

A billion years of history...

Geoscape Montréal

The St. Lawrence River and Mount Royal form nature's backdrop to the city of Montréal. Both played key roles in its founding and growth. In the river, the Lachine Rapids, which once blocked the progress of explorers seeking a passage to the Northwest, churn over the underlying resistant rock. And Mount Royal must have afforded the first inhabitants a natural lookout from which to observe the surrounding region. This hill, which gave its name to the city, is a remarkable geotourism attraction, offering a full view of the surrounding geological panorama: the broad St. Lawrence Plain, the Monteregian Hills to the east, the Laurentian Plateau to the north, the first hint of the Appalachians to the southeast, and the Adirondack Mountains to the south. In just over 350 years, the Montréal region has become the largest inland port in the world, a major international metropolis, and an important high-technology centre.



Water in Montréal

The St. Lawrence River, majestic gateway to a continent, is an integral part of the landscape of Montréal.

Once upon a time...



A group of remarkable hills

Is Mount Royal, that peaceful haven and treasured part of our heritage, really an ancient volcano?



Historical links in stone

From the first stone buildings of the seventeenth century, to the skyscrapers of today, some of which rival Mount Royal in height.

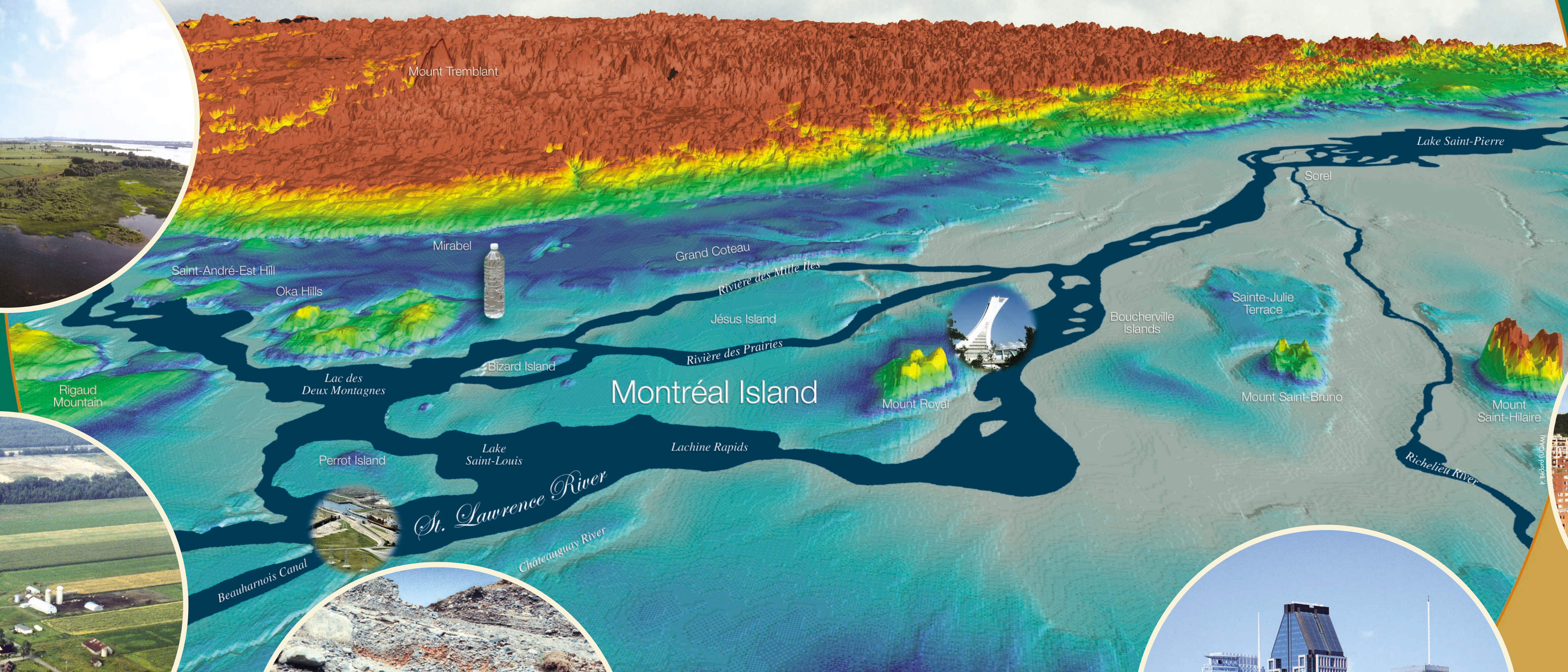


A geological heritage to discover

Ten thousand years ago, the Monteregian Hills emerged from the sea: like the pages of a book, the sedimentary layers on the slopes of Mount Saint-Hilaire tell the story of the past.



Gravel pit at Mount Saint-Hilaire: Champlain Sea sands and gravels.



Montréal and its islands

The Boucherville Islands, at the doorway to the city, are a pastoral park in the middle of the river.



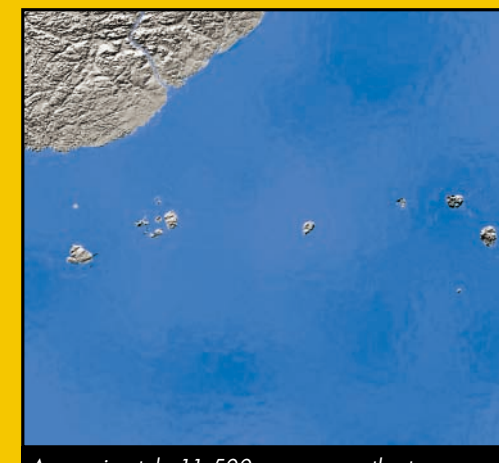
A broad clay plain that is a remnant of the Champlain Sea is the setting for a number of large farms.

The soil yields its harvest

Montréal and its islands

The Montréal region is known for the many islands that dot the St. Lawrence River, the Rivière des Prairies, and the Rivière des Mille Îles. But did you know that Montréal, Jésus, and Perrot islands, the largest in the metropolitan area, gradually rose out of the water as the land rebounded after the invasion of the Champlain Sea?

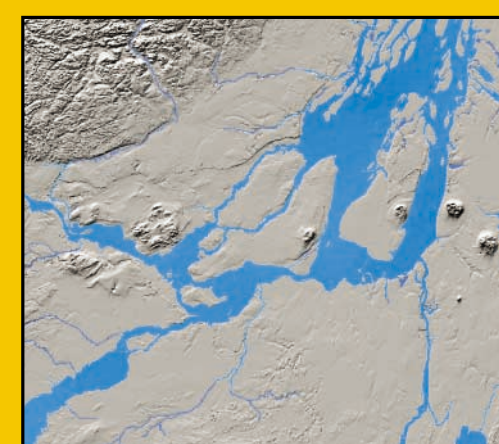
DIFFERENT PROCESSES GIVE RISE TO DIFFERENT SHAPES



Approximately 11 500 years ago, the tops of the Monteregian Hills emerged from the Champlain Sea. Then, as the continent gradually rebounded, the islands formed by the hills grew larger and larger.



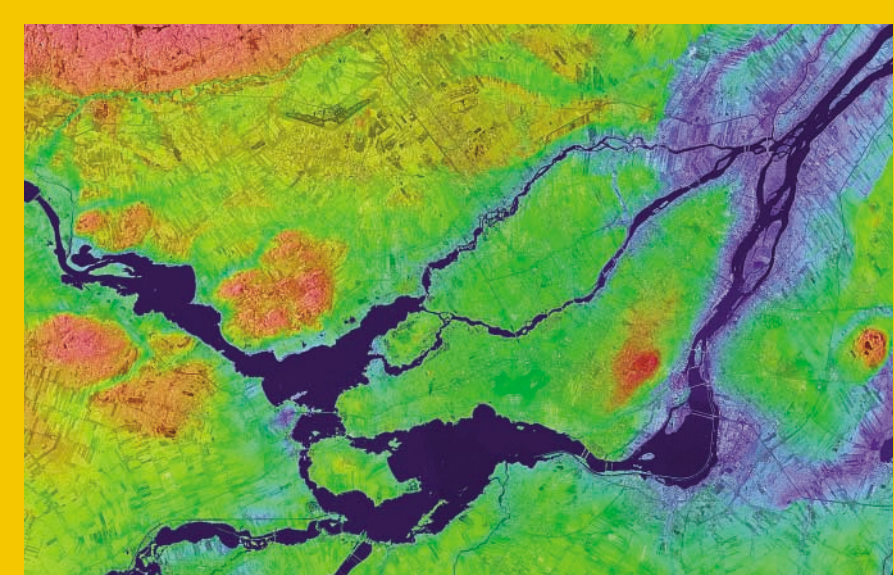
About 9000 years ago, the development of the first channels in the clays marked the transition from a marine to an estuarine environment. The rivers emptied into a body of water that was shrinking in size.



Jésus and Montréal islands as well as the Sainte-Hélène Islands emerged from the water 6000 years ago. The channels of lacrosse cut through glacial sands. The residual lake continued to shrink.



Today, the islands and a few shallow lakes, including lac des Deux Montagnes, Lake Saint-Louis, and Lake Saint-Pierre, are an integral part of the landscape of the Montréal region.



A SATELLITE VIEW OF MONTRÉAL

Satellite imagery helps us interpret the landscape. The high areas of the Laurentians and the Monteregian Hills appear red, whereas the lowlands or terraces, which are at lower altitudes, are depicted in ochre, green, and blue.

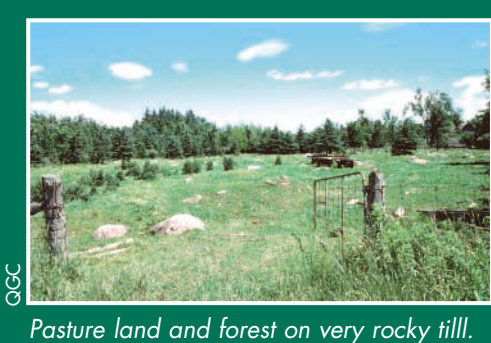
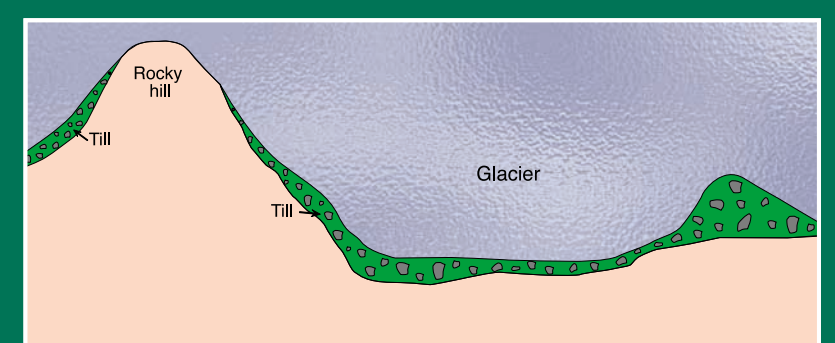
The soil yields its harvest

The rich farmland of the Montréal lowlands owes its existence to deposits left behind after the most recent glaciation and to the subsequent marine incursion known as the Champlain Sea and the bodies of water that succeeded it. In any given climate, soil formation is a function of the types of materials responsible for its development. Bedrock and till are poorly drained, contain little organic material, and are characterized by an abundance of surface stones and boulders; these materials do not generate the same type of soil as fine, easily worked sediment and support different crops.

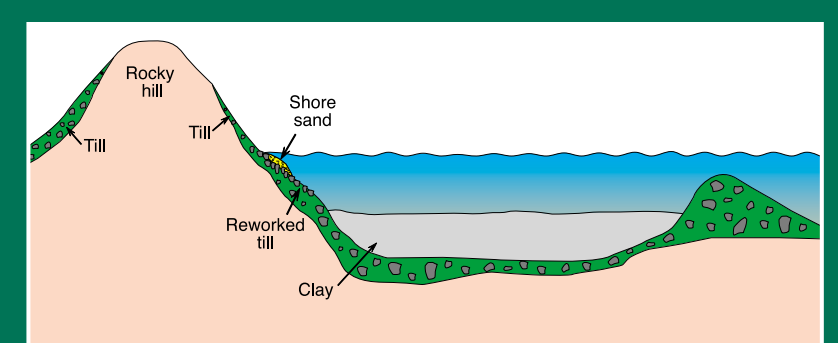
FROM THE ICE AGE TO THE PRESENT DAY: THE STORY OF SOIL FORMATION

In general, today's crops are an accurate reflection of the main types of deposits first laid down over 20 000 years ago. A practised eye can deduce certain facts about the recent geological history of a region by looking at the crops in the fields.

Relatively unaltered bedrock is not conducive to growing crops and is dominated by forest vegetation. Although glacial till is difficult to cultivate because it consists of sand and clay mixed with stones, it produces beautiful sugar bushes and pasture land. The first European immigrants commonly used this type of land as a source of firewood or cleared it to pasture their animals. Farmers who clear stones from their fields know that this is a never-ending task! New stones surface every spring, particularly after a period of intense freeze-thaw cycling.



Pasture land and forest on very rocky till.

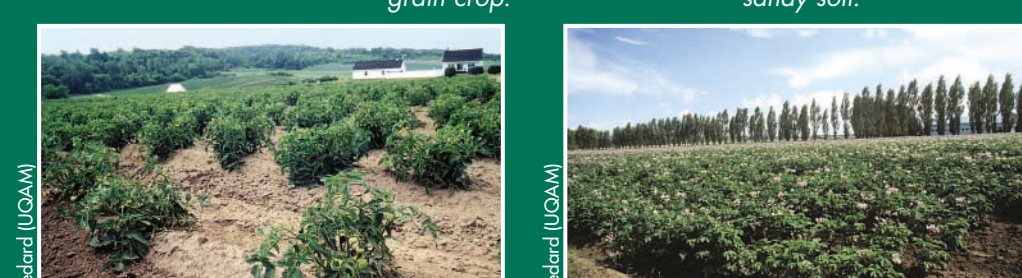


Growing apples on gravelly sandy soil.

After the glaciers melted, the waves of the Champlain Sea sorted the materials left behind, removing fine particles of sand and clay. The finest particles were carried offshore and deposited as clay, whereas the sands and gravels accumulated along the shorelines. Soil that develops on these sands and gravels is ideal for growing apple trees.



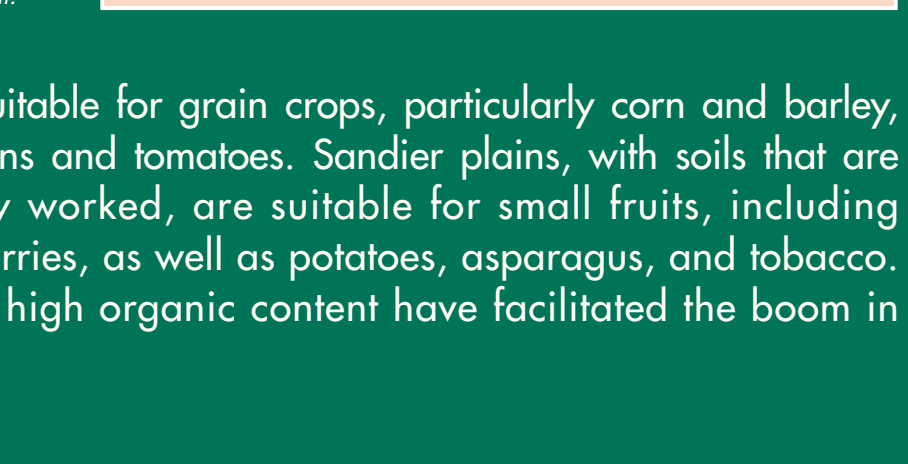
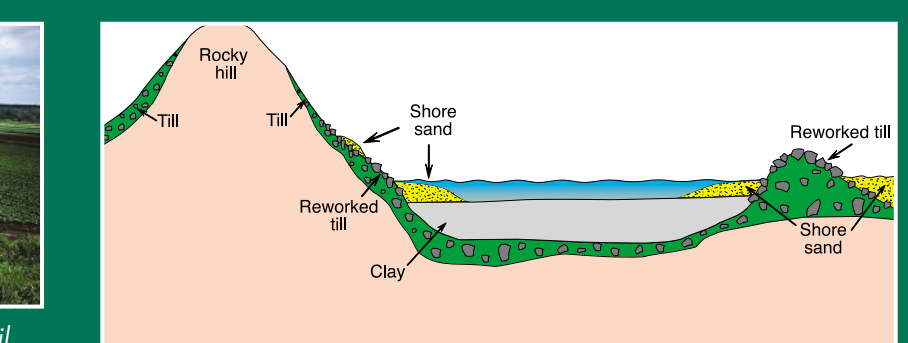
Corn in sandy silt soil. Barley — an attractive grain crop. Asparagus likes sandy soil.



Tomatoes in clay soil. A potato field bordered by a poplar windbreak.



Market gardening in black organic soil.



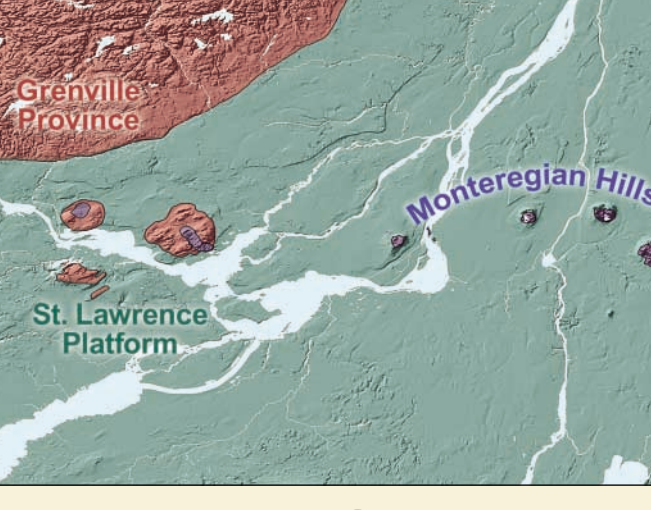
A potato field bordered by a poplar windbreak.

Heavy clay plains are suitable for grain crops, particularly corn and barley, and for growing soybeans and tomatoes. Sandier plains, with soils that are lighter and more easily worked, are suitable for small fruits, including strawberries and raspberries, as well as potatoes, asparagus, and tobacco. Finally, black soils with high organic content have facilitated the boom in market gardening.

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A geological heritage to discover

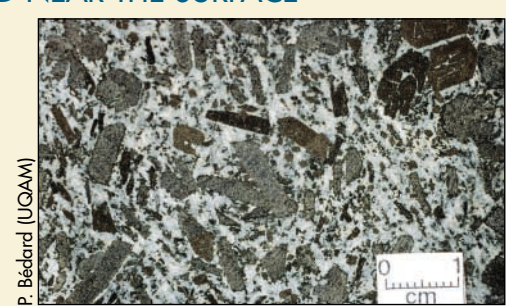


A group of remarkable hills

IS MOUNT ROYAL AN ANCIENT VOLCANO?
Contrary to popular belief, Mount Royal is not an ancient volcano that is now extinct. This misconception has arisen because of the shape of the hill. Mount Royal and some other Monteregian Hills have central depressions, many of which are occupied by a lake such as Lac des Castors on Mount Royal and Hertel Lake on Mount Saint-Hilaire. But these lakes are not crater lakes, and the rock that forms these hills is not volcanic!

MAGMA SOLIDIFIED NEAR THE SURFACE

One hundred and twenty-five million years ago, magma from depths of several tens of kilometres started to move toward the surface along fracture zones in the rock. As it cooled and crystallized, its ascent toward the surface was halted.

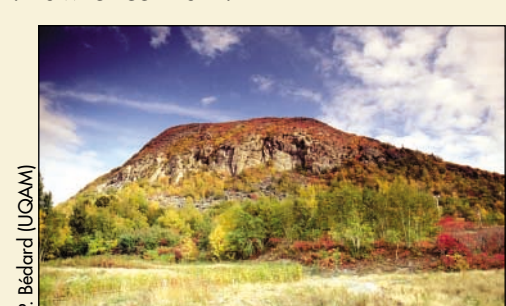


The rock that forms the heart of Mount Royal contains large black crystals of augite, a variety of pyroxene, proof that it cooled slowly.

When they solidified, the igneous rocks were still several kilometres below the surface of the Earth. They were gradually unearthed by the slow, natural process of erosion, at an average rate of 4 cm/millennium. The hills now dominate the landscape because they are far more resistant to erosion than the rocks that surround them. Today, their intriguing alignment breaks the monotony of the landscape in the St. Lawrence Plain.



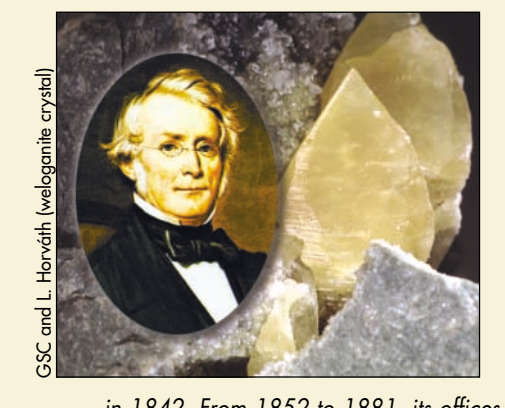
This vein of igneous rock is more resistant to erosion than the limestone it transects and stands out like a small, vertical wall. It mirrors the phenomenon of differential erosion that gave rise to Mount Royal.



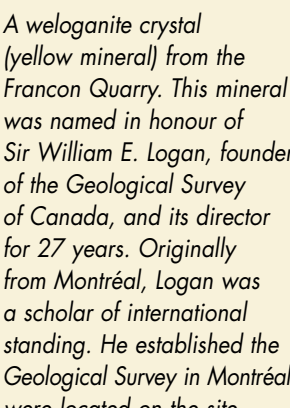
Fall colours on Mount Saint-Hilaire.

UNIQUE MINERALS

The quarry at Mount Saint-Hilaire is a mineralogical site known throughout the world for the abundance and diversity of the minerals found there. Montréal, too, lays claim to a number of small unique finds, including montroyalite, a mineral named for the city's own hill. Quarries and excavations are havens for mineral collectors and, in Montréal, the Francon Quarry is the best known locality for collecting rare minerals.



In 1842, from 1852 to 1881, its offices were located on the site of the current Palais de Justice.



A wolgastite crystal (yellow mineral) from the Francon Quarry. This mineral was named in honour of Sir William E. Logan, founder of the Geological Survey of Canada, and its director for 27 years. Originally from Montréal, Logan was a scholar of international standing. He established the Geological Survey in Montréal in 1842.

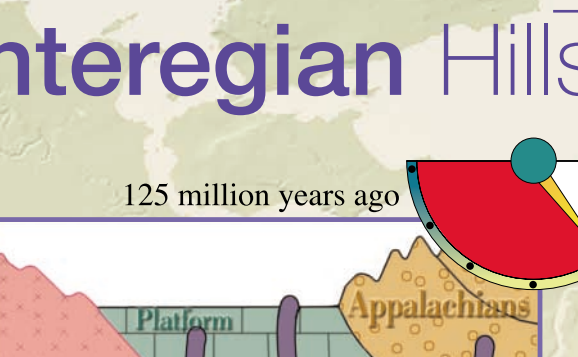
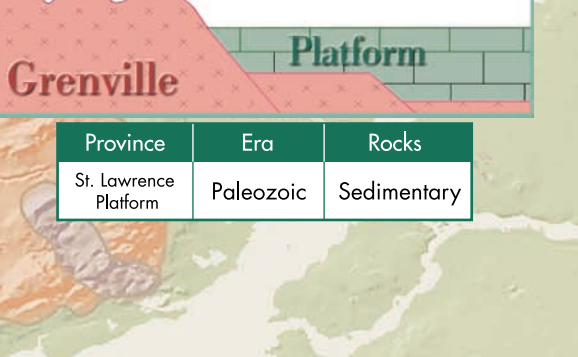
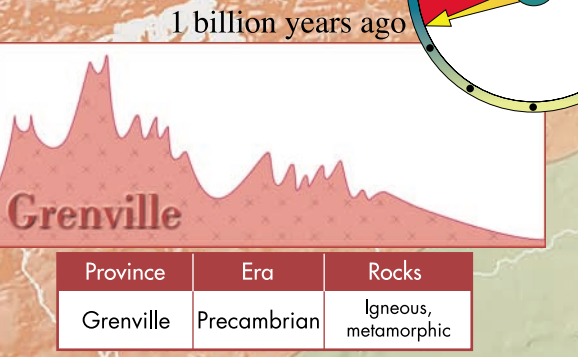
OLDER BODIES OF ROCK

The hills at Oka, Rigaud, and Saint-André-Est are small, distinctly older bodies of rock that formed long before the Monteregian Hills. It is important to protect the integrity of the habitats that cover the rock bodies and hills in the Montréal region because they do much to maintain the biodiversity of the area.

Grenville Province

The landscape that can be seen from the heights of Mount Royal reflects the geological history of the Montréal region. To the north, the plain is bounded by the Laurentian Mountains, a system that is more than one billion years old. The centre of the region is dotted by a number of distinctive features: the Monteregian Hills and the older Oka and Rigaud hills.

Today, the region is covered by a layer of unconsolidated materials consisting of clay, sand, and gravel that originated in the Quaternary, the current geological period. The major landforms of today were fashioned over several hundred million years by the breakup and collision of tectonic plates and by erosion.



Monteregian Hills

About 125 million years ago, magma rose through the Earth's crust in the Montréal region, crystallizing slowly at depth along many conduits. In this way, the Monteregian Hills were formed and with them, a number of rare minerals. Of all these features, Mount Saint-Hilaire is the best known as a source of rare specimens. In some cases, magma erupted at the surface, feeding volcanoes that have now completely disappeared. Since that time, erosion has removed several kilometres of rock. The hills that are visible today represent the magma chambers and part of the conduits through which the molten rock rose toward the surface.



...and the Quaternary

Between 1 600 000 and 10 000 years ago, the Earth experienced several successive glaciations, each resulting in the buildup of impressive ice caps (continental glaciers) covering almost all of the northern part of the continent. Slowly and gradually, these glaciers wore away and levelled the Grenvillian and Appalachian relief. The most recent of these glaciations ended about 10 000 years ago, leaving behind a till sheet comprising blocks, pebbles, sand, and mud.

About 12 000 years ago, the pace of deglaciation increased. The St. Lawrence River valley, still depressed because of the weight of the ice sheet, was invaded by the waters of the Atlantic, and the Champlain Sea was born. The richest farmlands in the St. Lawrence River valley are a legacy of the fine sediment left behind by this postglacial sea. By about 9500 years ago, this sea was succeeded by a lake, which gradually shrank to form channels now occupied by large peat bogs. Lake Saint-François and Lake Saint-Pierre are remnants of this episode.

THE CANADIAN SHIELD NEAR MONTRÉAL: THE GRENVILLE PROVINCE

The Grenville Province is a subdivision of the Canadian Shield, and it is here that the oldest rocks in the region are found. These rocks represent the deep roots, uncovered by erosion, of a chain of mountains that formed between 1500 and 900 million years ago. At that time, Laurentia, the ancestor of the Canadian Shield, collided with other continents that were dragged by moving tectonic plates. An imposing, Himalaya-type mountain range grew out of this collision. The rocks of the Laurentians contain deformation and metamorphic structures that tell the story of a long period of tectonic activity.

THE LOWLANDS: THE ST. LAWRENCE PLATFORM

Near the end of the Precambrian, about 600 million years ago, a huge continent began to break up. During the Paleozoic, a rift formed in the Grenvillian mountain range and gradually widened into an ocean. From 600 to approximately 420 million years ago, the Earth's crust gradually subsided and marine sediments accumulated on the continental shelf that formed a platform along the margins of the land. The ocean, known as Iapetus, received enormous quantities of fossiliferous mud and sand, that would gradually be transformed into the rocks that are now so useful to our economy. At the time, the Montréal region was located near the equator, and the landscape probably resembled that of the present-day Atlantic coast. Over the course of millions of years, Africa and North America would move toward each other, eventually forming a single continent. This new continental collision resulted in the formation of the Appalachians. The St. Lawrence Lowlands also emerged from the ocean and, once again, erosion began to eat away at the newly formed land.

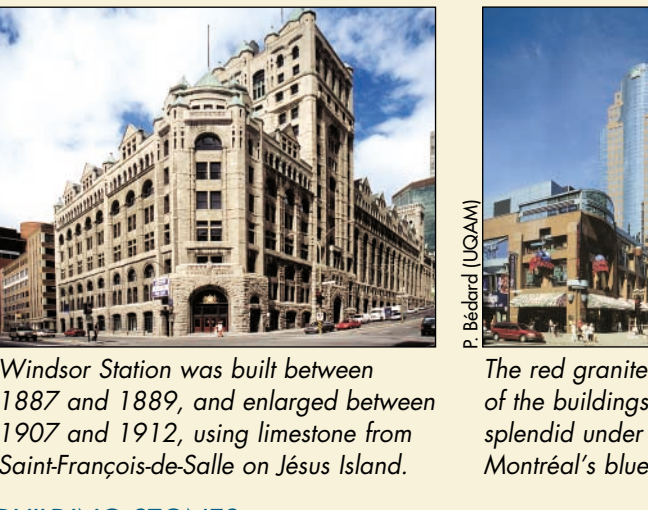
THE MONTEREGIAN HILLS: IGNEOUS INTRUSIONS

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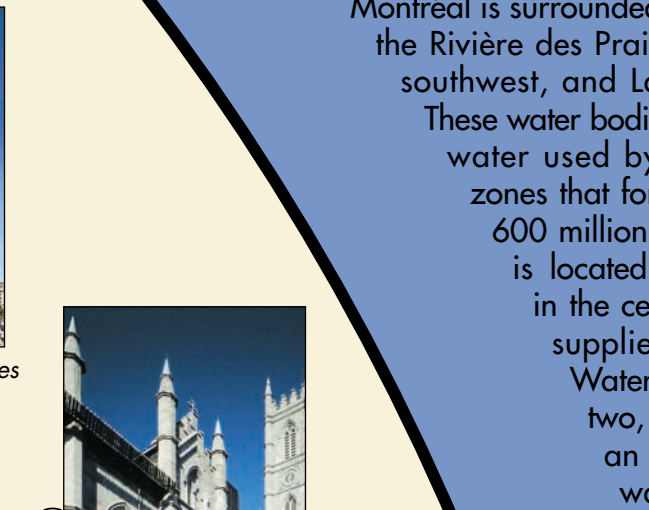
THE QUATERNARY: A PERIOD OF GLACIATION

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Historical links in stone



Windsor Station was built between 1887 and 1889, and enlarged between 1907 and 1912, using limestone from Saint-François-de-Salle on Jésus Island.



The red granite facades of the buildings look splendid under Montréal's blue skies.

BUILDING STONES

Most historical buildings in Montréal are constructed of a very uniform-looking, grey limestone that is 450 million years old. This rock is generally referred to as 'Montréal greystone'. It was available near the surface over a large part of the eastern end of the island, commonly right on construction sites themselves, and was widely used as a building stone and for manufacturing the lime needed for masonry work. In about 1850, over 2000 residents of the village of Coteau-Saint-Louis made their living by quarrying stone.

A SPECTACULAR ROCK

A very unique rock can be found on Montréal Island: it is a breccia that was formed during explosive volcanic events associated with the Monteregian intrusions. It can be seen on Bizard and Cadieux islands, and it makes up the basement of Sainte-Hélène Island. Several buildings on this island, including the restaurant, tower, and fort, now the Stewart Museum, were built using this breccia, which was quarried at the foot of the Jacques-Carrier Bridge.

CRUSHED STONE

In the early twentieth century, limestone was quarried primarily to obtain crushed stone. Le Pélican and Lafond parks and the Montréal Botanical Garden are located on former quarry sites. However, the Saint-Michel Quarry was the main centre for such activities. During the 1960s, the Francon and Miron quarries supplied the crushed stone and construction materials, including cement, that were needed to sustain the city's phenomenal growth. Their closure in the 1980s signalled an end to the stone quarrying that had been a feature of the island since the early days of the colony.

QUARRY REHABILITATION

With time, as resources were depleted, quarrying activity moved north, notably to Jésus Island. The pits were later converted to large municipal dumps, and it is only fairly recently that they were developed as parks. In some cases, neighbourhoods were established on former dumps, and problems of foundation stability developed. The city was built from rocks excavated in quarries on the sites of Laurier, Père-Maquette, Des Carrières, and Villier parks.



Biogas collection wells.



View of the site when garbage was being buried and after it had been covered.

Water in Montréal

MANY USES

Montréal is surrounded by water: the St. Lawrence River to the south, the Rivière des Prairies to the north, Lake Saint-Louis to the southwest, and Lac des Deux Montagnes to the west. These water bodies, which provide most of the drinking water used by Montréalers, follow ancient rift zones that formed when the continent broke up, 600 million years ago. The main water intake is located upstream of the Lachine Rapids, in the centre of the St. Lawrence River, and supplies water to two treatment plants. Water at the Atwater plant, the older of the two, is routed via the Aqueeduct Canal, an 8 km long water artery. The treated water is stored in several tanks, a number of which are located right in the heart of Mount Royal. Waterways around Montréal have many uses, including recreational fishing and swimming.



The Aqueeduct Canal channels water toward the city.

MONITORING THE RESOURCE

For the past several years, the Port of Montréal has been affected by particularly low water levels in the St. Lawrence River. Unusually dry climatic conditions and an increase in the amount of water removed from the river upstream of Montréal have resulted in record decreases in water levels and flow rates. This situation is of concern to all and has significant negative impacts on aquatic ecosystems, wetlands, shoreline erosion, and commercial shipping.

WATER RIGHT UNDER OUR FEET!

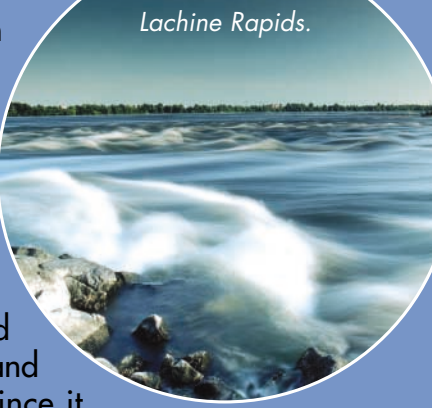
Although it cannot be seen from the surface, groundwater underlies the entire Montréal region, primarily in the fractured rocks of the St. Lawrence Platform. In quarries and other deep excavations, groundwater must be continuously pumped out. On Montréal Island, groundwater is not heavily used for human consumption, and only a few hundred homes at the west end of the island are supplied from this source. Around Montréal Island, groundwater is used for various purposes, including as a source of drinking water and for crop irrigation, fish farming, and commercial ends. Water bottled from a groundwater source in the Mirabel area is known throughout North America for its quality.



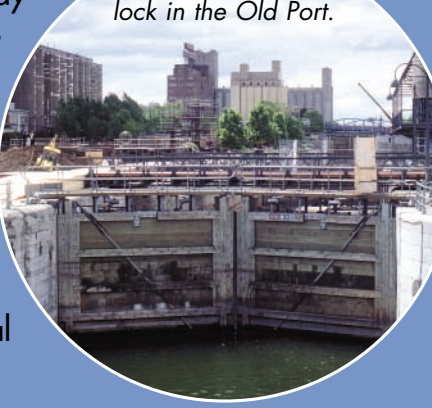
Groundwater reaches the surface.

A GATEWAY TO THE CONTINENT

At the beginning of the sixteenth century, Jacques Cartier must have been taken aback by the churning waters of the Lachine Rapids, and had to abandon his dream of discovering the Northwest passage. To bypass this obstacle to navigation, the Lachine Canal was completed in 1829, linking Lake Saint-Louis and Montréal. Widened several times since it was first constructed, the Lachine Canal facilitated trade with the interior of the continent and fostered the industrial development of the region. In 1959, the St. Lawrence Seaway replaced the Lachine Canal, which was later closed to navigation. The first of the Seaway locks is located at Saint-Lambert near the Victoria Bridge. The Côte-Sainte-Catherine and Beauharnois locks raise and lower ships through a total elevation change of 38.6 metres, over a distance of a few tens of kilometres. The Seaway brought world trade into the interior of North America and made Montréal a key transfer point for transatlantic cargo.



Lachine Rapids.



Lachine Canal lock in the Old Port.