico (Fig. 12-9). The Interior Plains of Canada extend from the 49th parallel north to the Arctic Ocean, a distance of 2700 kilometres. They are about 1300 kilometres wide in the south but only about 275 kilometres wide in the north.

During their formation, the Interior Plains were often covered by shallow inland seas. Sediments from the Shield and the Rocky Mountains were deposited in these seas over millions of years. Eventually the sediments were compressed by the weight of the layers above into sedimentary rock. The rock layers are several thousands of metres thick and took millions of years to form. Part of the sedimentary rock consisted of coral reefs that formed close to the surface of the seas during the Paleozoic era. Today, the reefs are thousands of metres below the surface of the land. They contain much of the oil and gas found today in Alberta and Saskatchewan.

Remember that Canada was closer to the equator at this time. Over millions of years, plate movements have shifted Canada to its current location.

Fig. 12-9 ▶ The Interior Plains

Other types of mineral deposits lie below some parts of the Interior Plains. At various times during the Mesozoic era, shallow seas covered the region that is now Saskatchewan. When they evaporated, thick layers of mineral deposits were left in the dried-out sea beds. These layers are now deep below Earth's surface, covered by newer rocks and glacial deposits. Potash is mined from these layers and used as fertilizer in Canada and many other countries. The swamps on the edges of these ancient seas produced plants that were eventually changed into coal that is mined today.

Potash is the name given to potassium chloride compounds. It is chemically similar to common table salt. Saskatchewan is the world's leading producer of potash.

Although many people think of the Interior Plains as flat, there are relatively few areas where this is true. The landscape is, for the most part, composed of rolling hills and deep, wide river valleys. Overall, the land slopes gently downward from west to east.

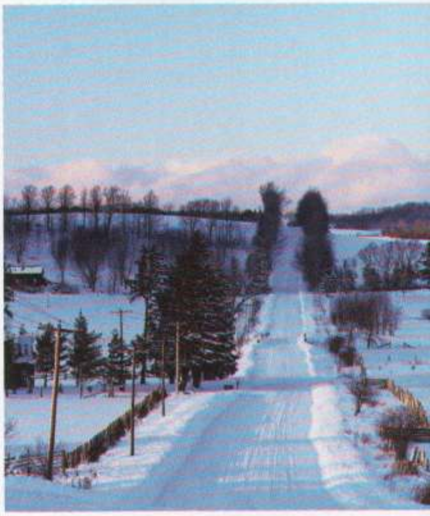
The landscape of the Interior Plains has been shaped by the forces of erosion. Consider the following: some sedimentary rocks are hard and **resistant**; others are quite soft. The softer rock erodes more quickly than the harder rock—a process called **differential erosion**. Different rates of erosion have caused three different levels of elevation on the Prairies—the Alberta Plain, Saskatchewan Plain, and Manitoba Lowland. Each level is separated by a sharp rise called an **escarpment**. Escarpments form when a harder rock layer that overlays a softer layer resists erosion.

resistant
able to withstand the forces of erosion

The Interior Plains, like the rest of Canada, were subjected to glaciation. Glaciation marked the landscape in visible ways and has affected land use. In many areas, the glaciers left deposits that produced a rounded, gently rolling landscape. When the glaciers melted, the meltwater formed a large lake over much of what is now southern Manitoba and Saskatchewan. The floor of this huge lake was covered by sediments that made it very flat. Later, the land rose, causing most of the water to drain into the ocean. Small portions of the ancient lake remain today as Lake Winnipeg, Lake Manitoba, Lake Winnipegosis, and Cedar Lake. The former lake bottom was left as flat land in what is now southern Manitoba and Saskatchewan. The soil that developed on the sediments of the lake bottom is deep and fertile. It is very good for growing grain such as wheat, barley, and oats and oil seeds such as canola, sunflower, and flax.

This ancient lake, called Lake Agassiz, was larger than all of the Great Lakes combined.

Because so much wheat is grown in the southern part of Canada's Interior Plains, the region is known as "Canada's breadbasket." Where the climate is too dry for crops, ranchers raise cattle. Agricultural and beef products from the region are shipped throughout Canada and to other countries.



▲ **Fig. 12-10** In the Great Lakes–St. Lawrence Lowlands, relatively undisturbed sedimentary rocks and a variety of glacial effects have produced a landscape that generally ranges from level to rolling.

GREAT LAKES–ST. LAWRENCE LOWLANDS

There is a famous story about two blind men learning about an elephant solely from touch. One man, holding a leg, states that an elephant is very much like a tree, while the other man, holding the tail, says an elephant is very much like a stout piece of rope. Each man has his own perception of what an elephant is like. Such is the case with the Great Lakes–St. Lawrence Lowlands. A person looking at a map of landform regions of

Canada will see this small but highly populated area as a separate region. On the other hand, a person looking at a North American landform region map will see that it is really only the most northeasterly part of the Great Plains of North America.

Geographers believe that there were water bodies in the Great Lakes region before glaciation. The glaciers deepened and widened the depressions containing these water bodies.

As you might suspect from the name, the region consists of two parts: the Great Lakes Lowlands to the west and the St. Lawrence Lowlands to the east. The parts are separated by a thin wedge of the Canadian Shield that juts across the St. Lawrence River near Kingston, Ontario, and extends into the United States. Like the rest of the Interior Plains, these lowlands have bedrock formed of sedimentary rock from the Paleozoic era. The Paleozoic bedrock can be seen in several escarpments in the Great Lakes Lowlands. The best known is the Niagara Escarpment, which extends from Niagara Falls to Manitoulin Island. The Niagara Escarpment was formed by differential erosion. The most prominent feature of this Escarpment is, of course, Niagara Falls.

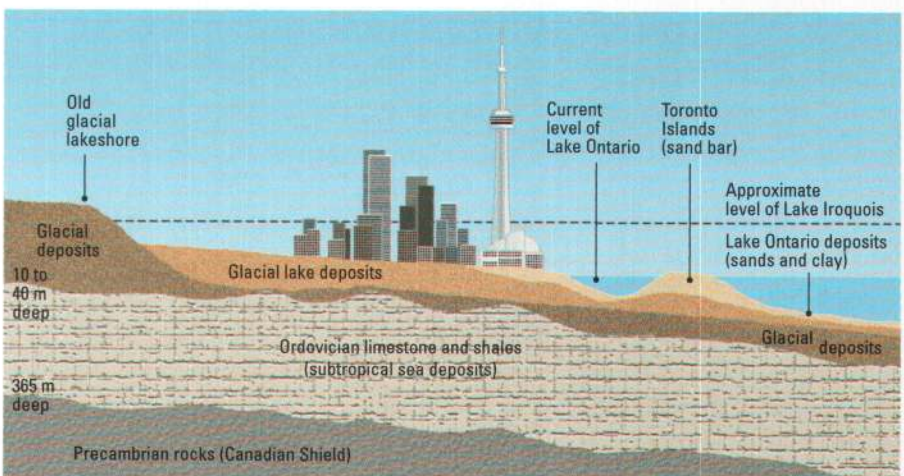
In the Great Lakes portion of the Lowlands, glaciation has created a rolling landscape (Fig. 12-10). The glaciers carried huge amounts of material (soil, sand, and gravel) from the Canadian Shield and dumped them throughout the region. The landscape is **characterized** by flat plains with glacial hills and deep river valleys. The Great Lakes are located in basins that were gouged out by glaciers. The lakes were even larger than they are today because of the enormous volume of water from the melting glaciers. They eventually shrank to their present size as much of the glacial meltwater drained into the ocean. The old shorelines of these glacial lakes surround the present-day Great Lakes (Fig. 12-11).

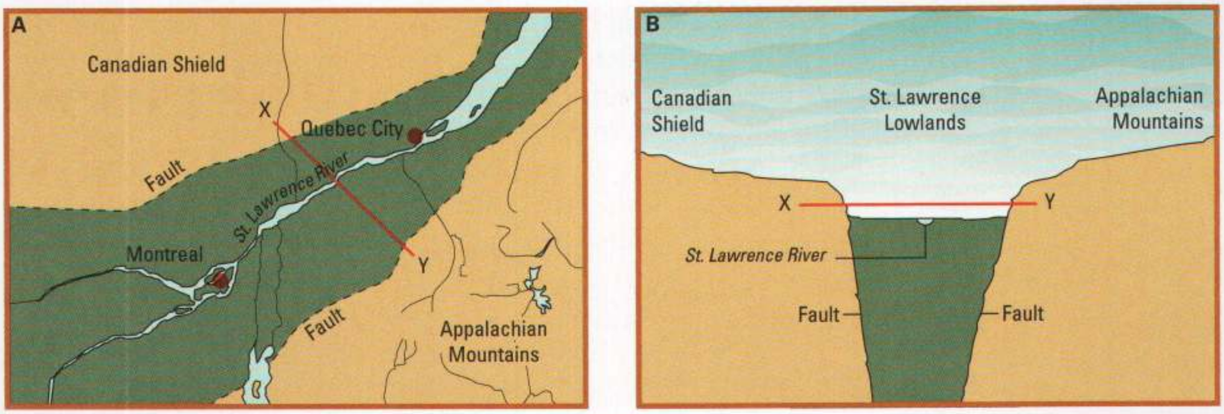
characterized
typical of the way a landscape appears

Much of the water in today's Great Lakes is meltwater from the glaciers.

The St. Lawrence Lowlands were formed in a different way from the Great Lakes Lowlands. A **rift valley** was formed by faulting (Fig. 12-12). This rift valley was flooded toward the end of the last ice age by a part of the Atlantic Ocean called the Champlain Sea.

Fig. 12-11 ▶ About 10 000 years ago, the melting glaciers created a glacial lake, Lake Iroquois, that covered the area where Toronto is now situated. The Ordovician was an early part of the Paleozoic era.





▲ **Fig. 12-12** The cross-section in B shows how the St. Lawrence Lowlands were created as a result of double faulting.

The Great Lakes–St. Lawrence Lowlands region is the most southerly region in Canada. It is well suited to agriculture because of its excellent soils and warm climate. The flat land is also ideal for transportation routes and the development of cities. Because of these factors, it is the most densely populated region in Canada. About 50% of Canada's population lives in the Great Lakes–St. Lawrence Lowlands, which make up only 1.4% of Canada's total area. Canada's two largest cities, Toronto and Montreal, are located here along with 70% of the country's manufacturing industries. Wouldn't you agree that the Great Lakes–St. Lawrence Lowlands could be called Canada's industrial and **urban** heartland?

HUDSON BAY–ARCTIC LOWLANDS

Around the southwestern shore of Hudson Bay and James Bay is a very flat, low area covered by swampy forest (Fig. 12-13). Known as the Hudson

◄ **Fig. 12-13** The Hudson Bay Lowlands

Bay Lowlands, this region has layers of sedimentary rock that rest on top of the ancient rock of the Shield. The waters of Hudson Bay covered much of this lowland at the end of the last ice age and deposited the sand, silt, and clay that became the layers of sedimentary rock.

Research is being done to determine whether these lignite, oil, and natural gas deposits are rich enough to make mining worthwhile.

The Arctic Lowlands, made up of a series of islands located in Canada's far north, have a gently rolling landscape. The harsh climate does not permit farming; the ground remains frozen most of the year. However, the Paleozoic sedimentary rock, from which the Lowlands are formed, contains **lignite** (a poor quality of coal), oil, and natural gas deposits.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. How was the sedimentary rock that underlies the lowlands formed?
2. a) How thick is the sedimentary rock in the Interior Plains and why is it so thick?
   b) Why are the ancient coral reefs of the Interior Plains important today?
3. a) Describe the topography of the Interior Plains as you would see it if you were driving across the region from west to east on the Trans-Canada Highway.
   b) Explain the major processes responsible for what you see.
4. Parts of the southern portion of Canada's Interior Plains are often called "Canada's breadbasket." Why?
5. What separates the Great Lakes Lowlands from the St. Lawrence Lowlands? Where does this occur and what is the appearance of this area?
6. Copy the paragraph below into your notebook. Wherever there is an asterisk (*), insert the correct word from this list:

   sedimentary, escarpment, rift, soft, south, faults, erosion, glaciation, Great Lakes

   To the * of the Canadian Shield is the Great Lakes–St. Lawrence Lowlands. Like the Interior Plains, these lowlands are underlain by * rock. The St. Lawrence Lowlands were created when land between two * collapsed creating a * valley. The landscape of the Great Lakes Lowlands is largely the result of * . The * were carved out by glaciers. The Niagara * is the biggest single feature of the lowlands.
7. a) Describe the characteristics of the Hudson Bay Lowlands and Arctic Lowlands.
   b) What minerals are present in the Arctic Lowlands? How did they get there?

THINKING

8. Examine the photographs of each of the lowland regions (Fig. 12-9, 12-10, and 12-13). Describe the differences you see.
9. Why might people in eastern Canada have an incorrect mental image of the appearance of the Interior Plains, i.e., why might many of them think it is all very flat land?
10. a) Name the four lakes in Manitoba and the five Great Lakes that are remnants of glacial lakes.
    b) Why are these lakes smaller than they were in the glacial period? Why did the lakes not disappear completely?
11. a) Describe any evidence of a glacial lake near your home.
    b) How does this feature affect the lives of those who live in your area?

APPLICATION

12. a) Mark the three different lowlands regions on the outline map of Canada on which you drew the Shield. (See Question 7a) on p. 133.)
    b) Label the lowlands regions on your map.
    c) On your map, label the major cities (populations of 100 000 and over) in each lowlands region. Save your map for another activity later in this chapter.
    d) How many of Canada's major cities are found in the lowlands?
    e) Compare the number of major cities in the lowlands with the number found in the Canadian Shield earlier in this chapter. Which region has more? Why?

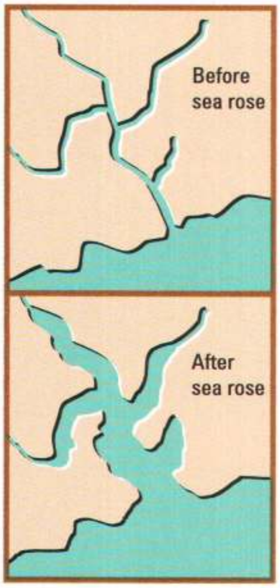
The Highlands

Canada's three highland areas lie to the east, north, and west of the Shield and lowlands areas. Each of these three striking mountainous areas—the Appalachians, the Innuitians, and the Western Cordillera—has a different geological history and appearance.

APPALACHIAN MOUNTAINS

The Appalachian Mountains stretch from the state of Georgia in the southern United States through the Maritimes to Newfoundland in the north. They are the oldest highland region in North America, formed about 300 million years ago. Layers of sedimentary rock were uplifted and folded at the end of the Paleozoic era when North America collided with Europe and northern Africa during the formation of Pangaea. Geologists

◀ **Fig. 12-14** Because of their age, the Appalachian Mountains appear rounded and are less striking in appearance than most of the Western Cordillera.



▲ **Fig. 12-15** Formation of a "drowned coastline." Former river valleys that were drowned by rising sea levels form deep, irregular inlets.

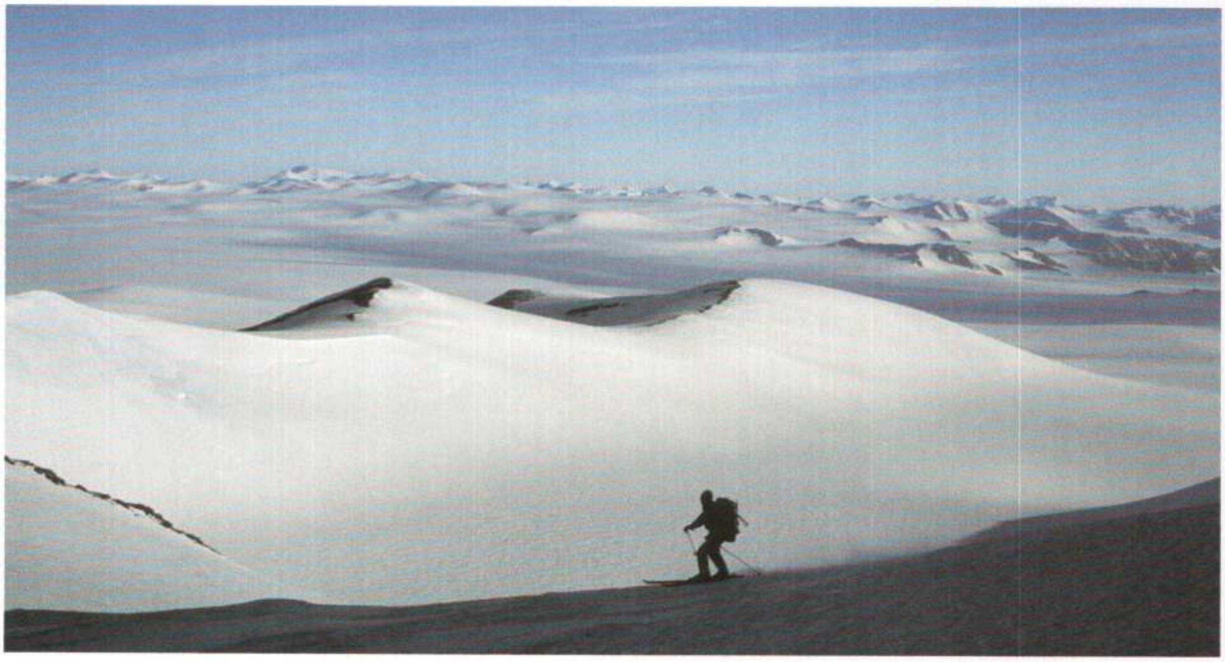
know this because rocks found in the Appalachians of Nova Scotia and Newfoundland are similar to rocks found in Wales and Scotland. The layers of sedimentary rock are rich in deposits of **non-metallic minerals** such as coal. Volcanic activity and faulting created igneous and metamorphic rock in certain areas of the Appalachians. **Plateaus** of this rock contain metallic minerals such as iron and zinc.

Millions of years of erosion have reduced the Appalachians' once-jagged peaks to rolling mountains and hills (Fig. 12-14). In recent geologic times, glaciation played a part in this erosion, grinding down the peaks and separating the hills and mountains with wide glacial valleys. During the last ice age, the weight of the ice pressed the Appalachians down. As the land sank and the ice melted, the small inlets along the east coast were flooded by the sea. The long bays that were created form a "drowned coastline" (Fig. 12-15). These long bays have provided deep harbours for ocean freighters, and some have become the sites of major cities. Other settlement is located mainly in the fertile river valleys and along the seacoast.

INNUITIAN MOUNTAINS

The Innuitian Mountains (Fig. 12-16) stand like icy watchtowers in Canada's far north. In some locations, they measure over 2500 metres in height. They were formed in the middle of the Mesozoic era when the North American plate moved northward. The Innuitians contain some igneous and metamorphic rock, but for the most part are composed of sedimentary rock.

▼ **Fig. 12-16** Innuitian Mountains



Since the Innuitians are younger than the Appalachians, erosion has not had time to wear them down as much. They are **barren** because trees can neither survive the extremely cold winter temperatures nor grow during the short summer. Vast areas are covered by ice and permanent snow. The Innuitian Mountains resemble the Appalachians in composition and, as you might expect, contain similar types of minerals. The mineral resources have not been exploited, however, because the region's **remote** location makes development too costly when cheaper alternatives exist elsewhere in Canada or in other countries.

barren
having no vegetation

remote
far away from the nearest settlement

Western Cordillera

The Western Cordillera stands along the western edge of the continent like a great wall. It consists of range after range of mountains separated by plateaus and valleys (Fig. 12-17). The great height and rugged appearance of these ranges tell us that they are geologically young. The collision of the North American and the Pacific plates is responsible for uplifting this region into several mountain ranges about 700 kilometres wide. The heavier Pacific plate forced its way (subducted) under the lighter North American plate, causing a great deal of folding, faulting, and volcanic activity. The result was the Western Cordillera.

A very narrow strip of flat coastal land exists between the Pacific Ocean and the base of the Western Cordillera. The growth of cities such as Vancouver and Victoria is limited by the presence of the Western Cordillera.

The mountains and valleys of the Western Cordillera run in a north–south direction. This presents an obstacle to transportation

◀ **Fig. 12-17** The Rocky Mountains in the Western Cordillera. The Rockies are the most easterly mountains in the Cordillera.

because main travel routes across the Cordillera must run in an east–west direction. There are only a few passes, or gaps, in the ranges of the Cordillera that are low enough to allow highways and railways to cross over.

Since it is so mountainous, the Cordillera is lightly populated. Most people live in farming and mining towns located in the river valleys. Vancouver and Victoria, the largest Canadian cities in the Western Cordillera, are built on flat land in coastal locations. Mountain towns such as Banff and Jasper have smaller populations, but thrive because of tourists who come to see the beautiful scenery. The scenery is famous partly because the mountains of the Western Cordillera are the site of the only remaining glaciers in Canada apart from those in the Arctic.

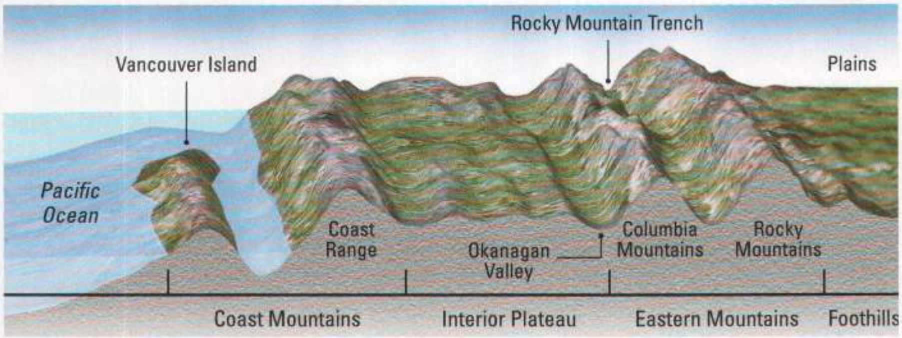
During the last ice age, glaciers occupied many coastal river valleys. These glaciers eroded the valleys below today's sea level. When the ice melted, these valleys were flooded by the sea, and became long narrow inlets called **fjords**. The steep sides of these fjords that cut into the towering mountains along the coast create spectacular scenery that today attracts thousands of tourists (Fig. 12-18). These tourists, however, must travel by boat or seaplane because there are few roads along the rugged coast of British Columbia. Roads are not very practical because of the long distances around the fjords.

Sea level during glacial times was much lower because so much of Earth's water was frozen in glaciers.

Many people tend to use the name "Rocky Mountains" and "Western Cordillera" **interchangeably**. This is a mistake. There are three major divisions in the Western Cordillera. See Fig. 12-19.

interchangeably used in place of the other

Fig. 12-18 ▶ A fjord in the Coast Mountains of British Columbia



◀ **Fig. 12-19** A profile of the Western Cordillera, from Vancouver Island to near Calgary

In Closing...

The movements of Earth's plates, and the resulting folding, faulting, and volcanic activity, have combined with the forces of erosion and glaciation to create a variety of landscapes that affect the way we live.

Canada could be described as "a core of ancient rock surrounded by lowlands and then highlands on three sides." This may be a simple description, but it summarizes the diversity of Canada's physical landforms.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. Use your own words to describe how the Appalachian Mountains were formed.
2. Why does the Appalachian region have many excellent harbours?
3. a) Describe the composition and appearance of the Innuitian Mountains.
   b) Why has this region not been developed as much as other regions?
4. a) How were the fjords of British Columbia created?
   b) What effect do the fjords have on land transportation along the coast?
5. Explain why the west coast of Canada has so many earthquakes.

THINKING

6. Examine the photo of the Appalachians (Fig. 12-14) and the photo of the Western Cordillera (Fig. 12-17). Which mountains are older? How can you tell?
7. a) Construct an organizer in your notebook similar to Fig. 12-20. Complete the information with the help of an atlas.

▼ **Fig. 12-20**

Mountain Range	Name of Highest Mountain	Height of Highest Mountain
Rocky Mountains		
Coast Mountains		
St. Elias Mountains		
Appalachian Mountains (Quebec)		

b) Of these mountains, which one is the highest in Canada?

c) Relate the height of the highest and lowest of these mountains to their age.

GeoLit Reminder

When organizing informational text:

- Re-read any part of the text that you do not understand.
- Use the text glossary or a dictionary for new words and terms.
- Record information in point form using subheadings or an organizer chart.
- Use maps, photographs, and diagrams for additional information.
- Refer back to your organized information when answering text questions.

COMMUNICATION

8. Review the material in this chapter and discuss the following quotation:

   "Canada is an east–west country trying to survive in a north–south continent."

APPLICATION

9. a) Mark the highland regions on the outline map of North America that you used for the Shield and lowlands.

   b) Name each region.

   c) Locate the major cities (population 100 000 and over) in each highland region.

   d) Compare the number of major cities in these highland regions with the number in the lowlands and the Shield. Why does this pattern exist?

10. Use an atlas map or road map of western Canada to identify four transportation routes between the Pacific coast and the Interior Plains of Alberta. Identify the mountain pass(es) used by each, as well as the major cities along each route.

13 Canada's Climate Connections

Key Ideas

This chapter helps you investigate these questions:

- What is the difference between climate and weather?
- What factors affect climate?
- How do maritime and continental climates differ?
- In what ways do the weather and climates of Canada affect us?

Key Terms

weather
climate
air mass
prevailing winds
polar front
jet stream
condensation
relief precipitation
convectional precipitation
continental climate
maritime climate
moderating effect

Weather records have been kept for dozens of places across Canada for many years. When averages are calculated from these records for such things as temperature, precipitation, atmospheric pressure, and winds, the long-term **weather** patterns that make up a location's **climate** become clear.

To help you understand why Canada's climate has so much variety, you should remember four basic facts:

1. Canada is a very large country; it extends for a great distance from north to south and from east to west.
2. Different elevations produce different climate conditions.
3. Coastal regions have different climates from inland regions.
4. Wind and pressure systems move weather conditions from one part of the country to another.

INTERNET

To obtain current weather conditions and forecasts across Canada, check the link at www.pearsoned.ca/makingconnections2.

Some very large lakes, such as the Great Lakes, also have an effect on climate.

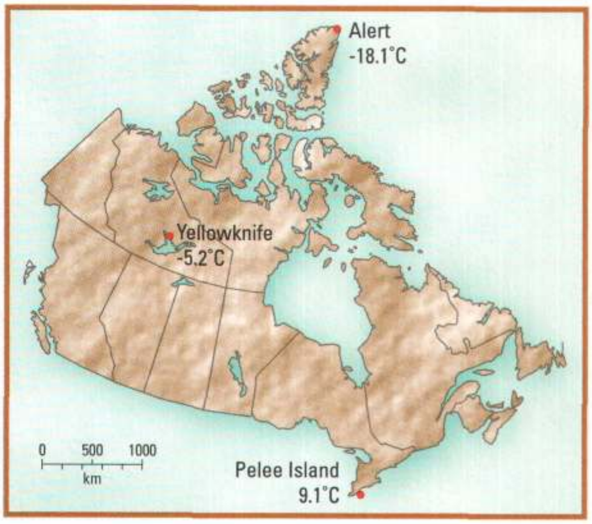
Factors That Affect Climate

Six major factors affect climate. They are:

1. ***L***atitude
2. ***O***cean currents
3. ***W***inds and air masses
4. ***E***levation (Altitude)
5. ***R***elief
6. ***Near Water***

The first letter of each factor, along with the last factor, can be combined to make a simple phrase that will help you remember these climate factors.

L O W E R Near Water



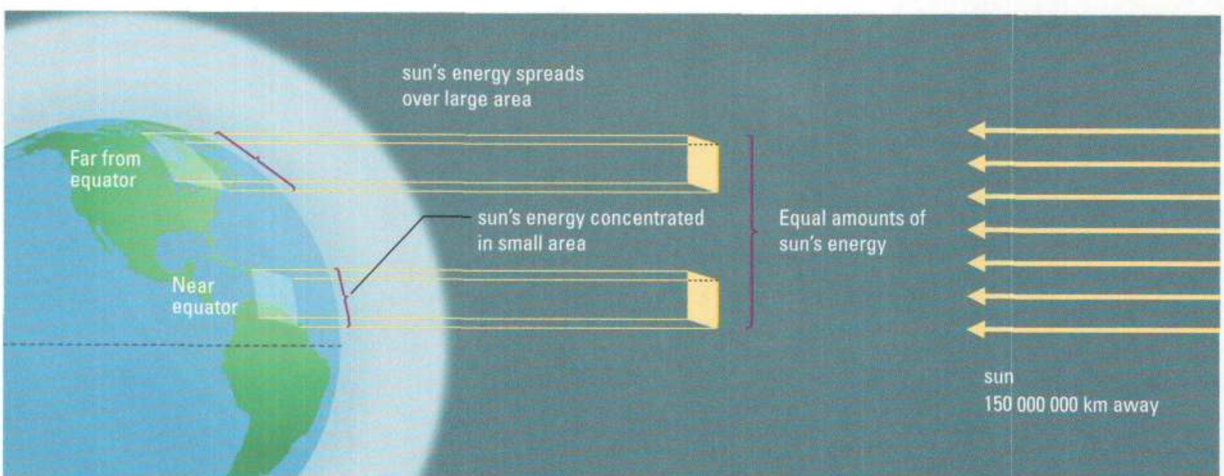
▲ **Fig. 13-1** Canada's great range of average annual temperatures is partly a result of the fact that the country stretches a great distance from north to south.

Latitude

The most southerly inhabited point in Canada is Pelee Island in Lake Erie at 41°N latitude. The most northerly point of the country is Alert, Nunavut, at the northern tip of Ellesmere Island at 83°N latitude. This wide range in latitude has a major impact on Canada's climate. Fig. 13-1 shows the **average annual temperature** at these two locations and at Yellowknife, which is about halfway between them at 62°N. What temperature changes occur as the latitude increases?

Distance from the equator is a key (but not the only) factor in determining whether a region has a hot climate or a cold one. In Fig. 13-2, you can see that the energy from the sun that hits Earth at the equator covers a small area. The same amount of energy that hits Earth at a more northerly location is spread over a larger area because of Earth's curvature. Places closer to the North and South poles experience colder temperatures than those near the equator because the same amount of energy is spread over a larger area.

▼ **Fig. 13-2** Earth's curvature causes the sun's energy to be less concentrated at the poles than near the equator.



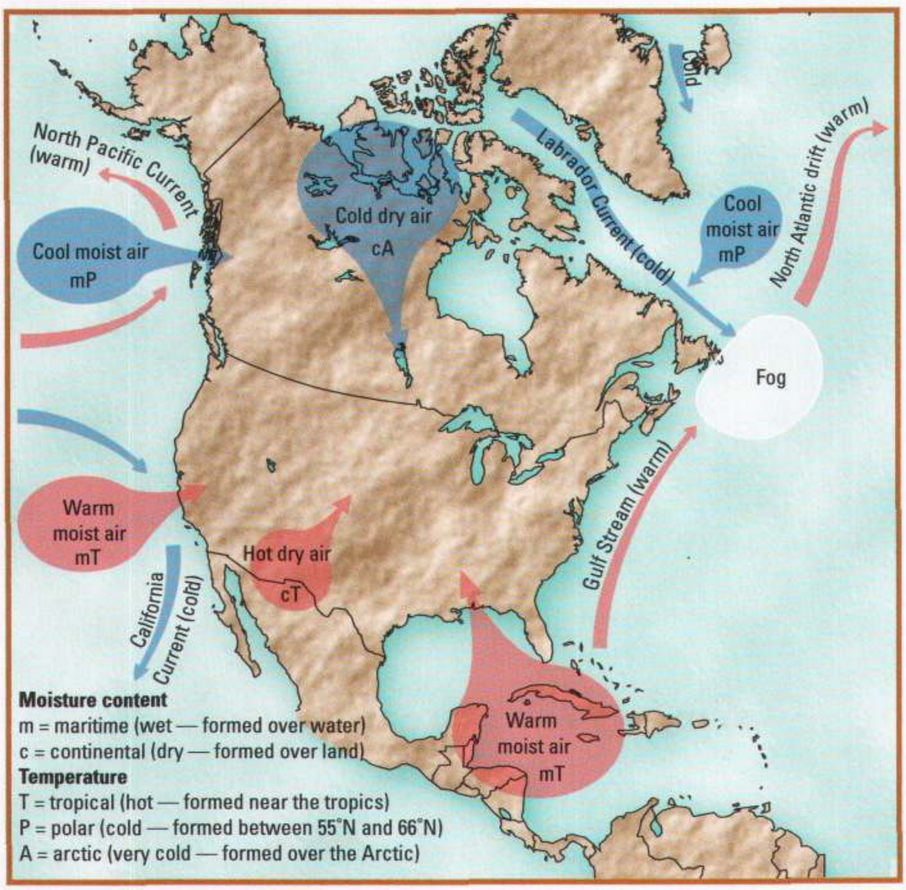
Ocean Currents

Ocean currents affect climate (Fig. 13-3). The temperature of an ocean current affects the temperature of the air that passes over it. The temperature of an ocean current in comparison to the surrounding water determines whether it is a cold or warm current. For example, on the west coast, the warm North Pacific Current heats the cool, moist air that passes over it, giving the coastal regions of British Columbia a milder climate than might be expected at this latitude.

For example, an ocean current of 15°C is a warm current if the surrounding water is 13°C, but it is considered to be a cold current if the surrounding water is 18°C.

On the east coast, the cold Labrador Current, which flows southward from the Arctic, cools the air of coastal locations in Labrador and northern Newfoundland. The Gulf Stream, flowing northward from the southern Atlantic, warms the air of coastal areas in Nova Scotia and southern Newfoundland. Where the air above the two currents meets on the Grand Banks, southeast of Newfoundland, conditions are often damp and foggy. Ships in that area must take special precautions to avoid collisions.

The meeting of warm air and cold air above these ocean currents produces fog more than 100 days per year.



◀ **Fig. 13-3** Canada's weather and climate are affected by air masses and ocean currents.

Winds and Air Masses

An **air mass** is a large volume of air that takes on the climatic conditions of the area where it is formed. An air mass originating over an ocean contains a considerable amount of moisture. As the air passes over land, the moisture may be released in some form of precipitation. As a result, a maritime location is likely to receive more precipitation than an inland, or continental, location. On the other hand, an air mass originating over land, far from the ocean, will be dry because it lacks a ready source of moisture. Air masses also take on the temperature characteristics of the areas in which they form. For example, the *mT* air mass that starts life over the Gulf of Mexico will be warm and moist, while the *mP* air mass that forms over the Pacific Ocean will also be moist, but relatively cold.

Air moves along the surface of Earth from high-pressure areas toward low-pressure areas. This moving air causes **wind**. Around Earth, there are high- and low-pressure belts that have created a well-established pattern of **prevailing winds** (Fig. 13-4). Over most of Canada, the prevailing winds blow from west to east. Called the "westerlies," these prevailing winds move air masses that affect our weather. Consider, for example, the *cP* air mass of northern Canada. As it moves southward, its cold, dry conditions are carried across Canada by the prevailing westerly winds. In contrast, the *mT* air mass from the Gulf of Mexico brings warm, moist conditions to eastern Canada.

The boundary between the cold, dry polar air and warm, wet tropical air is called the **polar front**. High in the atmosphere above the polar front is a current of fast-moving air called the polar-front **jet stream** (Fig. 13-5). This jet stream moves from west to east, controlling the location of the polar front: to the north of this jet stream there is colder air; to the south

As a cold, dry Arctic air mass moves southward, it becomes warmer and picks up moisture. Nevertheless, it remains colder and drier than the air in the region into which it moves.

Several jet streams encircle Earth—two or three in each hemisphere. A pilot needs to consider these high-altitude air currents when calculating the fuel needed for a particular trip.

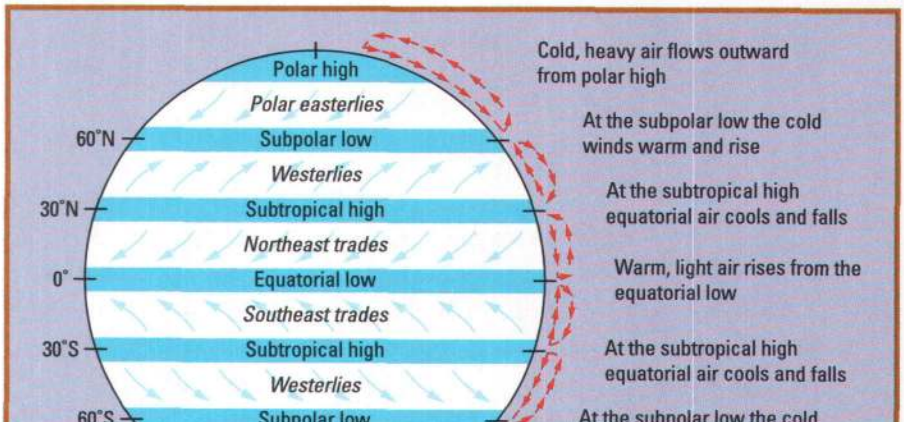
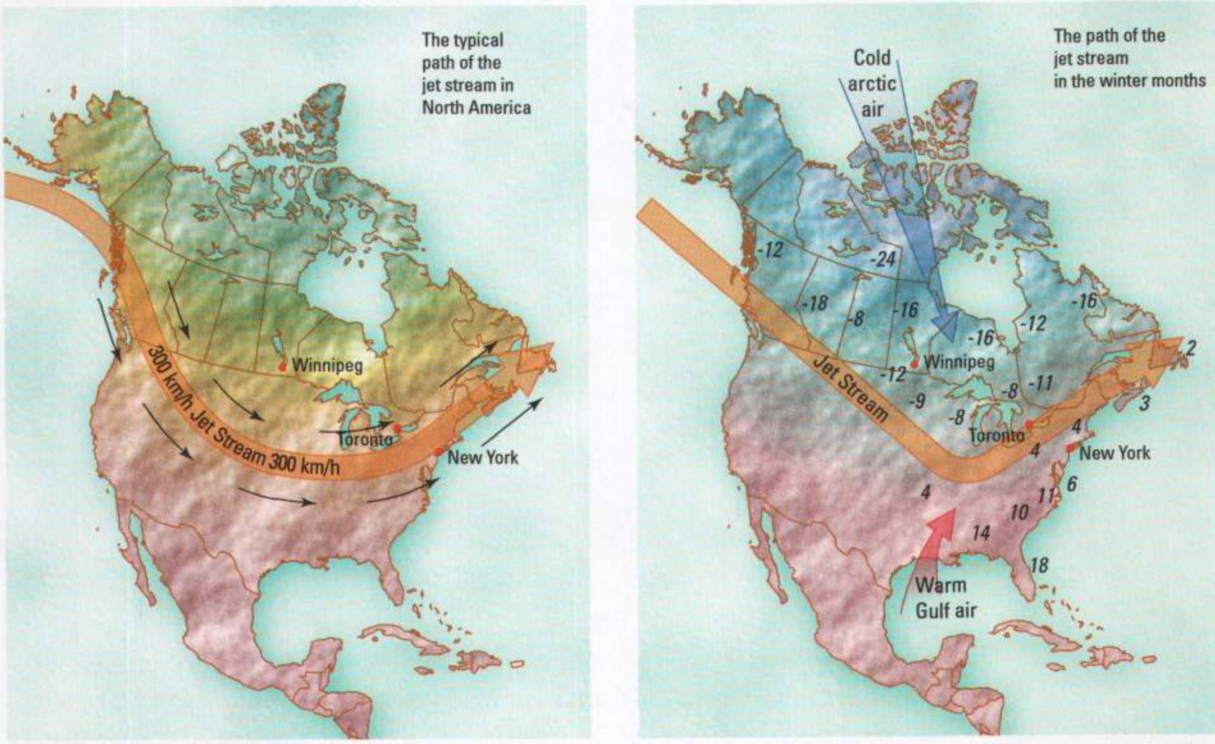


Fig. 13-4 ▶ Global pattern of prevailing winds. The degrees of latitude shown as the location of the pressure and wind belts are yearly averages. The winds shift north or south with the seasons. When you examine the diagram, remember that Canada is between 41°N and 83°N. Notice how the air rises high into the atmosphere at low pressure belts and descends at high pressure belts. The air then flows across Earth's surface from high pressure belts to low pressure belts, creating prevailing winds.



▲ **Fig. 13-5** The polar-front jet stream separates cold, dry air from warm, moist air. The position of the jet stream at any particular time has a major impact on our weather.

there is warmer air. In the summer, it is generally located to the north of where most Canadians live. In the winter, it is located to the south. Occasionally, however, the polar front moves out of its normal location, bringing mild spells in winter—the January thaw that we get most years—and cool spells in summer.

The polar front is also responsible for producing much of the rainfall that occurs in many parts of Canada, including all of Ontario. The production of **frontal rainfall** is a relatively complex process that involves the lighter, warmer air at the polar front being forced to rise over the colder, denser air.

INTERNET

You can read more about this process through the link at www.pearsoned.ca/makingconnections2.

Elevation

If you were to hike from sea level to the top of a high mountain, you would notice that the temperature drops steadily as you climb. As you approach the top, you might even find ice and snow all around you. You probably know that it gets colder as the elevation gets higher. But why does it get colder even though you are getting closer to the sun? Consider what happens as a mass of air moves up a mountain. The example in Fig. 13-6 shows what it could be like in the Vancouver area in the summer. As the air rises, it expands because of the lower **air pressure**. As the air expands, it cools. When air is cooled, it eventually reaches a temperature at which it is saturated with

When discussing an actual temperature, use "degrees Celsius." For example, "the temperature today is 20°C." When discussing a temperature change or a range of temperatures, use "Celsius degrees." For example, "the temperature fell by 10C°."

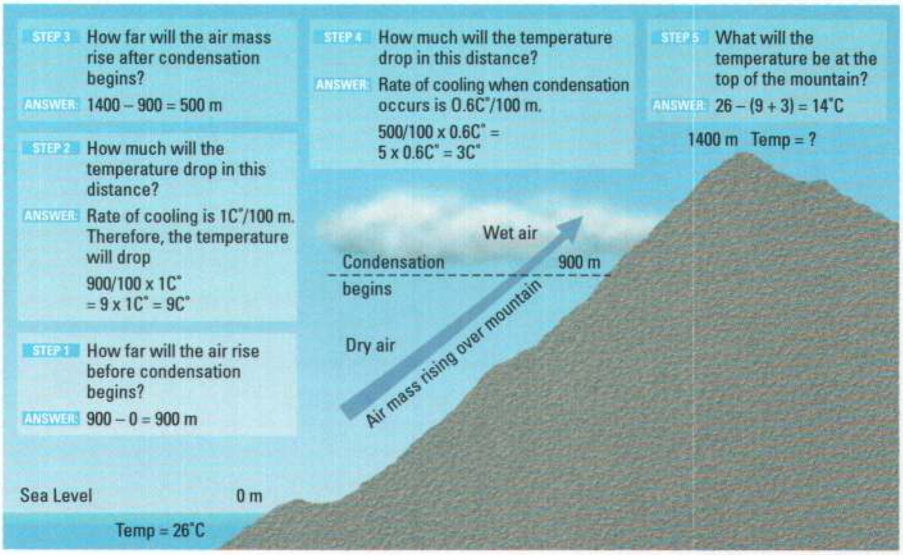


Fig. 13-6 ▶ Calculating changes in temperature of a rising air mass. When condensation occurs, heat is given off. Cooling of the air mass is still occurring, but since heat is being released by condensation, the overall rate of cooling is less than 1C°/100 m. The rate of cooling when there is condensation can vary somewhat: 0.6C°/100 m is an average figure for this cooling.

water vapour, that is, it is holding as much water as it possibly can at that temperature and air pressure. This is called the dewpoint. Further cooling leads to **condensation**. Condensation is the change of water vapour into liquid water. Liquid water becomes clouds and if the droplets grow large they may become rain, snow, or hail depending on the weather conditions. Since the process of condensation releases heat into the air, the air mass cools more slowly as it continues to rise. Fig. 13-6 illustrates how you can calculate the temperature of an air mass as it rises up a mountainside.

> Features other than high mountains may also cause relief precipitation. For example, southern Ontario's snowbelt is a result of wind blowing in from Lake Huron and Georgian Bay over hilly areas.

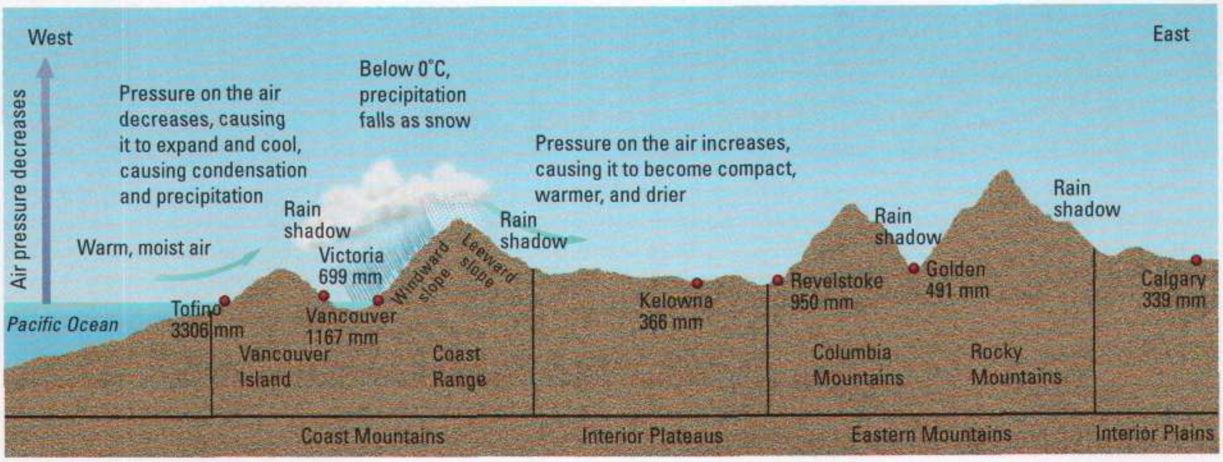
Relief

Mountain barriers create **relief precipitation**. As moist air rises up the **windward** slope of a mountain range, it expands and cools. As air cools, the amount of evaporation decreases while the rate of condensation increases. The result is an increase in the number of water droplets in the air. As more water vapour condenses, the droplets become larger and form raindrops. When they are too heavy to remain suspended in the atmosphere, they fall to the ground as rain. In colder temperatures (below freezing), water vapour **sublimates** into snow.

sublimates
changes directly from a gas to a solid without becoming a liquid

As cool air descends on the more protected **leeward** slope of a mountain range, it contracts and becomes warmer. Since more evaporation than condensation takes place as the air descends (remember that a great deal of moisture was lost as precipitation on the windward slope), cloud formation and precipitation decrease. This results in a drier climate, or **rain shadow**, on the leeward slope of the mountain range than on the windward slope. Rain shadows and wet windward slopes are common in the Western Cordillera, where air masses pass over a series of mountain ranges (Fig. 13-7).

> It tends to be warmer on the leeward side of the slope than on the windward side at the same elevation. Can you figure out why?



▲ **Fig. 13-7** Relief precipitation in the Western Cordillera

This is the pattern along the coast of British Columbia, which has rainy winters and dry summers.

CONVECTIONAL PRECIPITATION

So far, we have briefly considered two types (or causes) of precipitation: frontal precipitation, which occurs along the polar front and affects most of Canada almost all year, and relief precipitation, which occurs when moist air is forced to rise over an elevated area. Relief precipitation obviously affects only those areas with a noticeable amount of relief. Often, it is only apparent for part of the year since the westerly winds tend to shift with the seasons.

There is a third type of precipitation: **convectional precipitation**. It is the type of rainfall that is responsible for the fact that most parts of Canada get more precipitation in the summer than in the winter. You are undoubtedly familiar with the violent but short-lived rain showers that occur in the afternoons or evenings of hot days: these are an example of convectional precipitation.

Near Water

Areas located in the interior of large land masses, far from oceans, and far from large lakes, have a **continental climate** (Fig. 13-8). The **temperature range** in these areas is great because there is no large water body to moderate the hot temperatures of summer and the cold temperatures of winter. An area with a continental climate tends to have low amounts of precipitation because it is far from sources of moisture.

Coastal locations have a **maritime climate** (Fig. 13-9). In a maritime climate, the range between the highest and lowest average monthly temperature is relatively small because of the **moderating effect** of the large water body. The level of precipitation is relatively high compared to that of a continental climate because of the **proximity** of a large water body (Fig. 13-10).

proximity
closeness

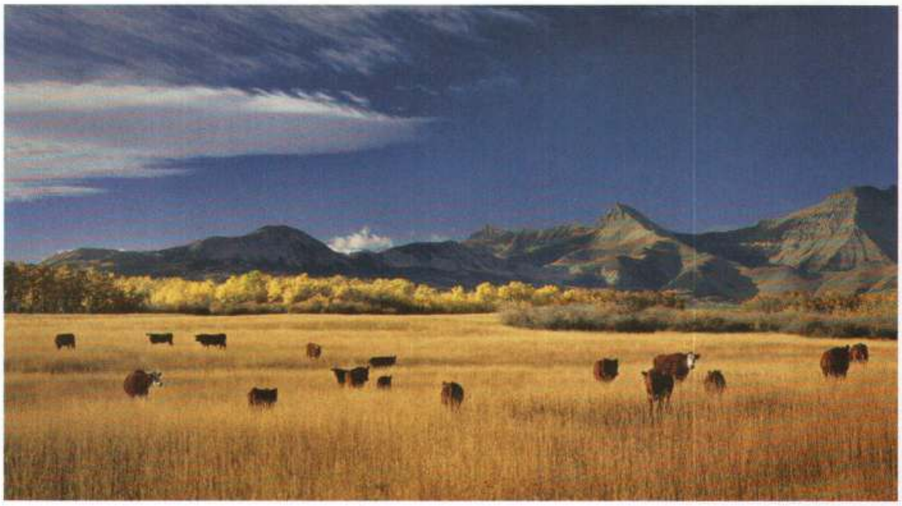


Fig. 13-8 ▶
A typical continental climate

Fig. 13-9 ▶
A typical maritime climate

▼ **Fig. 13-10** Maritime and continental climate comparison

Climate	Typical Seasonal Temperatures	Annual Temperature Range	Annual Precipitation
Continental	warm to hot summers; cold winters	25C° to 50C°	200 mm to 1000 mm (low to moderate)
e.g., Winnipeg, Manitoba	average annual temperature = 2.6°C	37.3C°	514 mm
Maritime	cool to warm summers; cool winters	20C° to 30C°	1000 mm to 2500 mm (moderate to high)
e.g., Halifax, Nova Scotia	average annual temperature = 6.1°C	24.3C°	1474 mm

Areas near the Great Lakes are a special case. While they are far enough from the oceans to be continental, the lakes are large enough to provide a partial maritime influence (i.e., a reduced temperature range and a source of moisture). The climate here is sometimes called *modified continental.*

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. Examine Fig. 13-2 and describe the effect of latitude on climate.
2. "Bodies of water have a moderating effect on land temperatures." Explain how this is accomplished.
3. a) How do ocean currents affect climate?
   b) The meeting of the cold Labrador Current and the warm Gulf Stream create special weather conditions. What are these conditions and how do they affect ships?
4. How do prevailing winds affect the movement of air masses?
5. How does the polar-front jet stream affect the movement of air masses?
6. a) Name the three types of precipitation.
   b) In each case, something happens to a mass of moist air. What is it that happens? What are the three different causes?
7. Explain what happens to the temperature and moisture content of air as it passes over a mountain.
8. a) Explain the difference between weather and climate.
   b) Give two examples of how each affects our lives.

THINKING

9. The Labrador Current brings icebergs southward from Arctic regions to the waters near Newfoundland and Labrador. This area of the Atlantic Ocean is called "iceberg alley."
   a) What famous marine disaster occurred in 1912 as a result of these icebergs?
   b) What effect might this current have on the oil exploration and development that is occurring off the east coast of Canada?

APPLICATION

10. Copy Fig. 13-11 into your notebook and complete it using the information in Fig. 13-3.

▼ **Fig. 13-11**

Label	Interpretation	Where Formed	Characteristics
cA	continental Arctic	over land and frozen water in Canada's Arctic	very cold and dry
mT			
mP			
cT			

11. Using the information in Fig. 13-6, calculate the temperature of air as it rises up a mountainside in the following example:

    Mount Garibaldi, north of Vancouver, is 2700 metres high. The temperature at the waterfront in Vancouver is 24°C. What will be the temperature of the air at the mountaintop if condensation starts at 1200 metres?

Canada's Climate Regions

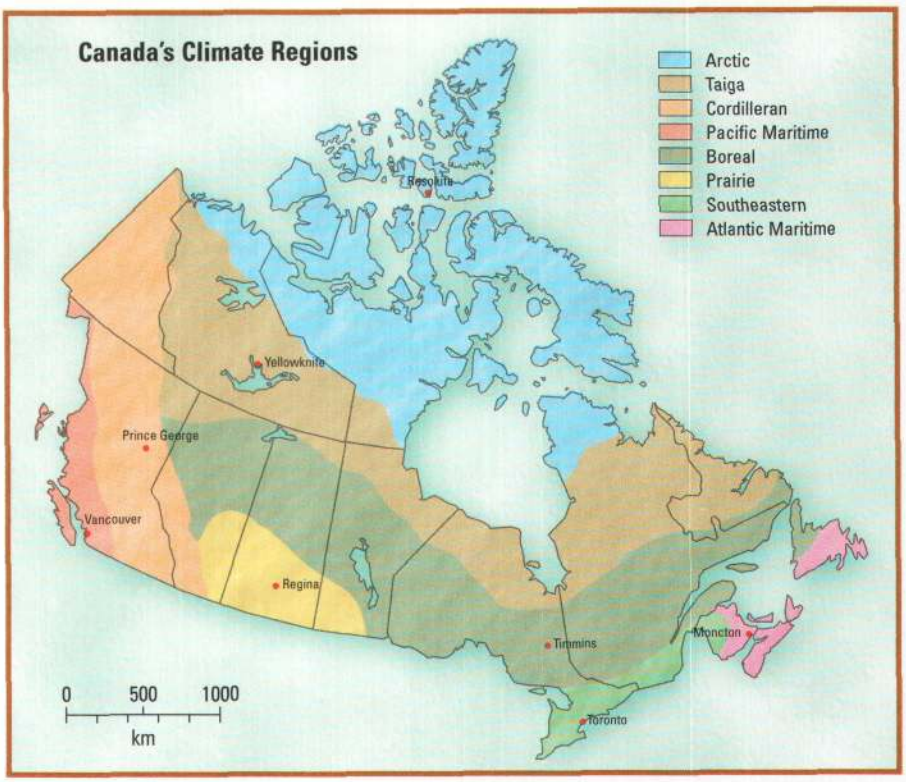
We may not be aware of it, but the weather in various parts of Canada often has a direct impact on us. For example, a drought in the Prairies might cause the cost of a loaf of bread to rise in the region where you live. If you were planning a ski holiday in the Rockies, you would be disappointed if heavy snows caused the closing of railway lines and highways in the mountains. And of course, the climate in your own part of the country determines what clothing you wear each season. Climate and weather patterns also have an effect on many other things: on a region's soil, and the agricultural patterns that develop; on a region's natural vegetation and wildlife, and the economic activities that might result (e.g., forestry); and on population patterns (e.g., harsh climate conditions that might discourage settlement).

Areas with similar climates may be grouped together to form a climate region. The climates of Canada may be grouped to create eight climate regions (Fig. 13-12). Complete the following activity to help you understand the characteristics of Canada's climate regions.

INTERNET

To obtain climate information for dozens of places across Canada, check the link at www.pearsoned.ca/makingconnections2.

Fig. 13-12 ▶



GeoLit Reminder

When reading a map:

- Examine the title, caption, legend, and labels.
- Scan the map for patterns and trends.
- What general information does the map provide?

Construct a chart similar to Fig. 13-13 to compare the climate characteristics of the eight **climate stations** in Fig. 13-15. A climate station is any place where climate information is gathered.

a) Complete columns 1 to 5 using the information on interpreting climate graphs in Fig. 13-14, and the information in the sample climate graphs in Fig. 13-15.

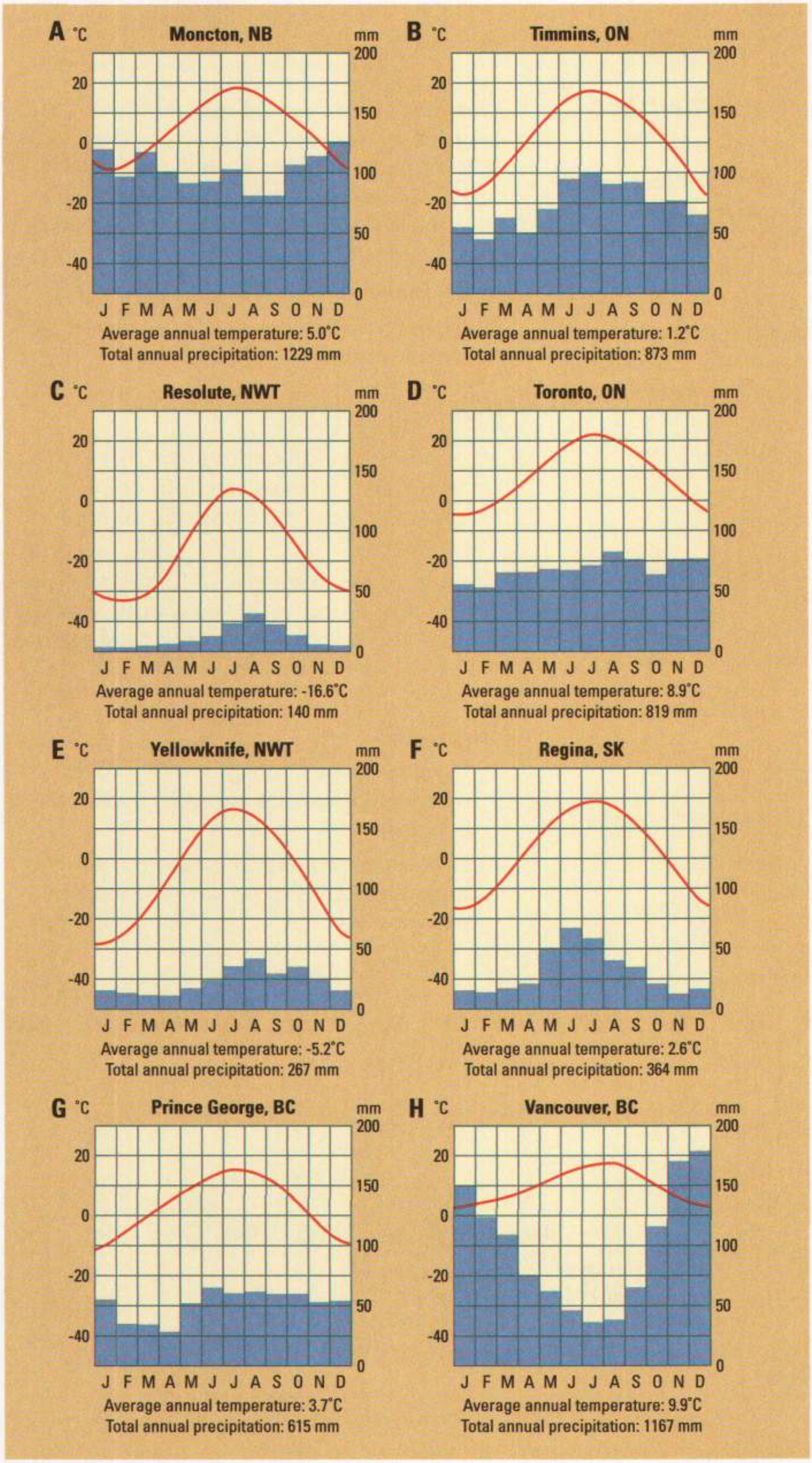
b) In the location column, write the name of the climate station and the climate region beside each letter.

Location	1 Average Temperature	2 Temperature Range	3 Total Precipitation	4 Season of Maximum Precipitation	5 Continental or Maritime
A					
B					
C					
D					
E					
F					
G					
H					

▲ Fig. 13-13

Factor	How Determined	Significance
Average annual temperature	• Add together the 12 average monthly temperatures and divide by 12.	• Indicates whether a location has a warm climate (Toronto), or a cool climate (Yellowknife).
Temperature range	• Maximum temperature (warmest) – minimum temperature (coldest) indicates whether a place has a continental climate (large range) or a maritime climate (small range). large (> 25C°) = CONTINENTAL small (< 25C°) = MARITIME	• Places that do not have a minimum temperature below 0°C will be on the west coast.
Total precipitation	• Add monthly precipitation totals. < 1000 mm = CONTINENTAL > 1000 mm = MARITIME	• Indicates whether a place has a dry or wet climate.
Seasonal distribution of precipitation	• "WINTER" add precipitation totals for Oct., Nov., Dec., Jan., Feb., Mar. Winter max. = MARITIME (large difference between winter and summer = west coast) (slight difference between winter and summer = east coast) • "SUMMER" add precipitation totals for Apr., May, Jun., Jul., Aug., Sep. Summer max. = CONTINENTAL	• Indicates the climate influences at work and therefore different climate types.

▲ **Fig. 13-14** This general guideline will help you to interpret climate graphs of places in Canada.



◀ **Fig. 13-15** This figure presents a sample climate graph for a location in each climate region.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. a) In which climate region do you live?
   b) Describe the climate of this region based on your own experience of it. Remember to talk about climate, not weather. Use descriptive words such as "winters are not very cold, but it rains a lot."
   c) Look at the climate statistics for a place in your region. Try to see how your climate experiences are reflected in the numerical data. Why does this only work well if you described your climate, rather than your weather?

GeoLit Reminder

When organizing informational text:

- Re-read any part of the text that you do not understand.
- Use the text glossary or a dictionary for new words and terms.
- Record information in point form using subheadings or an organizer chart.
- Use maps, photographs, and diagrams for additional information.
- Refer back to your organized information when answering text questions.

2. Using the climate regions map (Fig. 13-12) and information from Fig. 13-15, answer the following questions. You might find it easier to identify the similarities and differences if you use a table like Fig. 13-13. What similarities and differences exist between
   a) the Boreal and the Prairie climate regions?
   b) the Atlantic Maritime and Southeastern climate regions?

COMMUNICATION

3. Why would it be difficult to prove that a climate graph you know comes from the Cordilleran climate region actually comes from this region?
4. If you could live in any one of Canada's climate regions, which one would you choose? Explain your choice. Compare your choice and reasons with two other classmates.

APPLICATION

5. a) Using the same headings as in Fig. 13-13, determine the values for each climate station in Fig. 13-16.
   b) In which climate region is each climate station located? Explain how you reached your decision.

▼ **Fig. 13-16** In what region(s) would these climate locations be found?

STATION A	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average monthly temperature (°C)	-14	-11	-5	4	10	14	16	15	10	4	-6	-12	2.1
Average monthly precipitation (mm)	23	15	16	22	43	76	101	70	47	18	16	19	466

STATION B	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average monthly temperature (°C)	-9	-8	-3	3	9	15	19	18	13	7	2	-6	5.0
Average monthly precipitation (mm)	120	96	117	101	91	93	103	81	81	106	114	126	1229

14 Canada's Soil and Natural Vegetation Connections

Key Ideas

This chapter helps you investigate these questions:

- What are the soil and vegetation regions of Canada?
- How are soil and vegetation related?
- Why are soil and natural vegetation of great importance to Canadians?
- Why should we try to preserve fertile soils?
- What products do we obtain from the different types of vegetation in Canada?

Key Terms

soil
humus
soil profile
leaching
calcification
capillary action
tundra
transition zones
permafrost
boreal and taiga forest
coniferous trees
deciduous trees
mixed forest
short-grass prairie
long-grass prairie
parkland

Getting the "Dirt" on Soil

We tend to use the word *soil* very carelessly when it does, in fact, have a precise meaning. A true **soil** consists of four main parts: minerals, bacteria and organic materials; air; and moisture. Technically speaking, if one of these parts is missing, the material should not be considered soil.

1. **Minerals**

The minerals in soil come from a **parent material**. The parent material is usually rock, but it can also be loose materials that have been deposited by a glacier, the wind, or a river. The minerals become part of the soil when the rock is broken down by **weathering** into smaller particles of sand, silt, and clay. Many of these minerals, such as calcium, phosphorous, and potassium, are **nutrients** that plants need for growth.

2. **Bacteria and Organic Materials**

When plants and animals die, they are decomposed by bacteria in the soil. As bacteria break down the organic material, nutrients are released into the soil. As the organic material is broken down by bacteria, it forms **humus**, which provides nutrients and moisture for plants. Humus gives the soil its dark colour.

The process of decay is nature's way of recycling nutrients.

About half the volume of a high-quality soil is composed of water and air.

3. **Air**

Plants need air around their roots. A high humus level helps produce air in the soil because the loose, decaying materials allow for many air pockets. Air pockets are also created by worms, insects, and small animals that tunnel through the soil.

4. **Moisture**

Water dissolves nutrients in the soil and is then taken up by plants through their roots. Water is also necessary in the chemical and physical processes that weather rock and decay organic materials.

Issue

DO WE TREAT OUR SOIL LIKE DIRT?

◄ **Fig. 14-1** Ontario's 67 000 farms produce more than a quarter of Canada's total farm products.

Background

When was the last time you thought about protecting our soil? If you live in an urban area, like most Canadians, chances are you never think about this, but you should. Soil is very important to how we live—in fact, without fertile soils we would have nothing to eat. If you live on a farm, chances are very good that your family talks about the need to protect and improve your farm's soil.

Activities

1. In pairs or small groups, brainstorm possible answers to the following questions. Compile a list of your answers.
   a) What roles does soil play in nature and for people?
   b) What threats does it face?
2. Check your knowledge of why soil matters by reviewing the Web links at www.pearson.ca/makingconnections2. Each group member should select a different Web site to review. In your groups, share any new information you found about the roles soil plays and the threats it faces, and add these to the list you compiled in Question 1.

Soil Formation

A typical **soil profile** is shown in Fig. 14-2. New mineral materials are added at the bottom of the soil by the weathering of the parent material. At the same time, organic materials are added at the top. This top layer of soil containing humus is called **topsoil**. Topsoil formation is a very slow process. Since the end of the last ice age, 6000 to 12 000 years ago, only 15 to 25 centimetres of topsoil have formed under the forests of Canada. In contrast, between 40 and 100 centimetres of topsoil have developed under the grasslands of the prairies.

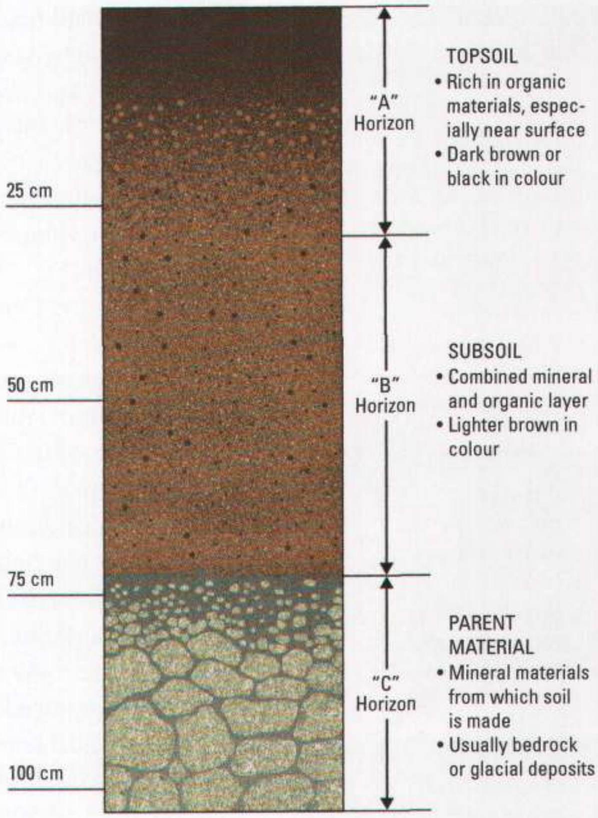
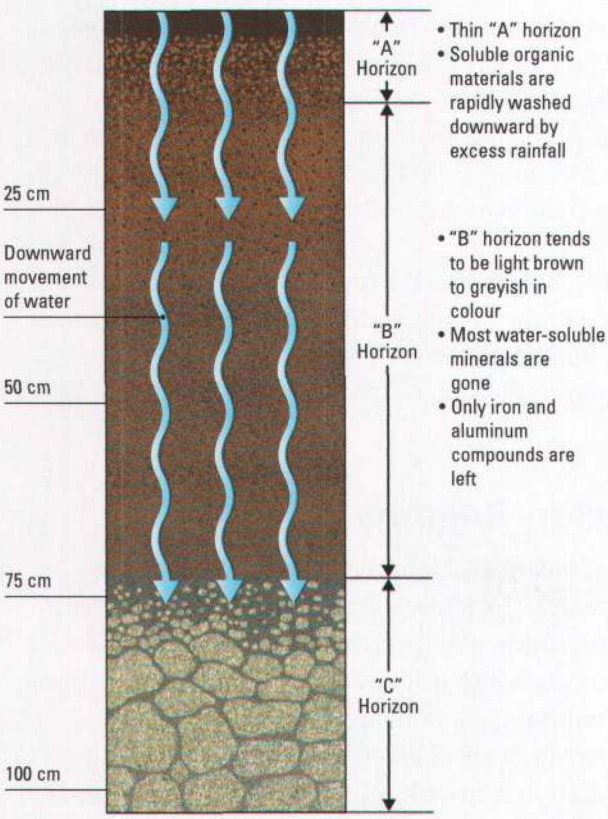
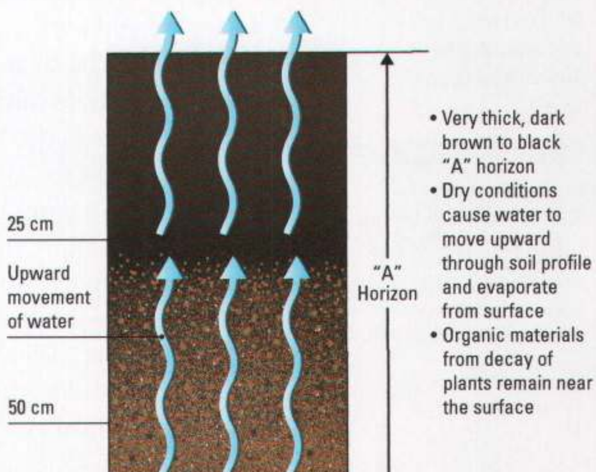


Fig. 14-2 ▶ A typical soil profile

▼ **Fig. 14-3** A typical wet-climate soil profile. In these areas, the downward movement of water means that leaching is the dominant process.





◀ **Fig. 14-4** A typical dry-climate soil profile. In these areas, the upward movement of water means that calcification is the dominant process.

The size of rock particles is an important part of soil structure. The larger particles of sand allow rainwater to drain quickly through the soil, while the smaller particles of more absorbent clay prevent rapid drainage.

INTERNET

You can learn more about Canada's soils through the link at www.pearsoned.ca/makingconnections2.

This upward capillary action of water can also be observed if you dip the edge of a paper towel into a bowl of water.

In the Western Cordillera, you may find highly leached soils and calcified soils—and even bare rock—located within a few kilometres of one another.

A well-balanced mixture of sand, silt, clay, and humus is called **loam.** It is the best soil for growing plants because it encourages root growth and holds moisture, and allows water to pass through it at a rate moderate enough to allow plants to take up nutrients.

Two other processes, which are related to climate, contribute to soil formation. The first is called **leaching**. In areas where there is a great deal of precipitation, there is a continual downward movement of water through the soil (Fig. 14-3). As the water moves down, it dissolves the chemical nutrients in the soil and carries them away. This downward movement of water removes nutrients that plants need. In very wet climates, leaching can take water-soluble minerals so deep that plant roots cannot reach them. You can identify a leached soil by its poor, often thin, topsoil layer. Examine Fig. 14-5 to see how much of Canada is covered with wet-climate soils that are prone to leaching. Leached soils can be much more productive for farming if natural or chemical fertilizers are used to replace leached nutrients.

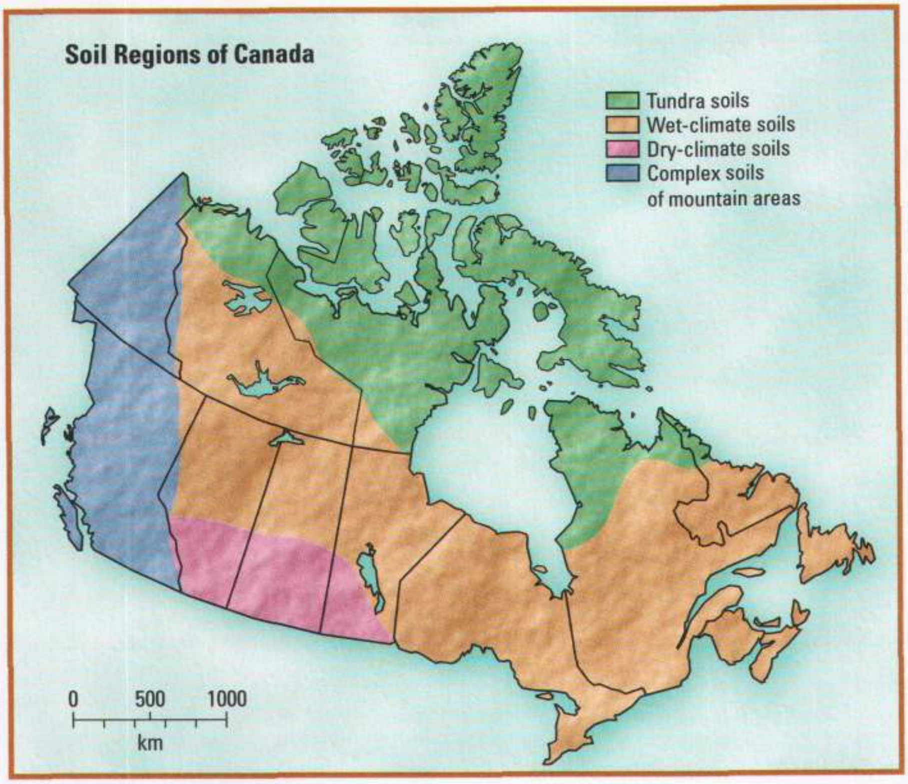
The second process, known as **calcification**, occurs in areas with drier climates (Fig. 14-4). Here, instead of downward movement of water, there is upward movement. As water in the topsoil evaporates, water from below is drawn up to replace it. This process is called **capillary action**. As the water evaporates, it leaves behind the minerals that were dissolved in it. The result is the creation of a thick topsoil layer that is rich in minerals. This process is called calcification because calcium is the main mineral deposited near the surface. In very dry climates, however, the amount of mineral deposition can be so great that it forms a layer poisonous to plants. Dry-climate soils where calcification is common are shown in Fig. 14-5.

Fig. 14-5 shows two other soil regions: complex soils of mountain areas and tundra soils. Because of the Western Cordillera's varied relief and climate patterns, a complex pattern of soils exists, and the characteristics of the soil can change completely over very short distances. In contrast, the harsh climate of the tundra soils region makes soil formation difficult. The short, cool growing season limits plant growth and slows the breakdown of organic materials into humus. Because of the permafrost, the soil drains poorly and is often waterlogged. As a result, air may be missing from the soil's profile.

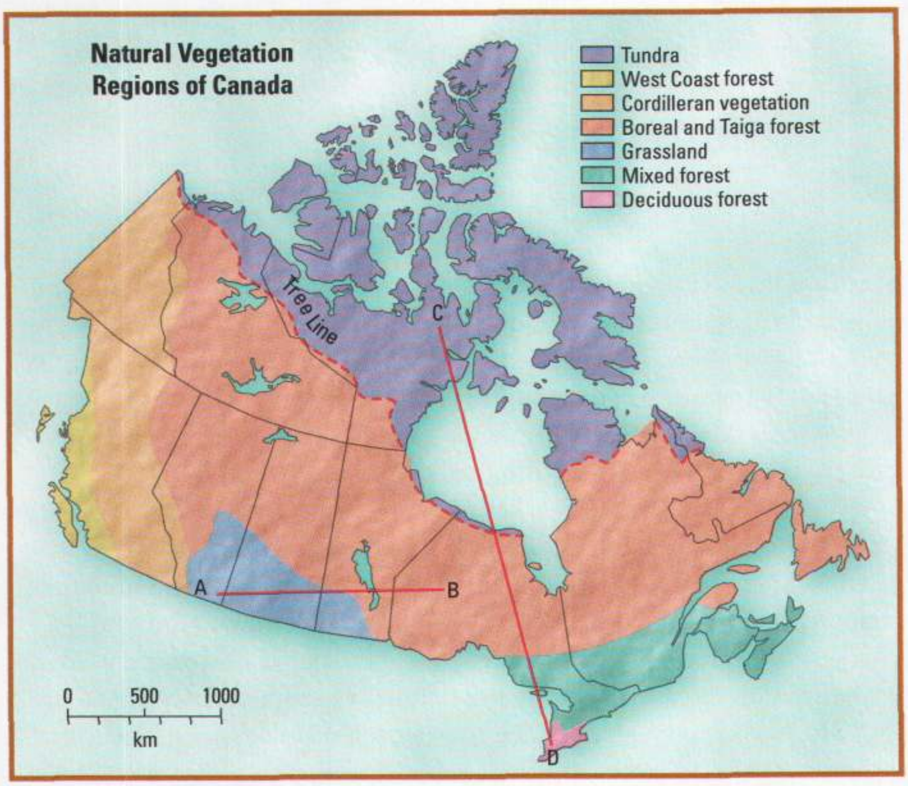
Natural Vegetation Regions

Plants must have moisture and heat for their survival. The relative amount of each determines which plants will grow. For example, a warm, moist climate may support a forest of large trees; a warm, dry climate may support only short grasses. Areas with distinct types of natural vegetation are classified as different natural vegetation regions (Fig. 14-6).

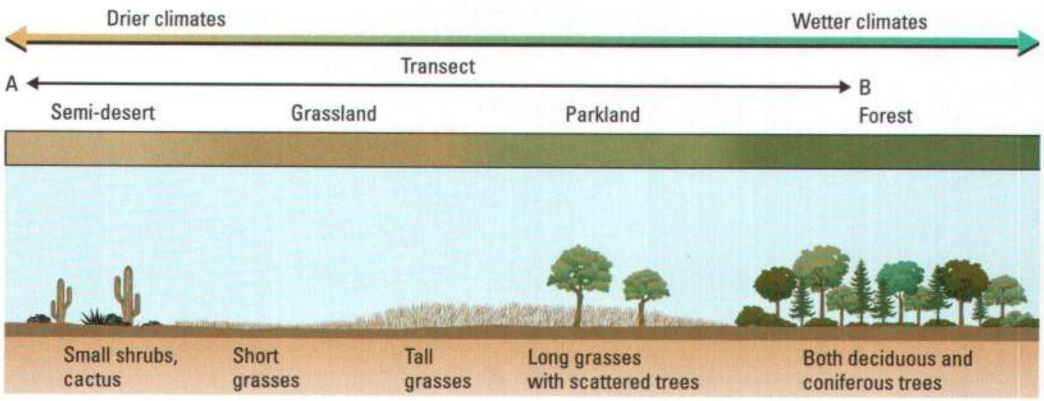
Natural vegetation refers to those plants that grow without any human interference. Natural vegetation is usually quite different from plants that



◀ **Fig. 14-5** Soil Regions of Canada

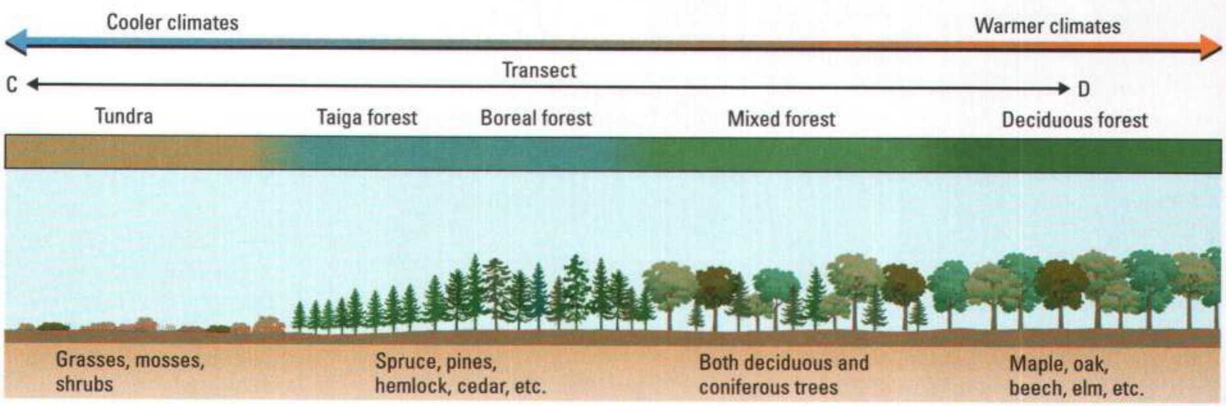


◀ **Fig. 14-6** Natural Vegetation Regions of Canada. The A–B and C–D transects are shown in Fig. 14-7 and Fig. 14-8.



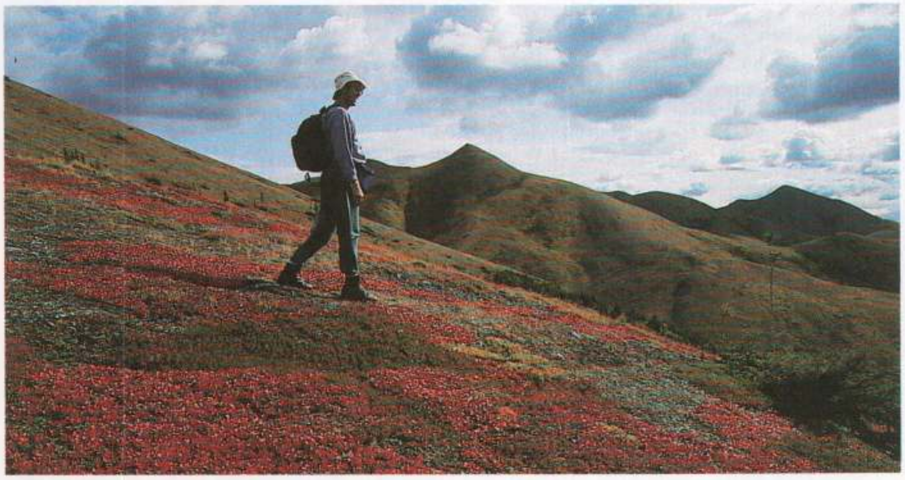
▲ **Fig. 14-7** Vegetation changes as precipitation levels change. The A–B transect refers to Fig. 14-6.

▼ **Fig. 14-8** Vegetation changes as average temperatures change. The C–D transect refers to Fig. 14-6.



people cultivate for food or for use in industry. Different types of natural vegetation grow in response to different climatic and soil conditions. Figs. 14-7 and 14-8 show the types of natural vegetation that grow as precipitation and temperature change from place to place. There are three main types of natural vegetation in Canada: **tundra**, forest, and grassland. Of these, forest vegetation is predominant.

Geographers have identified seven natural vegetation regions across Canada. Notice that the natural vegetation regions in Fig. 14-6 are separated by lines. It is a mistake to think that these lines show an immediate change from one region to another. Instead, they represent areas of change called **transition zones**. The characteristics of one region gradually change into those of the next. Some transition zones are so large that they are considered regions in themselves, for example, the mixed forest vegetation region.



◀ **Fig. 14-9** Tundra vegetation: plants remain small to obtain warmth from the ground, and protection from cold, harsh winds.

Tundra

The tundra is the most northerly vegetation region of Canada (Fig. 14-9). It is located above the **tree line**, which marks the northern boundary of most tree growth. Only a few **stunted** trees grow in the tundra because the climate is too cold and dry. Most of the tundra has **permafrost**, or permanently frozen ground. Only the top metre or so of permafrost, known as the **active layer**, thaws during the short summer. Since water cannot drain downward, the surface remains waterlogged. This thawing permits a very short growing season. Small shrubs, mosses, and lichens grow close to the ground, where they soak up as much heat as possible from the surface. Lichens are slow-growing plants that cling to rocks. Since tundra plants bloom and mature very quickly, they are able to produce their seeds before the cold weather returns. There is very little humus in the tundra's thin layer of soil because of the small amount of vegetation, the water-logged nature of the soil, and the cold climate. The lack of vegetation limits the variety of wildlife as well as the population of each species.

stunted
smaller than normal size

Some stunted trees are able to grow, however, in sheltered valleys in the southern part of this region.

Forest

BOREAL AND TAIGA FOREST

To the south of the tundra is the **boreal and taiga forest**, the largest vegetation region in Canada (Fig. 14-10). It is separated from the tundra by the tree line. **Coniferous trees** grow south of this tree line because there is a longer growing season and more precipitation than in the tundra. Coniferous trees, or evergreens, lose some needles throughout the year, but are never bare. Since they don't drop many needles, and because leaching occurs, the humus layer beneath them is very shallow. This gives the topsoil a grey colour. Since the needles are acidic, they make the soil acidic. The lack of humus, combined with the high acidity and the

Coniferous trees are also known as needle-leaved trees. The tamarack is an exception. It is a coniferous tree but it is not an evergreen. It drops its needles in the fall.

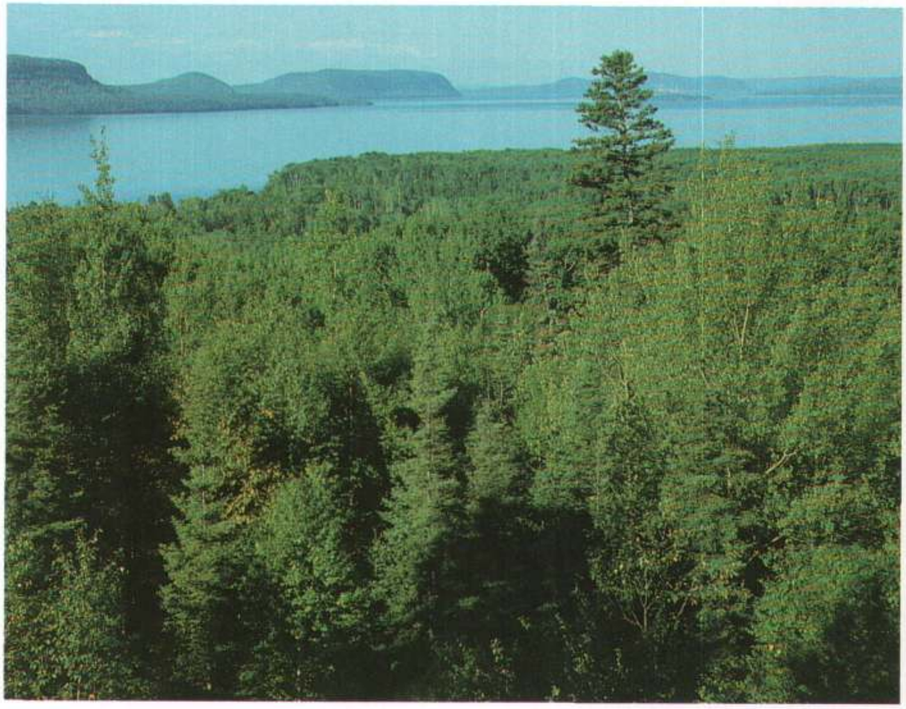


Fig. 14-10 ▶
Boreal and taiga forest: coniferous trees have the following characteristics that allow them to thrive in harsh, northern conditions.
a) They are able to extract nutrients from the poor soil with their long roots.
b) Their sticky sap acts as an anti-freeze that prevents the needles from freezing.
c) Their waxy needles and thick bark prevent the loss of moisture in times of drought.
d) Their needles and flexible branches easily shed snow to prevent damage.
e) Their needles are able to conduct photosynthesis on warm days beyond the normal growing season.

The cool temperatures and the lack of soil organisms, such as bacteria and earthworms, also slow down the process of humus formation.

leaching effect of water, makes these wet-climate soils infertile and unsuitable for agriculture. The northern part of the region is the taiga forest and the southern part is the boreal forest. The taiga forest tends to be less dense than the boreal forest, and has smaller trees that take much longer to grow. The difference between these two areas reflects the colder and drier climate that exists in the northern part of the region.

Coniferous trees have characteristics that make them well-suited to cold temperatures and short growing seasons (Fig. 14-11a). Trees such as white and black spruce, balsam fir, and pine grow sparsely along the northern edge of the boreal and taiga forest, but more densely farther south. They are harvested by pulp and paper and lumbering companies. Some **deciduous trees,** such as poplar and white birch, are hardy enough to withstand the harsh winter conditions in the southern portion of the boreal forest (Fig. 14-11b).

Deciduous trees are also known as broadleaf trees.

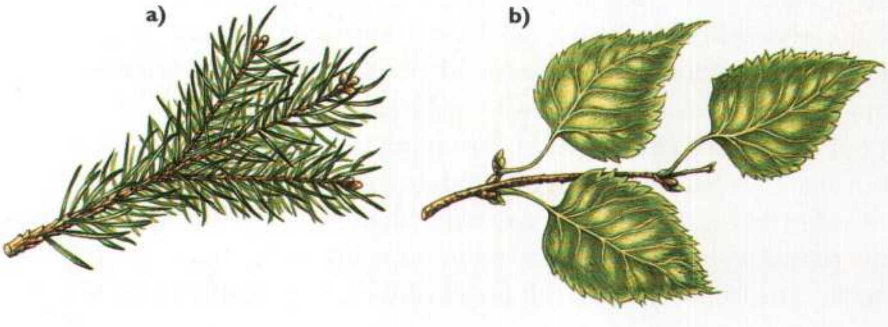


Fig. 14-11 ▶
Typical leaves of coniferous and deciduous trees

MIXED FOREST

South of the boreal and taiga forest in eastern Canada is a **mixed forest** of deciduous and coniferous trees (Fig. 14-12). Maple, beech, ash, oak, and birch are found in the same forest with spruce, fir, pine, cedar, and hemlock. This variety of trees provided an excellent resource for the lumbering industry. Today, little of the forest remains in the southern part of the region because of farming, lumbering, urban development, and transportation routes. Along the exposed coastlines of the Maritime provinces, where the cold winds create a harsher climate, the forest may give way to small shrubs, such as junipers, that grow close to the ground for protection.

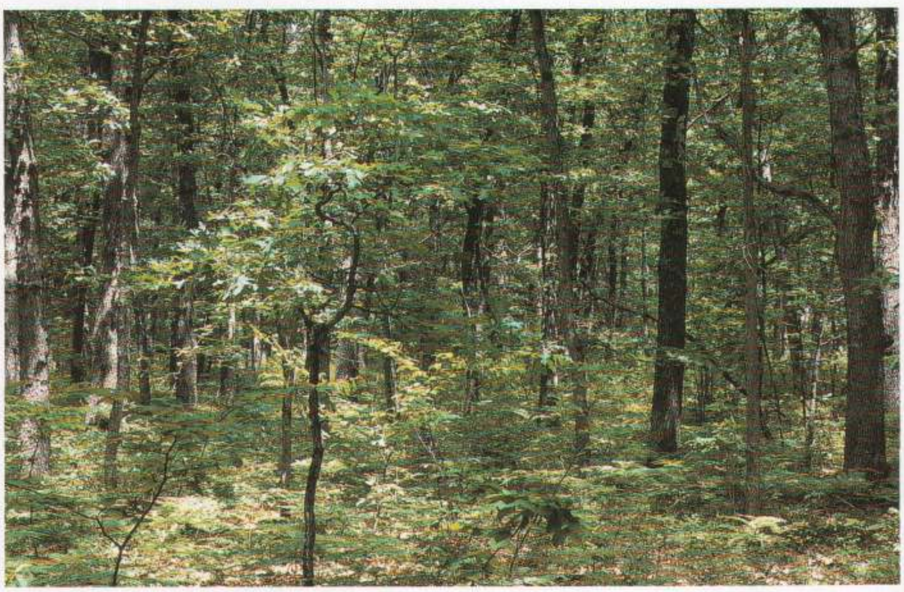
The mixed forest is a transition zone between the boreal and taiga forest to the north and the deciduous forest to the south. Both deciduous and coniferous trees can survive in the warm summers and cool winters. The regular, abundant precipitation in this region is suitable for both deciduous and coniferous trees. The humus created from the leaves of such a wide variety of trees creates deep grey-brown topsoil rich in minerals. Because humus holds water, leaching is less of a problem in the mixed forest than in the boreal and taiga forest. Soils in mixed forest regions are well-suited to farming.

▲ **Fig. 14-12** Mixed forest

When settlers first came to the mixed forest region, it was covered in trees. In order to build roads and farms, the forests had to be cleared. This process was so difficult that the forest was often seen as an enemy that had to be defeated.

DECIDUOUS FOREST

The deciduous forest region in Canada is very small. It is found in southwestern Ontario (Fig. 14-13) and is the northernmost portion of the large deciduous-forest regions of the northeastern United States. Only small remnants of Canada's deciduous forest remain, since most of it has been cleared for farming and urban development.



◀ **Fig. 14-13** Deciduous forest: deciduous trees have the following characteristics.

a) They lose their leaves in the autumn. If they kept their leaves over the winter, the weight of the snow on them might break their branches.
b) They are dormant in winter, but with the warmth of spring, sap flows to the buds and causes new leaves to grow.
c) Most deciduous trees need at least five months with average temperatures above 10°C.

The summers in southwestern Ontario are long and hot, the winters relatively mild, and the precipitation plentiful. These conditions are ideal for **hardwood trees** such as maple, beech, hickory, ash, and black walnut. These trees need at least five months of warm weather to store up energy in the form of sap in their roots and trunk to survive the winter.

hardwood trees
broadleaf deciduous trees that have tough, dense wood, often used for making furniture

The soils of the deciduous forest are similar to those of the mixed forest but contain more humus and are less acidic because of the greater number of deciduous trees. The humus-rich topsoil is dark brown in colour. Some of the soluble nutrients are leached from the topsoil by the abundant rain. Still, they are the most fertile soils of eastern Canada.

GRASSLANDS

When new immigrants first settled on the grasslands, they often made their homes out of sod since few trees were available to make log cabins.

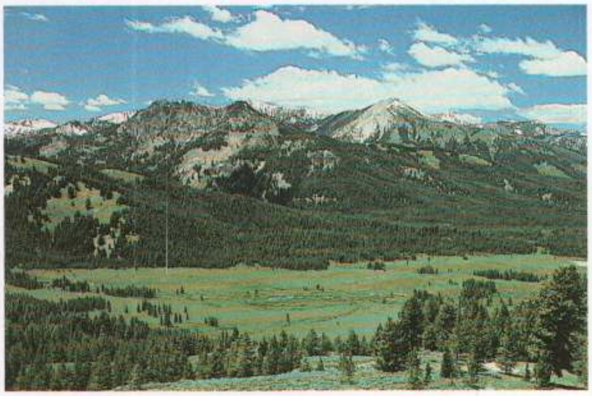
The grasslands, or the prairies, are located in the southern part of Manitoba, Saskatchewan, and Alberta. The climate here is too dry for most species of trees to survive. Some, such as trembling aspen, willow, and spruce, grow in the most eastern part of the region and in river valleys, where more moisture is available. Native grasses, however, are suited to this dry climate. The deep, intertwined root system of the grass forms a **sod mat**. This sod mat absorbs and stores moisture, and holds the soil in place. The grass dies off on the surface if it doesn't find enough water, but its roots remain alive. When moisture becomes available, the grass sprouts again.

The grasslands consist of three sub-regions. The driest areas of southern Saskatchewan and Alberta make up the **short-grass prairie** (Fig. 14-14). **Drought-resistant** short grasses, sagebrush, and cactus are the only types of vegetation that can survive here. The warm, dry climate limits the growth of vegetation, which in turn limits the amount of humus produced in the soil. The limited rainfall and high evaporation have created calcified brown soils. Without irrigation, such areas are unsuitable for most crops. The land can be used for grazing animals.

drought-resistant
able to live with limited amounts of rainfall

▲ **Fig. 14-14** Short-grass prairie vegetation is found in warm, very dry locations.

▲ **Fig. 14-15** Long-grass prairie vegetation is found in warm, dry locations.



▲ **Fig. 14-16** Cordilleran vegetation: from lush forests to barren tundra vegetation

▲ **Fig. 14-17** West Coast forest: a temperate rain forest with the largest trees in Canada

Surrounding the short-grass prairie is a region where increased precipitation encourages the growth of taller grasses (Fig. 14-15). This **long-grass prairie** is ideal for growing grains and **oil seeds**. Year after year as the tall grasses die in the fall, they produce large amounts of humus that result in a rich, black soil. The rainfall is just enough to keep the minerals within easy reach of the grass roots. This is the richest soil in Canada and some of the most productive grain-growing land in the world. Between the warm, dry grasslands and the cooler, wetter boreal forest is the third grassland sub-region, called **parkland**. This is a transition zone of long-grass prairie dotted with clumps of trees.

GeoLit Reminder

When reading visual text:

- Determine the type of visual text.
- Identify elements that stand out,
- How does this image make you feel?
- What is the purpose of this image?
- What additional information do you need to understand this image?

CORDILLERAN VEGETATION

The natural vegetation of the Western Cordillera varies greatly (Fig. 14-16). The variation of vegetation is a result of the wide range of temperatures, rainfall, soils, and elevations throughout the region. Soils of all types are found throughout the Western Cordillera, and account for the variety of natural vegetation in the region, ranging from large coniferous forests in wetter locations to grasses and even cacti in drier areas.

WEST COAST FOREST

Along the west coast of Canada grow lush forests of Douglas fir, Sitka spruce, red cedar, and western hemlock. The heavy rainfall plus the mild climate of the coastal region provide excellent growing conditions for the trees of this **temperate rain forest** (Fig. 14-17). Trees more than a metre in diameter and over 50 metres high are common. These huge trees have played a crucial role in British Columbia's forest industry. Some of the **old-growth forests** have become the focus of environmental groups that wish to protect them. The lush vegetation provides a lot of plant material to make humus, but the high rainfall leaches minerals deep into the soil.

temperate
climate with a range of moderate temperatures, e.g., warm summers and cool winters

rain forest
lush forest in an area with very heavy precipitation

old-growth forest
area of mature forest that has never been cut down

In Closing...

The different vegetation regions in Canada provide us with many products. The coniferous trees of the boreal and taiga forest are the raw materials for pulp, paper, and lumber. Deciduous trees provide wood for eastern Canada's furniture industry. The huge trees of the west coast forest provide lumber for use in Canada and for export. Beef for your next barbecue may come from cattle raised on the short grasses of the western prairies and may be cooked using charcoal from the hardwood trees of eastern Canada.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. Describe the four components that make up a true soil.
2. a) How is topsoil formed?
   b) How long has it taken to form topsoil in Canada?
   c) Why does the topsoil differ in thickness in different parts of Canada?
3. Why is the size of rock particles important to soil structure?
4. Explain the difference between leaching and calcification.
5. In your own words, explain the meaning of the term *natural vegetation*.
6. There are two classes of trees. Which one can survive a harsher climate? Why?
7. Name the Canadian vegetation region that is the
   a) largest
   b) smallest
   c) wettest
   d) coldest
   e) northernmost
   f) southernmost
   g) westernmost
   h) easternmost
8. Explain, in your own words, the term *transition zone*. Give an example of a transition zone so large that it is also considered a vegetation region. Explain why this vegetation region is a transition zone.

THINKING

9. In the Western Cordillera, how is it possible to have leached soils within a few kilometres of calcified soils?
10. Fig. 14-18 shows the relationship between precipitation and soil fertility in temperate latitudes. Copy the graph into your notebook, and mark the following on it:
    a) a brown prairie soil
    b) a lightly leached soil
    c) a black prairie soil
    d) a heavily leached soil
    e) the boundary between wet-climate and dry-climate soils

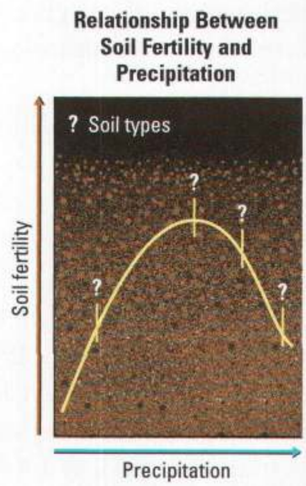


Fig. 14-18 ▶

COMMUNICATION

11. "Natural vegetation is usually quite different from plants that people cultivate for food or for use *in industry*." Explain the differences.
12. "If you climb up a mountain, you will find a similar sequence of vegetation to that you would find if you travelled from southern Canada to the High Arctic." Explain why this is a valid statement.

APPLICATION

13. Copy Fig. 14-19 into your notebook. Complete the chart using the information in this chapter.
14. a) Using Figs. 14-6 and 13-12, page 154, match each *vegetation* region to the corresponding climate region.
    b) The mixed forest and the deciduous forest regions are found in the same climate region. Explain how two vegetation regions can both occur in the same climate region.

▼ **Fig. 14-19**

Vegetation Region	Types of Natural Vegetation	Temperature Characteristics	Precipitation Characteristics	Soil Characteristics
Tundra	shrubs, mosses, lichens, small flowers	cold, short growing season	very little precipitation, most areas less than 400 mm	thin soils, permafrost
Boreal and Taiga Forest				
Mixed Forest				
Deciduous Forest				
Grassland — short grass — long grass — parkland				
Cordilleran Vegetation				
West Coast Forest				

15 Making the Connections: Canada's Ecozones

Key Ideas

This chapter helps you investigate these questions:

- What is an ecozone, and is the ecozone concept useful?
- In what ways do Canadian ecozones differ from one another, and in what ways are they similar?

Key Terms

ecozone

gross domestic product

Ecology is the study of living things and how they relate to each other and the environment.

INTERNET

You can learn more about ecozones through the link at www.pearsoned.ca/makingconnections2.

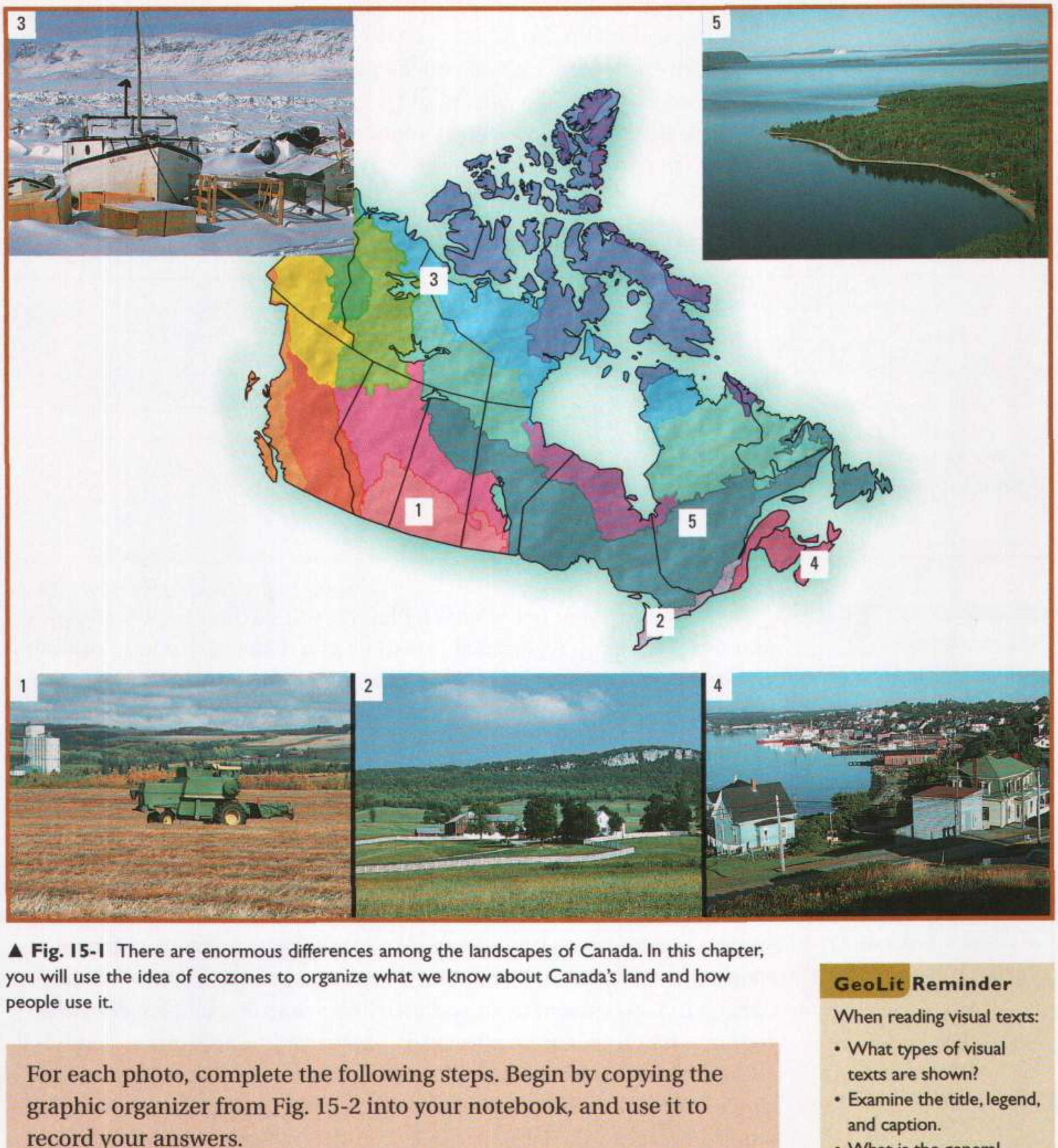
Examine Fig. 15-1. Each photograph shows a different part of Canada. The location of each photo is noted on the map. A quick look at these pictures tells you that Canada is made up of different kinds of terrain that offer special opportunities and challenges to the people who live in them. In previous chapters, you learned about Canada's landforms, climate, soil, geological history, water, and natural vegetation regions. In this chapter, you will see how all these things, together with the activities of people and animals, interact to form new kinds of regions called **ecozones** (short for ecological zones).

An area can be defined as a distinct ecological zone based on the way its landform, climate, soil, geological history, water features, vegetation, wildlife, and human activities are linked together. All these factors are connected in such a way that a change in just one factor will result in change and adjustment in the rest of them. For example, a shift in temperature within an ecozone will affect its plant growth, which in turn will affect the food supply of its animals. Here is another example: an increase in the human population within an ecozone leads to the loss of farmland or forest because people need land for urban uses.

Comparing Regions

terrestrial
having to do with Earth or the land

The photos in Fig. 15-1 represent five of Canada's **terrestrial** ecozones. This exercise will help you understand how Canada's ecozones were determined.



▲ **Fig. 15-1** There are enormous differences among the landscapes of Canada. In this chapter, you will use the idea of ecozones to organize what we know about Canada's land and how people use it.

For each photo, complete the following steps. Begin by copying the graphic organizer from Fig. 15-2 into your notebook, and use it to record your answers.

1. Study the map and photos in Fig. 15-1. Make a mental note of the location of each landscape in relation to major bodies of water and provincial and national borders.
2. Using Fig. 12-5 on page 130, determine the landform region in which each photo was taken.
3. Repeat this process for the climate region (Fig. 13-12 on p. 154), soil region (Fig. 14-5 on p. 163), and natural vegetation region (Fig. 14-6 on p. 163) in which each photo was taken.

GeoLit Reminder

When reading visual texts:

- What types of visual texts are shown?
- Examine the title, legend, and caption.
- What is the general purpose of these visuals?
- How do the visuals compare?
- What do I already know about the topic illustrated by the visual texts?
- What additional information do I need to gather about these visuals?

4. List any human activity you see in each photo.
5. Record any other human activity you think might be common in the region shown in each photo.
6. How do you know that each photo represents a different region?

▼ **Fig. 15-2**

Photo	Landform Region	Climate Region	Vegetation Region	Soil Region	Activities Shown*	Other Activities**
1						
2						
3						
4						
5						

* Human activities shown in the photograph

** Other human activities not shown in the photograph, but that you know occur in this ecozone

The term *bioregion* is often used instead of *ecozone* in other parts of the world, and especially in the United States.

By examining your completed table, you will see that each of these photos represents a region that is distinct as a result of a unique combination of environmental and human factors. Each distinct region is one of Canada's ecozones.

In addition to Canada's 15 terrestrial (land) ecozones, there are 5 marine ecozones that cover the oceans surrounding the country.

Canada's Ecozones

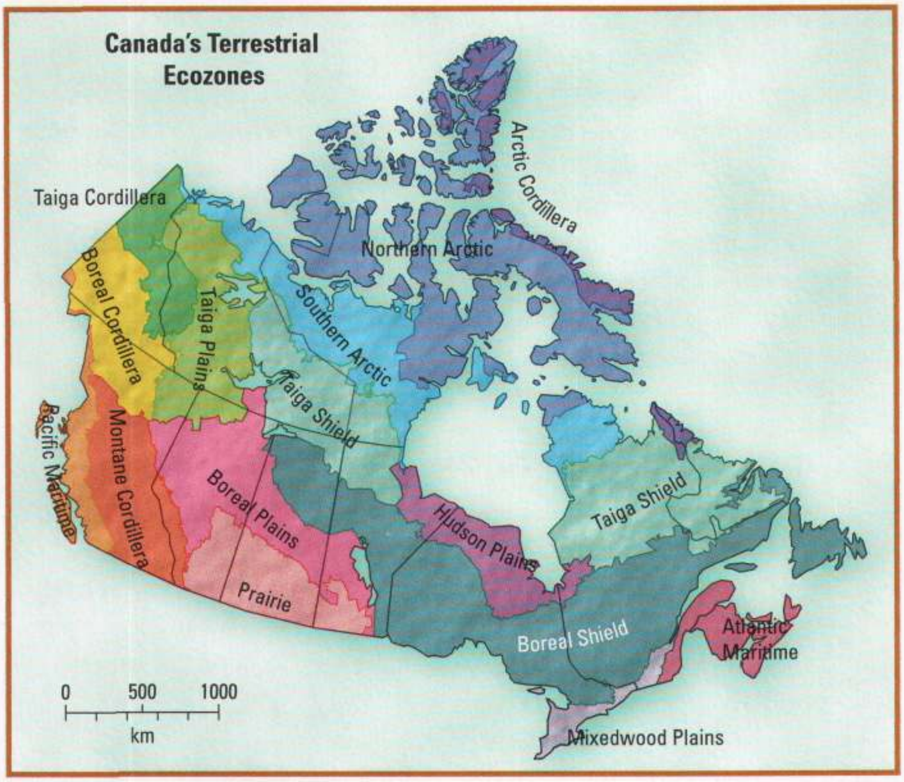
Canada has an almost infinite number of different natural environments. Geographers faced the problem of grouping these natural environments together to create a manageable number of ecozones. If too few zones were created, any given zone would have too many different environments within it. If too many ecozones were created, it would be difficult to keep track of them and their characteristics. Fifteen terrestrial ecozones for Canada were selected as a reasonable **compromise** (Fig. 15-3).

compromise
solution that balances opposing sides or demands

Ecozones may differ in some of their characteristics, but they may be similar in others. For example, let's compare the Boreal Shield ecozone and the Mixedwood Plains ecozone (Fig. 15-4). We can see significant differences in landform, climate, and human activities. In regard to their soils, however, there is no difference.

Ecoregions, ecoprovinces, and ecodistricts are even smaller areas that can be used to examine Canada in more detail.

When geographers began to establish Canada's ecozones, they considered many factors in order to determine the boundaries between ecozones. In certain cases, some factors were more important than others in determining these boundaries. For example, in the Northern and Southern Arctic ecozones, climate was an important factor in determining where the boundaries would be drawn. The climate is noticeably colder in



◀ **Fig. 15-3** Canada's terrestrial ecozones

Factor	**Boreal Shield**	**Mixedwood Plains**
Landforms	Canadian Shield	Great Lakes Lowlands
Climate	Boreal region	Southeastern region
Vegetation	Evergreen and mixed forest	Deciduous and mixed forest
Soils	Wet climate, leached soils	Wet climate, leached soils
Wildlife (examples only)	Moose, black bear, lynx, boreal owl, woodland caribou	Raccoon, skunk, great blue heron, grey squirrel
Human activities	Forestry, mining, trapping	Agriculture, urbanization

▲ **Fig. 15-4** The Mixedwood Plains and Boreal Shield ecozones are next to each other, yet are very different in many ways.

the area that became the Northern Arctic ecozone and clearly distinguished one ecozone from the other. Human activities, on the other hand, were not an important factor in distinguishing one ecozone from the other because they are similar in both regions.

Why Ecozones Are a Useful Idea

The first map of Canadian ecozones was published in 1986. Before then, people had a tendency to keep environmental and human information about any one particular area separate. They did not usually examine the relationships that existed between the physical, biological, and human features within a specific area. This situation changed when the concept of the ecozone allowed people to bring together all the different environmental and human factors in each unique region in Canada, and to study the links among them. This book is called *Making Connections: Canada's Geography* to remind you of the importance of the links or "connections" between all of Canada's geographic characteristics.

In this chapter, we concentrate primarily on the physical characteristics of Canada's 15 terrestrial ecozones. Later in the book, we will look at human aspects of Canadian life and geography to add to our knowledge about each ecozone.

A Tour of Canada's Terrestrial Ecozones

Canada's terrestrial ecozones are described in the following section. You should start your tour of Canada's ecozones with the one in which you live. Then, gradually move outward from your neighbouring ecozones to more distant ones. The more distant ones may be very different from your own. By using this approach, you will be able to compare other ecozones to the one you know best.

A NOTE ABOUT THE DATA IN THE ECOZONE CHARTS

In the charts that follow, "growing season" is the average number of days per year when the average temperature is more than 5°C. Total population statistics for each ecozone are from 2001 unless otherwise indicated. GDP, which stands for **gross domestic product** and represents the value of all economic production in the ecozone, is given in 1991 figures. Unfortunately, while the ecozone concept has proven useful in understanding Canadian geography, it has not "caught on" with agencies, such as Statistics Canada, that are responsible for collecting and publishing numerical data. However, while GDP for each ecozone has changed since the 1991 data was recorded, the relationship between the ecozones with regard to GDP has not changed very much. In other words, the Atlantic Maritime ecozone still has a GDP greater than the Taiga Cordillera or Boreal Cordillera ecozone, but less than the Boreal Shield or Mixedwood Plains ecozones.

Mixedwood Plains Ecozone:
(Area 107 017 km²)

Landforms: Plains and rolling hills; Great Lakes are an important feature

Climate: Cool, short winters (-7°C); relatively long, mild summers (20°C); precipitation 700 to 1000 mm; growing season 180 to 260 days

Vegetation: Coniferous (white pine, eastern hemlock, red pine) mixed with deciduous (sugar maple, red oak, basswood); little natural vegetation remains

Soils: Leached, wet-climate soils

Human Activities: Total population 15 631 830; GDP $325.2 billion; urbanization, manufacturing, agriculture, recreation

Major Urban Areas: Toronto (2004: 5 203 600), Montreal, Ottawa, Quebec, Hamilton, Windsor, London

Atlantic Maritime Ecozone:
(Area 192 017 km²)

Landforms: Hills and coastal plains

Climate: Long, mild winters (-4°C); moderately warm summers (17°C); precipitation 1000 to 1400 mm; growing season 180 to 210 days

Vegetation: Coniferous (white pine, red spruce, red pine) mixed with deciduous (sugar maple, red oak, yellow birch)

Soils: Leached, wet-climate soils

Human Activities: Total population 2 537 685; GDP $39.9 billion; forestry, agriculture, fishing, tourism, urbanization

Major Urban Areas: Halifax (2004: 379 800), Fredericton, Saint John, Charlottetown

Boreal Plains Ecozone:
(Area 668 664 km²)

Landforms: Level to gently rolling plains

Climate: Long, cold winters (-20°C); short, warm summers (17°C); precipitation 450 mm; growing season 130 to 165 days

Vegetation: Coniferous forests (white spruce, black spruce, balsam fir, Jack pine, and tamarack) mixed with deciduous (aspen, poplar, and white birch); extensive marsh areas

Soils: Rich soils formed under forests; marsh soils in some areas

Human Activities: Total population 771 205; GDP $13.7 billion; forestry, farming, tourism, oil and gas development

Major Urban Areas: Hinton (9405), La Ronge, The Pas, Flin Flon, Peace River, Fort Smith

Boreal Shield Ecozone:
(Area 1 640 949 km²)

Landforms: Plains and low hills of the Canadian Shield

Climate: Long winters (-15°C); short summers (17°C); precipitation 400 to 1000 mm; growing season 130 to 190 days

Vegetation: Coniferous (black spruce, white spruce, Jack pine, balsam fir) mixed with deciduous (yellow birch, sugar maple, black ash)

Soils: Heavily leached soils; bare rock; swampy areas

Human Activities: Total population 2 821 808; GDP $49 billion; forestry, mining, tourism, recreation, trapping

Major Urban Areas: St. John's (2004: 179 900), Chicoutimi, Sudbury, Sault Ste. Marie, Thunder Bay, Thompson

Prairie Ecozone:
(Area 443 159 km²)

Landforms: Flat to rolling plains

Climate: Moderately long, cold winters (-15°C); moderately warm summers (18°C); precipitation 250 to 700 mm; growing season 170 to 190 days

Vegetation: Short-grass prairie in drier areas; long-grass prairie in wetter areas; some trees; little natural vegetation remains

Soils: Rich, grassland soils

Human Activities: Total population 4 222 569; GDP $90.8 billion; agriculture, urbanization, oil and gas development

Major Urban Areas: Edmonton (2004: 1 001 600), Calgary, Winnipeg, Regina, Saskatoon

Montane Cordillera Ecozone:
(Area 474 753 km²)

Landforms: Mountains, plains and plateaus

Climate: Temperatures vary with latitude and elevation; moderate winters (-12°C); moderate summers (15°C); precipitation varies widely with elevation and physical aspects, 500 to 1000 mm; growing season 140 to 240 days

Vegetation: Enormous variations depending on elevation; dominated by coniferous (Engelmann spruce, ponderosa pine, Douglas fir)

Soils: Wide variety of mountain soils

Human Activities: Total population 859 134; GDP $14 billion; forestry, agriculture, tourism

Major Urban Areas: Kamloops (77 281), Prince George, Penticton

Pacific Maritime Ecozone:
(Area 196 200 km^2)

Landforms: Mountains with small areas of coastal plains

Climate: Mild winters (3°C); cool summers (15°C); precipitation 600 to 2000 mm; growing season 200 to 260 days

Vegetation: Varies with elevation; coniferous trees (western red cedar, Douglas fir, western hemlock, Sitka spruce)

Soils: Wide variety of mountain soils

Human Activities: Total population 3 027 206; GDP $58.2 billion; forestry, urbanization, agriculture, fish processing, tourism, recreation

Major Urban Areas: Vancouver (2004: 2 160 000), Victoria, Prince Rupert

Boreal Cordillera Ecozone:
(Area 459 864 km^2)

Landforms: Mountainous, some hills

Climate: Long, cold winters (-20°C); short, cool summers (12°C); very dry, precipitation 300 to 500 mm; growing season 125 to 150 days

Vegetation: Mainly coniferous (white spruce, subalpine fir)

Soils: Variety of mountain soils

Human Activities: Total population 30 690; GDP $0.9 billion; hunting, trapping, forestry, tourism, mining

Major Urban Areas: Whitehorse (19 058), Dawson

Taiga Cordillera Ecozone:
(Area 264 213 km^2)

Landforms: Mountainous

Climate: Long, cold winters (-24°C); short, cool summers (13°C); very dry, precipitation 250 to 400 mm; growing season 90 to 130 days

Vegetation: Tundra of all types; areas of scattered forest

Soils: Variety of poor-quality soils; bare rock

Human Activities: Total population 370; GDP $0.005 billion; hunting, trapping, forestry, tourism

Major Urban Areas: Old Crow (299)

Taiga Plains Ecozone:
(Area 569 363 km^2)

Landforms: Interior plains and some foothills

Climate: Long, cold winters (-23°C); short, cool summers (12°C); dry, precipitation 200 to 400 mm; growing season 80 days to 150 days

Vegetation: Open forest to dense forest (black spruce, white spruce, Jack pine, tamarack, paper birch, trembling aspen)

Soils: Continuous permafrost in north; scattered permafrost further south; wide variety of poor quality soils

Human Activities : Total population 20 726; GDP $0.5 billion; hunting, trapping, tourism, oil and gas development, agricultural

Major Urban Areas: Hay River (3510), Inuvik, Fort Simpson

Taiga Shield Ecozone:
(Area 1 122 504 km^2)

Landforms: Plains and hills of Canadian Shield

Climate: Moderately long, cold winters (-25°C); moderately short, cool summers (12°C); precipitation 300 to 900 mm; growing season 100 to 140 days

Vegetation: Black spruce, Jack pine, paper birch, trembling aspen

Soils: Thin, highly leached soils; bare rock

Human Activities: Total population 38 116; GDP $1.1 billion; tourism, mining, hunting, trapping

Major Urban Areas: Yellowknife (16 541), Uranium City, Happy Valley-Goose Bay

Hudson Plains Ecozone:
(Area 359 546 km^2)

Landforms: Low-lying, swampy plains

Climate: Moderately long, cold winters (-17°C); moderately short, cool summers (14°C); precipitation 400 to 700 mm; growing season 90 to 150 days

Vegetation: Ground-hugging tundra; increasingly dense forest in south (white spruce, black spruce, tamarack, Jack pine)

Soils: Scattered permafrost; poorly developed organic and permafrost soils

Human Activities: Total population 9530; GDP $0.1 billion; hunting, trapping, recreation

Major Urban Areas: Moosonee (936), Churchill, Attawapiskat

Southern Arctic Ecozone:
(Area 702 542 km^2)

Landforms: Plains and hills of Canadian Shield

Climate: Long winters (-25°C), short, cool summers (10°C), dry, precipitation 200 to 300 mm; growing season 80 days

Vegetation: Tundra, including shrubs

Soils: Permafrost everywhere; tundra soils, bare rock

Human Activities: Total population 14 470; GDP $0.15 billion; hunting, trapping, tourism, mineral development

Major Urban Areas: Rankin Inlet (2177), Tuktoyaktuk, Povungnituk

Northern Arctic Ecozone:
(Area 1 371 340 km^2)

Landforms: Plains and upland areas

Climate: Long winters (-30°C), short summers (5°C); precipitation 200 mm; growing season 50 days

Vegetation: Tundra; ground-hugging plants

Soils: Permafrost; tundra soils

Human Activities: Total population 20 451; GDP $0.38 billion; hunting, tourism, some mining

Major Urban Areas: Iqaluit (5236), Cambridge Bay, Resolute

Arctic Cordillera Ecozone:
(Area 234 708 km^2)

Landforms: Innuitian Mountains

Climate: Long winters (-40°C), short summers (0°C); precipitation less than 200 mm; virtually no growing season

Vegetation: Mostly no vegetation; tundra

Soils: Permafrost; tundra soils; bare rock

Human Activities: Total population 1304; GDP $0.012 billion; hunting, tourism

Major Urban Areas: Pond Inlet (1220), Clyde River, Broughton Island

In Closing...

By dividing Canada's land mass into 15 unique ecozones, geographers have made Canada's geography more understandable. Within each ecozone, you can see the cause-and-effect relationships that exist among physical, biological, and human factors. You can also see that ecozones are dynamic in nature: they change as the environment and human activities change within them.

Most of the features that help define an ecozone are natural—the landforms, water, climate, soil, vegetation, and wildlife—but remember that human activities also play a role in setting the boundaries and making each ecozone unique.

QUESTIONS

KNOWLEDGE AND UNDERSTANDING

1. a) What is an ecozone?
   b) Describe the two characteristics of the ecozone concept that make it a useful way to study Canada.
2. Which ecozones list tourism or recreation as a major human activity? How would the kind of tourism/recreation vary in different ecozones?

THINKING

3. a) What is the GDP of an ecozone?
   b) Create a pie graph to show the distribution of Canada's GDP among the ecozones. (Instructions for creating pie graphs are given in Chapter 8.) What does this graph tell you about the location of most of Canada's economic activities?
   c) Rank the ecozones separately from highest to lowest according to
      i. GDP
      ii. area
      iii. population
   d) What relationship do you see between GDP and area?
   e) What relationship do you see between GDP and population?
4. Examine the growing seasons found in each ecozone. In what ecozones would you expect to find most of Canada's agricultural activities?
5. a) Ecozone boundaries exist for various combinations of three major factors: landform boundaries, climate/vegetation/soil boundaries, and human activity locations. Examine Fig. 15-5, where boundaries are identified on the map. The general reason for each ecozone boundary is suggested. For each, give the specific reason for the boundary.
   b) Choose any two other ecozone boundaries and explain why they exist.

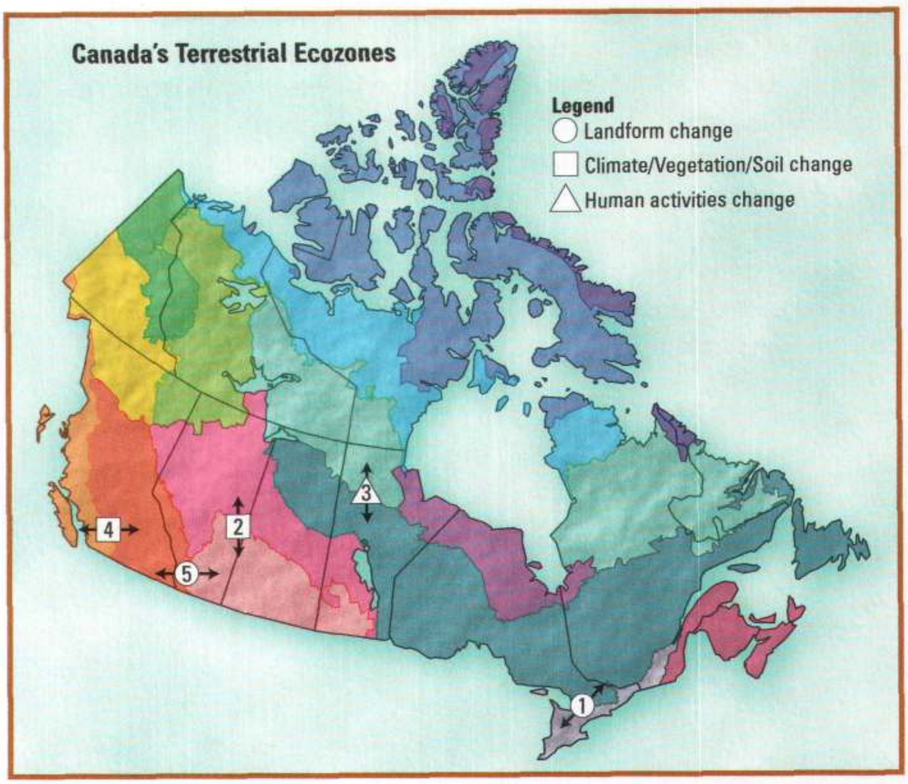


Fig. 15-5 ▶ Canada's terrestrial ecozones

6. In this chapter, you learned about the usefulness of ecozones in helping us to understand and explain Canada's geography. Consider how this would apply in each of these cases:
   a) solving environmental problems
   b) planning how a natural resource should be developed
   c) planning a family holiday trip

COMMUNICATION

7. Complete either Question 7a) or 7b):
   a) If you live in a highly populated ecozone, which lightly populated ecozone would you like to
      i. live in? ii. visit?
      Give reasons for each choice.
   b) If you live in a lightly populated ecozone, which highly populated ecozone would you like to
      i. live in? ii. visit?
      Give reasons for each choice.
8. In most previous studies of Grade 9 Canadian Geography, the four ecozones Taiga Cordillera, Boreal Cordillera, Montane Cordillera, and Pacific Maritime would have been included in one region called the Western Cordillera. Compare the population densities of these four ecozones (see Fig. 15-6). How does this illustrate the difficulty of choosing just the right number of regions?

APPLICATION

9. a) The population density of each ecozone is shown in Fig. 15-6. Divide these values into four categories on the basis of where you think "natural breaks" occur, for example, between the Mixedwood Plains and the Atlantic Maritime. You do not have to have an equal number of ecozones in each group.
   b) On a base map of ecozones that your teacher will supply, shade each category differently. It will be most effective if you use four different shades of one colour rather than four different colours. For example, you may want to use four shades of red. Always use the darkest shade for the highest value.
   c) Be sure to include a legend and suitable title for your map.

▼ **Fig. 15-6**

Ecozone	Population Density, 2001 (people/km^2)
Arctic Cordillera	0.56
Atlantic Maritime	1321.60
Boreal Cordillera	6.67
Boreal Plains	115.34
Boreal Shield	103.31
Hudson Plains	2.65
Mixedwood Plains	14 606.81
Montane Cordillera	180.96
Northern Arctic	1.49
Pacific Maritime	1542.92
Prairies	952.83
Southern Arctic	2.06
Taiga Cordillera	0.14
Taiga Plains	3.64
Taiga Shield	3.40

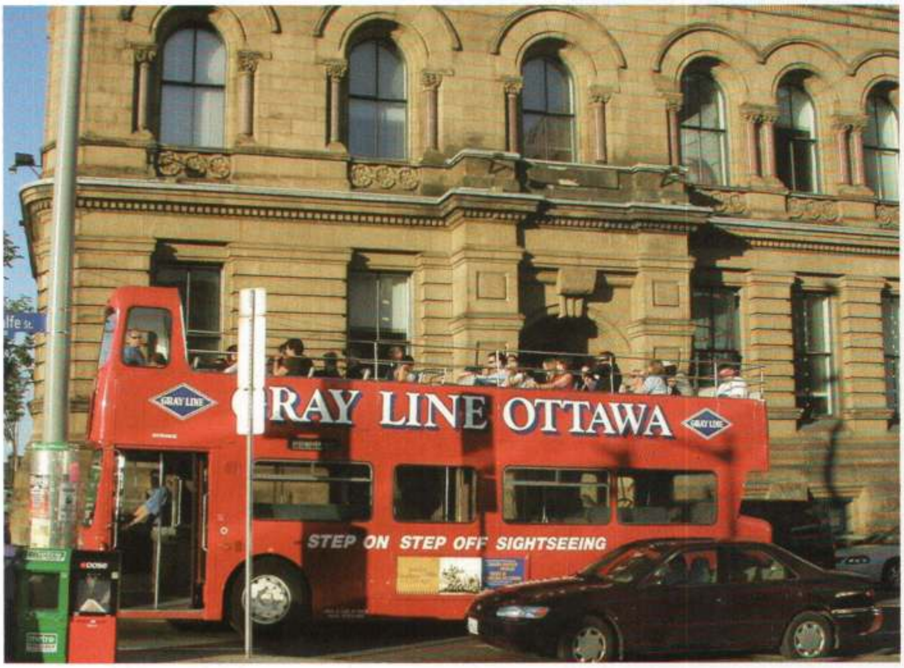
   d) Comment on the pattern of population density that you see. Remember that Canada's overall population density is about 3 people per square kilometre.

   Question 9 can also be done using ArcView GIS software. Your teacher will give you instructions on how to do this.

10. a) Collect information about your local ecozone through personal observations; interviews with teachers and local experts; and visits to museums, conservation areas, and wildlife organizations. Put this information in an organizer under the headings: Landform, Climate, Vegetation, Wildlife, and Human Activities.
    b) Choose three other ecozones in different parts of the country. Draw an organizer using the same headings as 10a). In what ways are the four ecozones similar? In what ways are they different?
    c) Choose one of the four ecozones. How do climate and landforms affect the types of wildlife, vegetation, and human activity found there?

Destination: Canada!

Fig. CA3-1 ▶

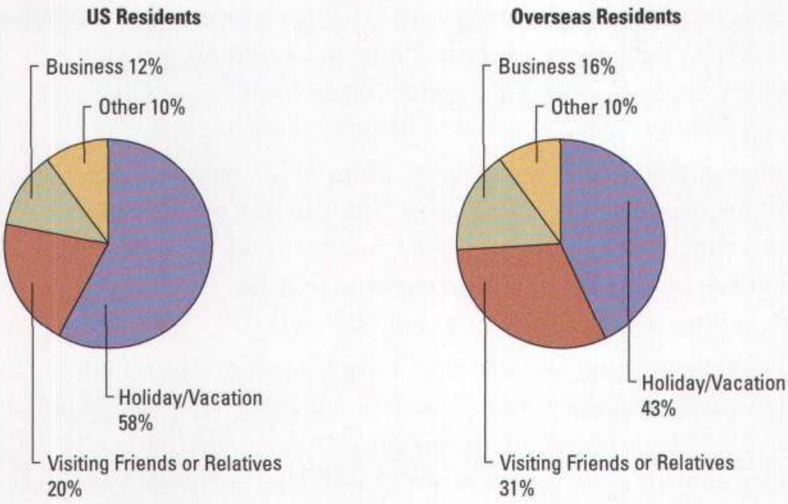


Background

Have you recently travelled within Canada or to another country? If so, the money you spent on accommodations, food, tourist attractions, and even souvenirs contributed to a major global industry. Here are some facts about the tourist industry.

- International tourism spending in 2004 was about $735 billion.
- In Canada, tourists spent roughly $57.5 billion in 2003. Canadians account for about two-thirds of this spending.
- More than 190 000 businesses in every province and territory are involved in the tourist industry. These businesses employ about 1.6 million Canadians directly or indirectly.
- About 39 million international visitors travelled to Canada in 2004. Roughly 80% of these were American. The United Kingdom, France, Germany, Japan, and Australia are the top five sources of tourists after the United States.

Fig. CA3-2 shows the main reasons for the visits by Americans, and by other foreign tourists. Fig. CA3-3 shows the top 10 activities visitors to Canada participated in.



◀ **Fig. CA3-2** Distribution of international tourists to Canada by purpose, 2003

	US Residents %*	Overseas Residents %*
Shopping	62	87
Sightseeing	51	75
Participating in sports/outdoor activities	32	32
Visiting friends or relatives	31	59
Visiting a historical site	28	39
Visiting a national or provincial nature park	23	47
Going to a bar or night club	23	33
Visiting a museum or art gallery	21	37
Attending cultural events	11	14
Visiting a zoo, aquarium, botanical garden	11	27

*More than one activity may be participated in while on a trip.

◀ **Fig. CA3-3** Top activities participated in by international tourists to Canada, 2003

What attracts millions of Canadians and international travellers to visit this country? If you could visit any region of Canada, which region would you choose? If you were a travel operator, how would you promote your choice of Canadian destination? Completing the activity below will help you answer these questions.

Activity

1. Your first task is to decide which ecozones of Canada you would like to visit. Begin by reviewing Fig 15-3, the ecozones map on page 175. Using what you have learned in this unit about Canada's landforms, climate, soil, and vegetation, choose three ecozones that you would like to visit. Review the Tour of Canada's Terrestrial Ecozones information in

Ecozone information is also available at links found at: www.pearsoned.ca/makingconnections2.

GeoLit Reminder

When writing your travel summary:

- Review the instructions.
- Organize gathered information about your selected travel destination.
- Support main activities and attractions with gathered information and images.
- Conclude your summary with an informational paragraph promoting your travel destination.
- Review and edit your work.

Chapter 15 for a summary of your ecozones' features. Then check out Web sites such as www.travelcanada.ca, or resources at your school library or local government tourist office for information about recreational and cultural activities in your selected regions.

2. Once you have gathered all your information, complete Fig. CA3-4 to help you analyze and evaluate the information you gathered. Include at least three items in the "positive," "minus," and "interesting" columns for each of your regions. Remember to note down your reasons for including each item in the column you select.
3. Using the information recorded in Fig. CA3-4, decide on one ecozone for your Canadian tourism destination. Explain why your location will attract visitors from Canada and around the world. What physical features contribute to your region's appeal? How do the physical features of the ecozone you chose affect the recreational and cultural activities available?
4. Now that you have selected a tourism destination in Canada, it is time for promotion! Create a one-page travel summary of your tourism destination that will attract visitors to your destination. Your summary should include:
   - an eye-catching logo and title for your destination
   - a sketch map of the location of your destination
   - point-form descriptions of the natural and human characteristics of your destination
   - an outline of the main activities and attractions for your destination
   - "sensitive tourist" suggestions so that visitors can minimize their impact on the local environment and community
   - additional images, visuals, or drawings to highlight your destination
5. As part of a Web site promotional campaign, write an informational paragraph that concisely describes your tourism destination and encourages people to visit.
6. With your classmates, set up a travel operators' forum, where each of you can display your ad and talk about why you believe your region represents a good tourist destination.

	Positive	**Minus**	**Interesting**
e.g., Northern Arctic	Beautiful and unusual scenery	Hard to get to	For its portion of the ecozone, Nunavut has the slogan "untamed, unspoiled, undiscovered."

▲ **Fig. CA3-4** Positive–Minus–Interesting Organizer