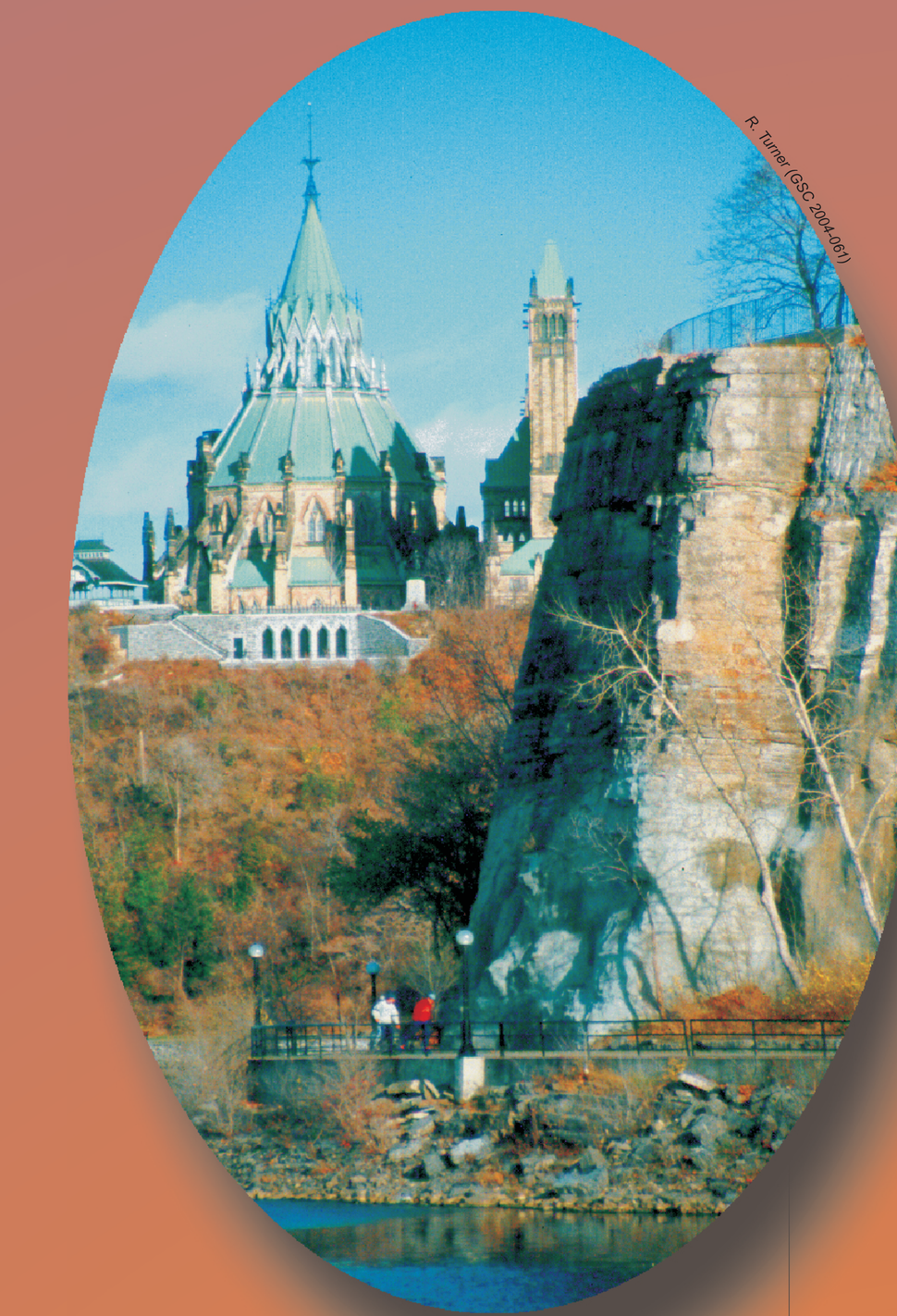
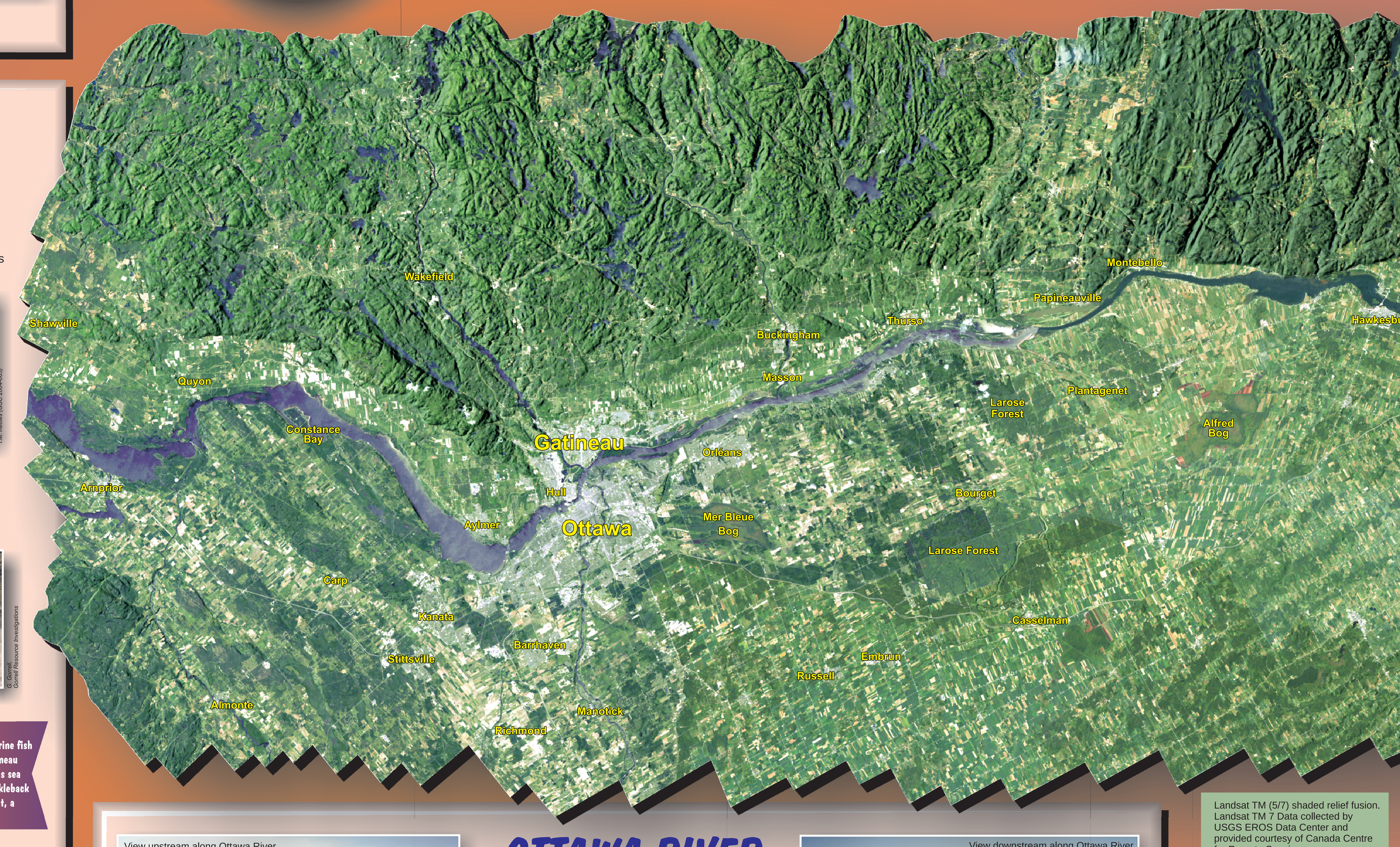
Geoscape Ottawa–Gatineau

Living With Our Geological Landscape



We live in the Ottawa valley, a lowland traversed by the Ottawa River and its tributaries, and bordered by the rugged terrain of the Canadian Shield. Over geological time, this area has experienced mountain building and erosion, tropical and temperate seas, thick ice sheets, and erosion by rivers. The greater Ottawa–Gatineau area is underlain by soil, sediment, and rock that have been, and still are being, shaped by earth processes, yielding a geological landscape, or geoscape. Understanding how our geoscape works is essential to the wise use of the land.

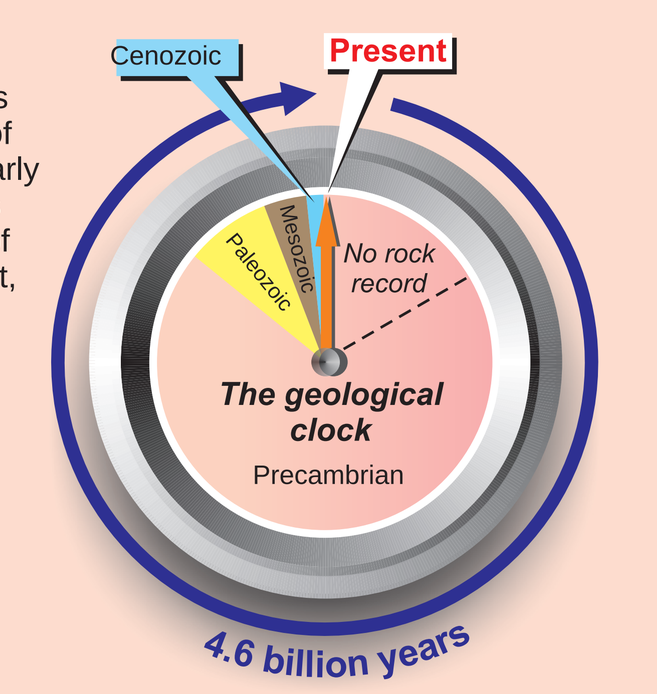


Landsat TM (5/7) shaded relief fusion. Landsat TM 7 Data collected by USGS EROS Data Center and provided courtesy of Canada Centre for Remote Sensing.

DEEP TIME: Ancient Rocks

It's All About Time

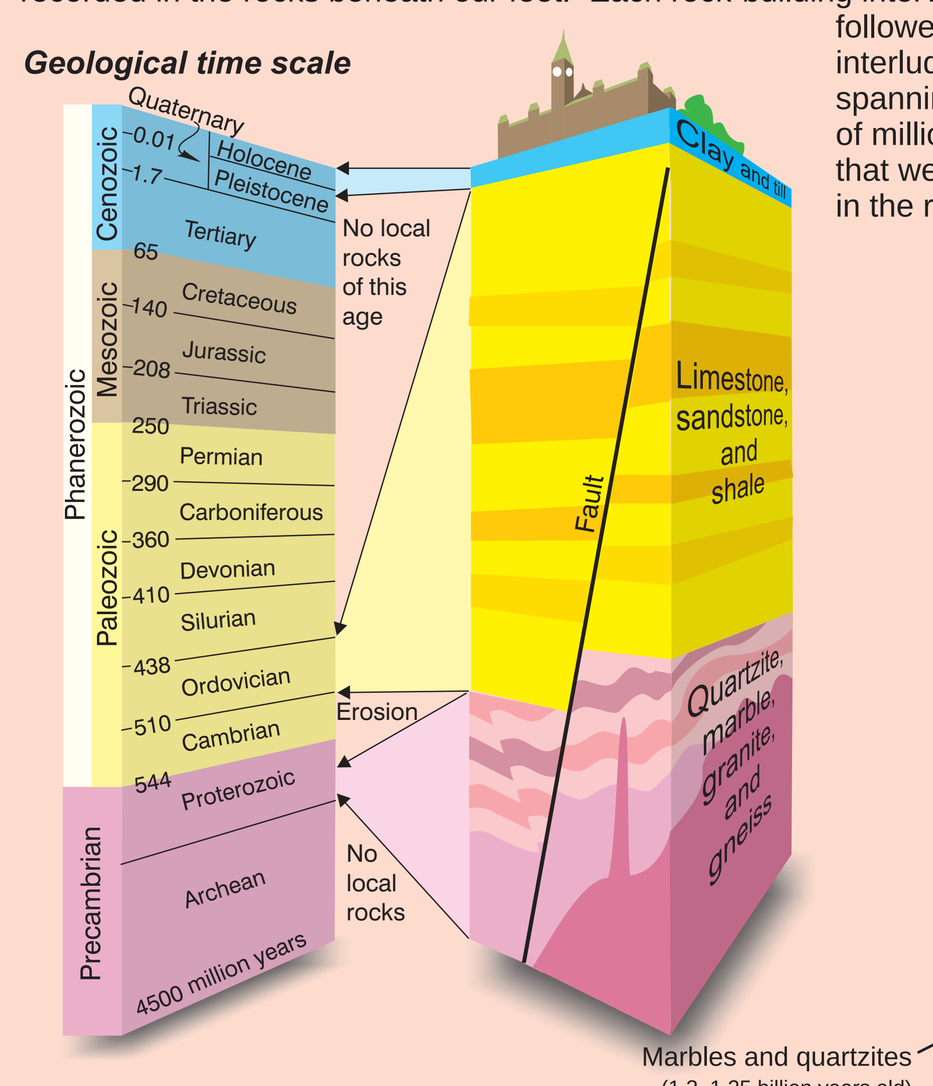
The Earth formed about 4.6 billion years ago. Geologists have broken this enormous length of time into major divisions using fossil assemblages and radiometric dating of rocks. During the vastness of Precambrian time, the Earth's crust developed, and early life evolved. The Paleozoic began with the first appearance of fossils with hard parts and ended with the largest extinction in Earth's history. The Mesozoic was the Age of Dinosaurs and ended with their extinction. The Cenozoic, which includes the present, is the Age of Mammals and includes the evolution of man and a major Ice Age.



Beneath Our Feet

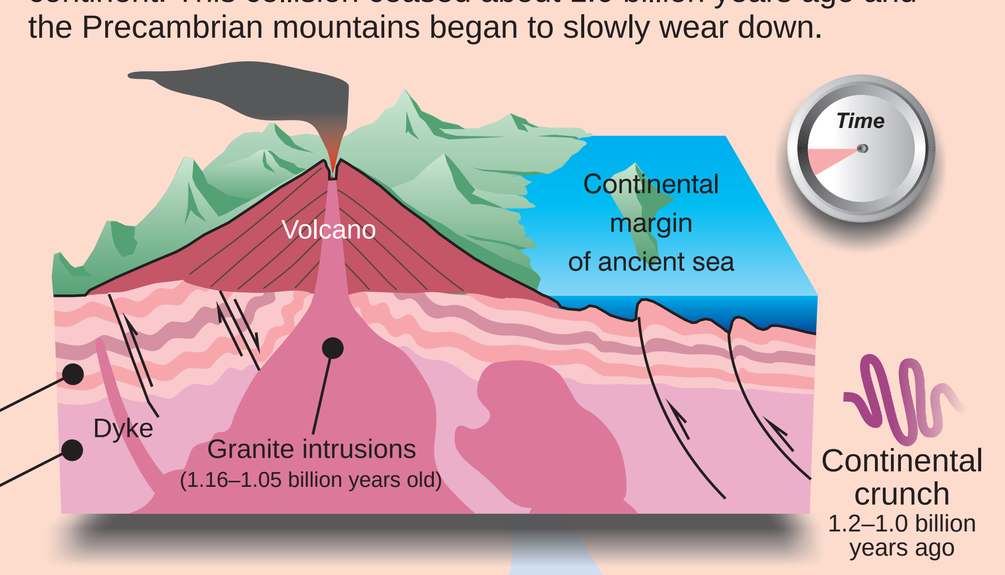
The late Precambrian, early Paleozoic, and late Cenozoic (Quaternary) are recorded in the rocks beneath our feet. Each rock-building interval was followed by a long interlude of erosion, spanning hundreds of millions of years, that we see as a gap in the rock record.

Geological time scale

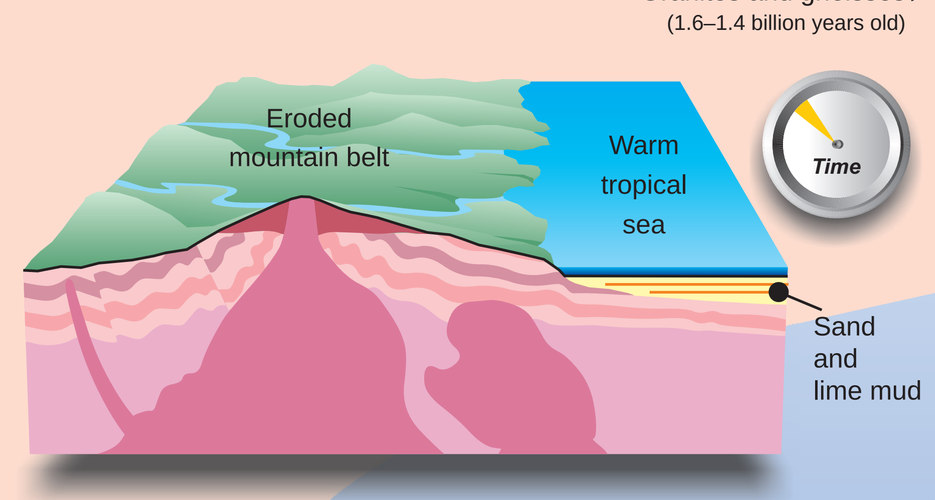


Ancient Mountains

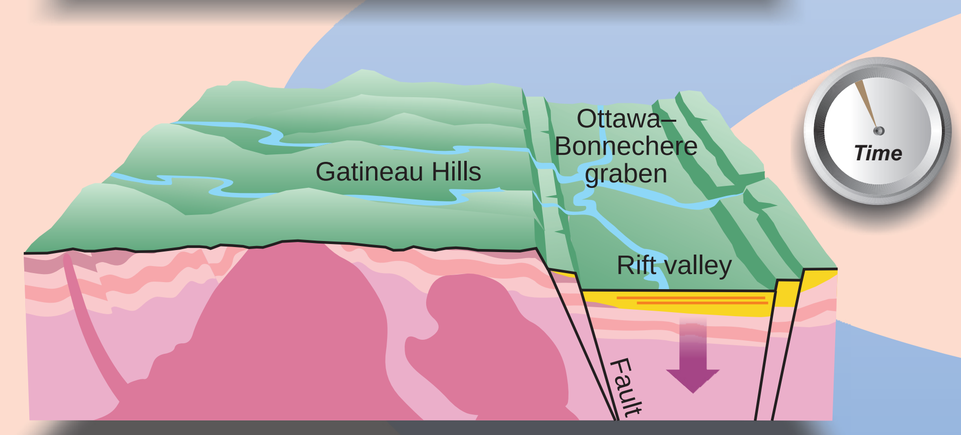
The oldest rocks in the region are the **Precambrian** marble, quartzite, and granite of the Gatineau Hills and parts of the Carp–Kanata area. These rocks are the deeply eroded roots of ancient mountains that were once as tall as the present-day Himalayas. Between 1.2 and 1.0 billion years ago, sedimentary and volcanic rocks, originally deposited along the margin of ancient North America, were deformed, metamorphosed, and intruded by magma as a result of collision with another continent. This collision ceased about 1.0 billion years ago and the Precambrian mountains began to slowly wear down.



Tropical Ottawa–Gatineau

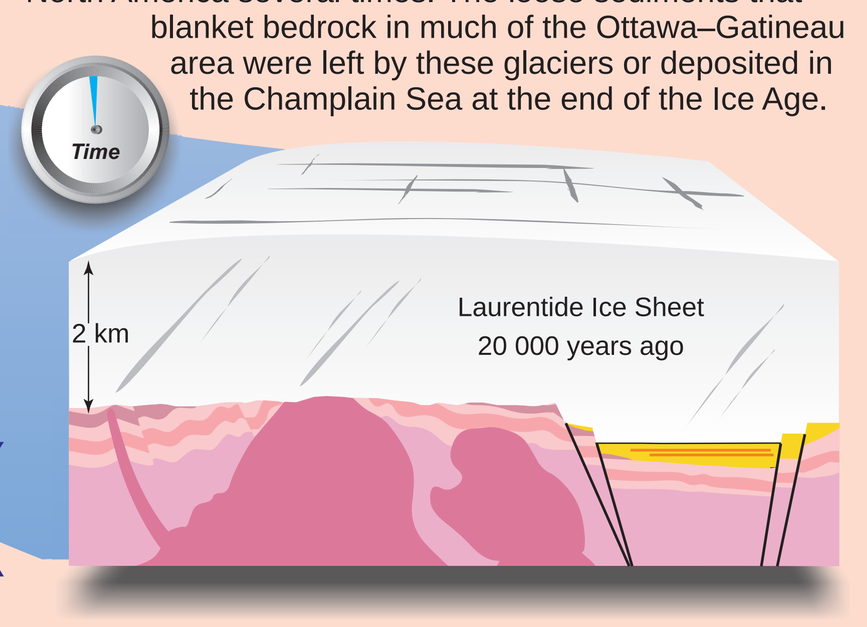


In the **Paleozoic,** between 510 and 440 million years ago, a warm tropical sea flooded the region. (We were near the equator then!) The oldest Paleozoic rock (the Nepean sandstone) was an ancient Cambrian beach. In the Ordovician, an ocean covered this beach and limestones and shales were deposited. Trilobites, cephalopods, crinoids, corals, snails, and other shelled animals that lived in the ancient coral reefs can be found by the thousands in the shales and limestones under our feet.



The Big Chill

During the **Quaternary,** great ice sheets covered northern North America several times. The loose sediments that blanket bedrock in much of the Ottawa–Gatineau area were left by these glaciers or deposited in the Champlain Sea at the end of the Ice Age.



Breaking Apart

About 175 million years ago, in the **Mesozoic,** the Ottawa–Bonnechere graben formed when the land surface moved downward between two major fault zones. These ancient faults are occasionally reactivated today, releasing crustal stress in the form of earthquakes.

Did you know? ... The dramatic escarpment that forms the southern edge of the Gatineau Hills between Quyon and Gatineau is a fault scarp along the northern side of the Ottawa–Bonnechere graben.

WEALTH FROM THE LAND

Mining Today for Aggregates and Peat

Crushed stone quarry

G.R. Brooks (GSC 2004-059)

The major mineral resources of the region are crushed stone, sand, and gravel. This aggregate is used by the construction industry to make concrete and build roads. Finely crushed aggregate is also used in plastics, glass, paint, wallboard, and roofing tiles.

Dried peat is vacuumed from bog surface

G.R. Brooks (GSC 2004-060)

Peat is plant material that slowly accumulates and decomposes in bogs. Peat moss, an important resource for the horticultural industry, is extracted at several sites in the region, especially the Alfred Bog. Because bogs are wetlands, important for the survival of wildlife and water recharge areas, peat mining is controversial. Several bogs have been designated as conservation areas (Mer Bleue Bog).

Past Mines

Metals such as lead, iron, molybdenum, zinc, and silver were mined from the mid 1800s to mid 1900s in the greater Ottawa–Gatineau area. Even greater wealth came from industrial minerals such as feldspar, apatite, mica, graphite, and brucite.

Museum of Nature

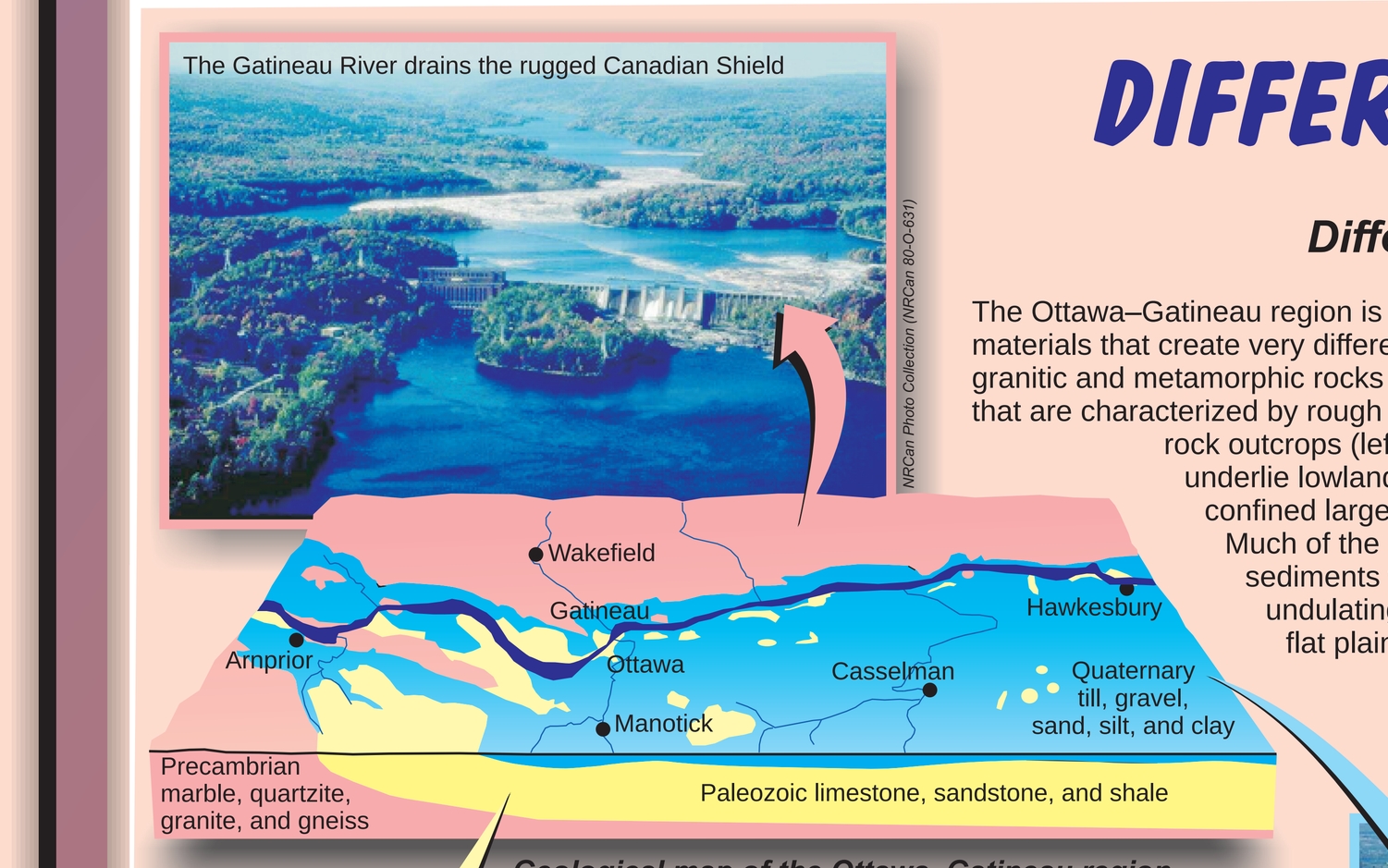
J.M. Aylsworth (GSC 2004-064)

Mining for Stone

Although no longer active, stone quarrying played an important role in the history of local mining. The stones in many buildings in Ottawa are from local quarries. Quarries to the east of Kanata, near Hwy 417, provided the sandstone to face the Parliament Buildings and the Museum of Nature. Crushed limestone, from quarries such as those near Carlington Hill in Ottawa and the casino in Gatineau, supplied lime for the production of cement.

Did you know? ... Bytownite, Wakefieldite, Carletonite, Weloganite, Sabinaite... Since the mid 1800s, about 45 local mineralogists, collectors, localities, and institutions have had newly discovered minerals named in their honour.

DIFFERENT ROCKS



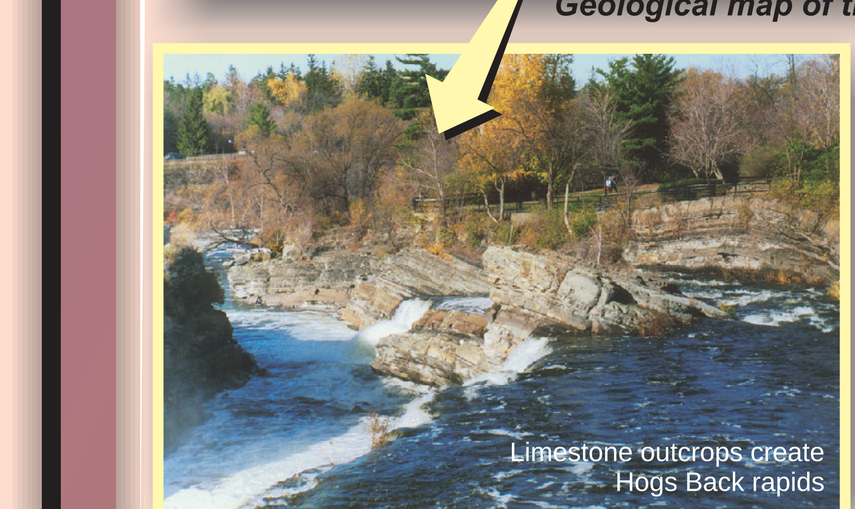
The Gatineau River drains the rugged Canadian Shield

NRCan Photo Collection (NRCan 80-O-631)

Different Landscapes

The Ottawa–Gatineau region is underlain by three different geological materials that create very different landscapes. The resistant Precambrian granitic and metamorphic rocks of the Canadian Shield form highland areas that are characterized by rough terrain, numerous small lakes, and abundant rock outcrops (left). In contrast, the flat-lying Paleozoic rocks underlie lowland plains and low hills, and outcrops are confined largely to low scarps and riverbanks (bottom left). Much of the region is covered by a blanket of Quaternary sediments which form landscapes that range from gently undulating plains and low hills of glacial deposits to the flat plains of the Champlain Sea (bottom right).

Geological map of the Ottawa–Gatineau region



Limestone outcrops create Hogs Back rapids

J.M. Aylsworth (GSC 2004-058)

Different Resources

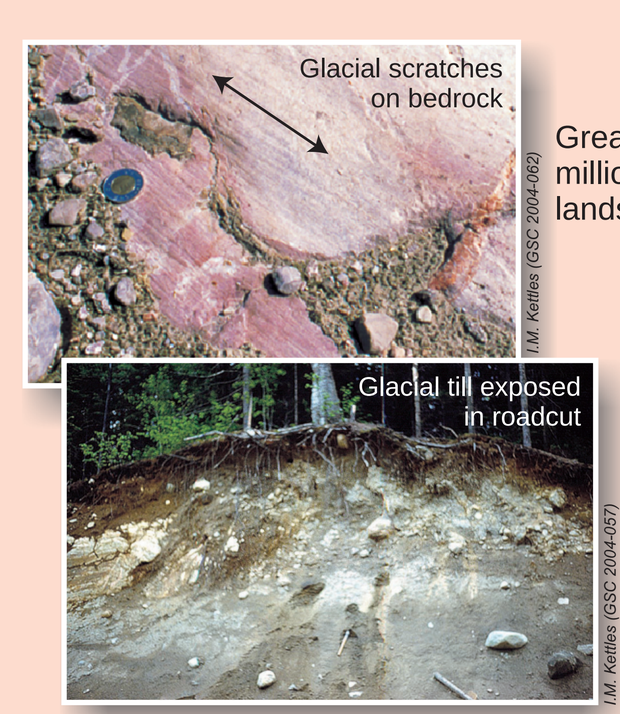
Each geological material contains unique resources. Precambrian rocks contain a variety of metal and mineral resources. Paleozoic limestone and sandstone provide building stone and cement and concrete products. Quaternary sediments provide sand and gravel, and are also the parent material of agricultural soils.

Flat sediment plain at the Central Experimental Farm, Ottawa

NRCan Photo Collection (NRCan 80-O-635)

CHANGING LANDSCAPE: The Recent Past

Ice Sculpts the Land



Glacial scratches on bedrock

I.M. Kettles (GSC 2004-062)

Glacial till exposed in roadcut

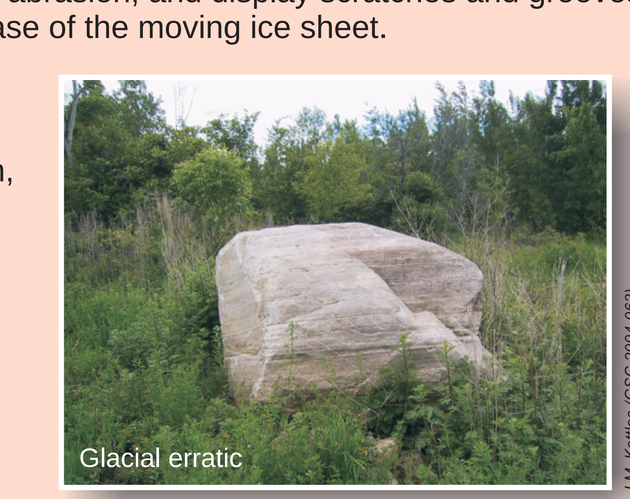
I.M. Kettles (GSC 2004-057)

Great ice sheets flowed over the Ottawa–Gatineau region several times during the last 1.6 million years. The last one covered the region from 20 000 to 11 000 years ago. Our landscape reflects this glacial heritage. For example...

- Rock outcrops in the Gatineau Hills and in the Kanata area have rounded shapes and smooth surfaces created by glacial abrasion, and display scratches and grooves eroded by particles embedded in the base of the moving ice sheet.

- Stony soils have developed on till, the mixture of clay, silt, sand, pebbles and boulders carried by, and deposited from, the glacier.

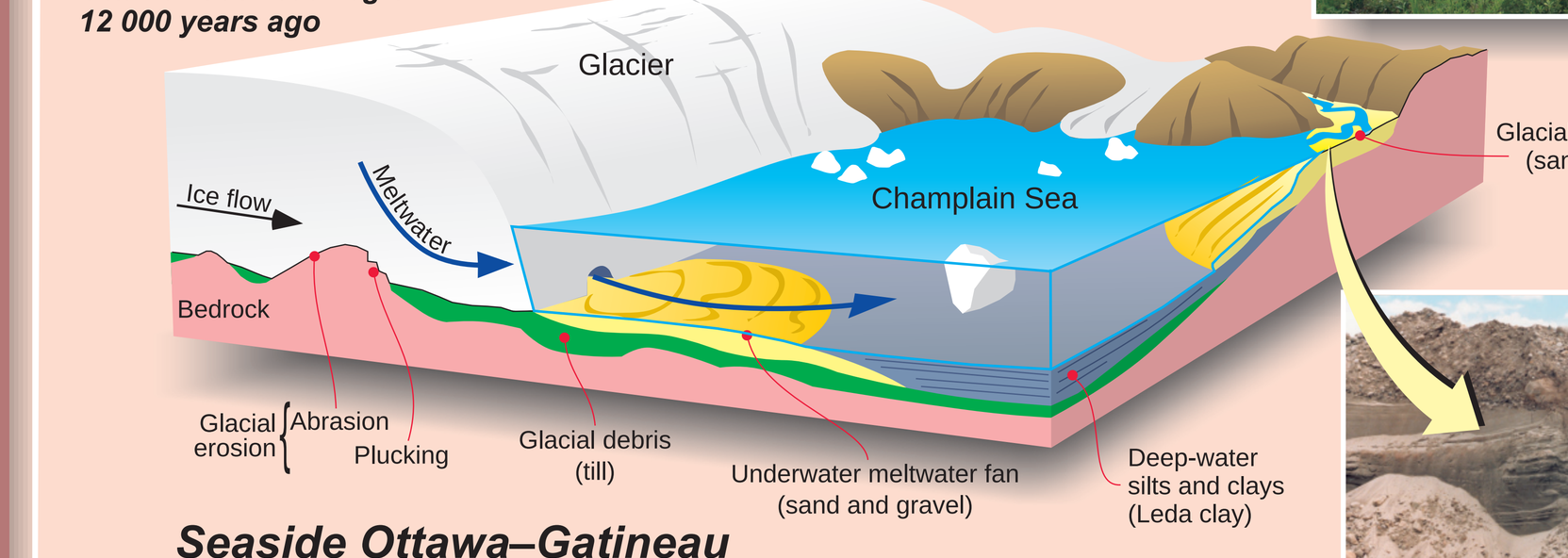
- Huge isolated boulders, left behind by glaciers and known as erratics, occur scattered across the region.



Glacial erratic

I.M. Kettles (GSC 2004-063)

Ottawa–Gatineau region 12 000 years ago



Glacial gravel and sand

G. Gorrell, Gorrell Resource Investigations

Seaside Ottawa–Gatineau

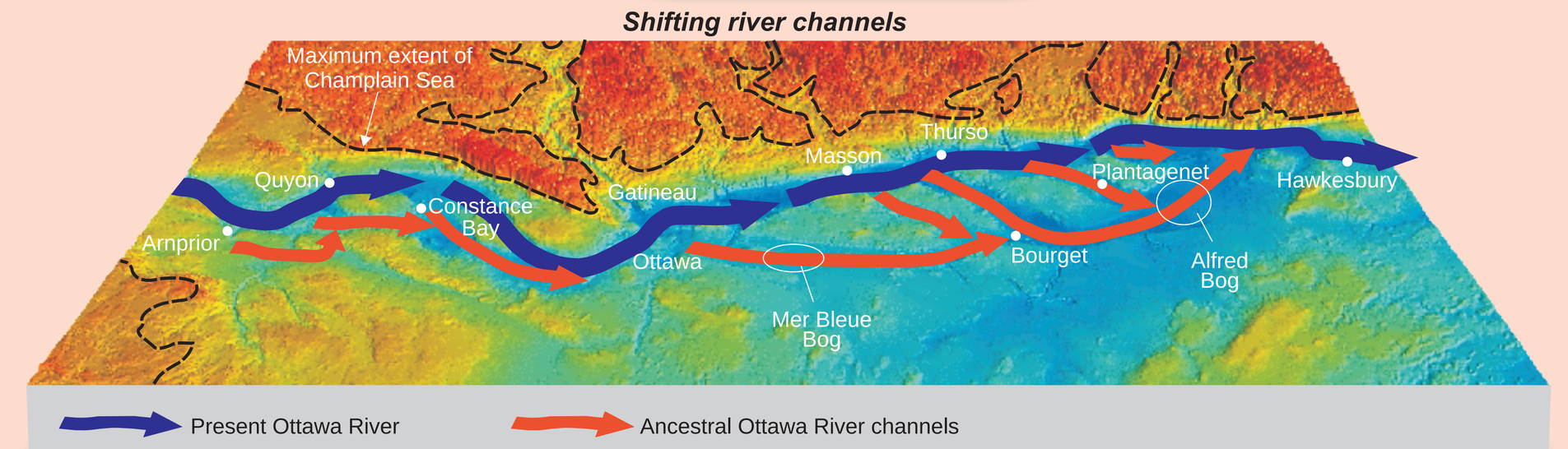
Whales once swam in the sea covering the Ottawa valley. The great weight of the ice sheet depressed the land surface by hundreds of metres, and, as the glacier retreated, about 12 000 years ago, the Atlantic Ocean flooded the Ottawa valley, forming the Champlain Sea. As the glacially depressed lands gradually rose, the sea receded, finally leaving the Ottawa valley about 10 000 years ago. Beaches and deltas, now lying 220 m above present sea level, and a widespread blanket of marine mud (Leda clay) containing fossils ranging from tiny seashells to whale bones, are evidence of this sea in the present landscape.

Bones of a young beluga whale found in a well excavation near Pakenham

R. Harington, Canadian Museum of Nature

Did you know? ... Landlocked marine fish survive today in the Ottawa–Gatineau area. Trapped in isolated basins as sea level dropped, a marine-type stickleback in Pink Lake, Gatineau Park, and 'red' trout, a form of salmon found throughout the area,

Shifting river channels



The River Evolves

The modern Ottawa River evolved as the ancestral river and its tributaries adjusted to the retreat of the Champlain Sea. Between 10 000 and 8000 years ago, there was a much larger flow of water through the ancestral Ottawa River than at present. Large glacial lakes in northern Ontario and the Prairie Provinces, and the upper Great Lakes all drained into the Ottawa River. Several

Geoscape Ottawa–Gatineau
Living With Our Geological Landscape

Geological Survey of Canada, Miscellaneous Report 85, 2004

The following agencies and organizations participated in the planning, preparation and/or production of Geoscape Ottawa–Gatineau: Geological Survey of Canada and Canada Centre for Remote Sensing, Natural Resources Canada; Canadian Museum of Nature; Department of Geography and Environmental Studies and Department of Earth Sciences, Carleton University; Department of Earth Sciences, University of Ottawa; Environment Canada; Écomusée de Hull; Friends of Petrie Island; National Capital Commission; Ottawa-Carleton District School Board; Ottawa-Carleton Catholic School Board; Commission scolaire des Draveurs; Ontario Ministry of Natural Resources; City of Ottawa; Rideau Valley Conservation Authority; South Nation Conservation Authority.

Text and figures were contributed by J.M. Aylsworth, A.L. Bent, G.R. Brooks, D. Corrigan, J.A. Donaldson, B.J. Dougherty, L.A. Dredge, C.R. Harington, S. Heenan, D. Irwin, I.M. Kettles, D.E. Lawrence, B.E. Medioli, F. Michel, J.B. Percival, M. Poirer, H.A.J. Russell, J.K. Torrance, and R.J.W. Turner.

Graphic design and cartography: R.G. Franklin, J.M. Aylsworth, and R.J.W. Turner.

Funding for this poster was provided by Natural Resources Canada and the Ontario Ministry of Energy, Science and Technology.

Recommended citation:
Aylsworth, J.M.
2004: Geoscape Ottawa–Gatineau; Geological Survey of Canada, Miscellaneous Report 85.

601 Booth Street, Ottawa, Ontario K1A 0E8

3303-33rd Street N.W., Calgary, Alberta T2L 2A7

101-605 Robson Street, Vancouver, B.C. V6B 5J3

Web site: www.nrcan.gc.ca/gsc

Need more information? To view the Geoscape poster for Ottawa–Gatineau and other Canadian communities visit our website at www.geoscape.nrcan.gc.ca

Natural Resources Canada / Ressources naturelles Canada

Geomatics Canada

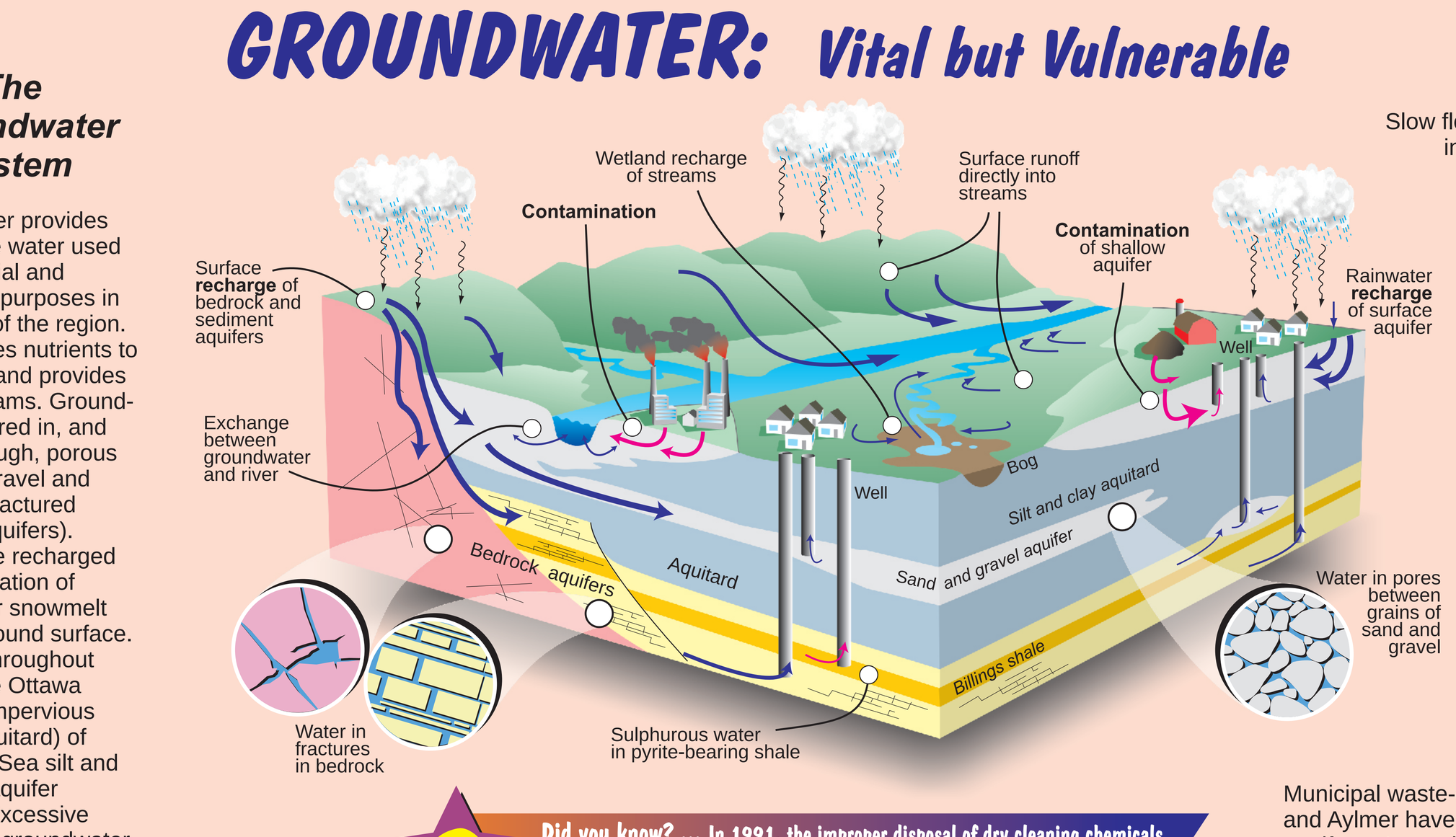
Ontario

Canada

GROUNDWATER: Vital but Vulnerable

The Groundwater System

Groundwater provides much of the water used for residential and agricultural purposes in rural parts of the region. It also moves nutrients to vegetation and provides flow to streams. Groundwater is stored in, and moves through, porous sand and gravel and porous or fractured bedrock (aquifers). Aquifers are recharged by the infiltration of rainwater or snowmelt from the ground surface. However, throughout much of the Ottawa valley, an impervious blanket (aquitard) of Champlain Sea silt and clay limits aquifer recharge. Excessive pumping of groundwater can deplete aquifers.



Water Quality

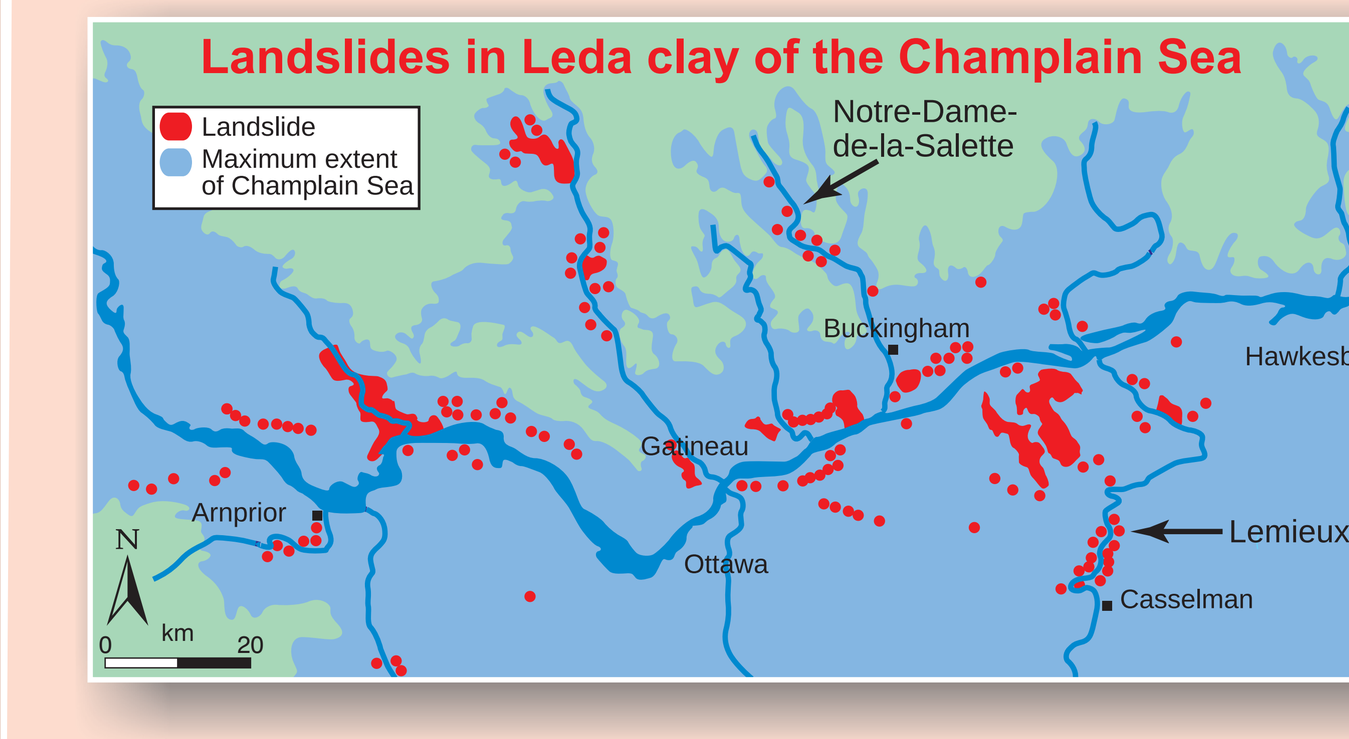
Slow flow rates and long residence times in aquifers cause groundwater quality to be controlled by the chemical composition of the aquifer. Pyrite-bearing rocks yield water with a characteristic rotten-egg odour. Water from salt-rich Champlain Sea sediments can be saline. Calcium and magnesium, dissolved from limestone and dolostone, produce what is known as hard water.

Vulnerable!

Groundwater can be contaminated. Contaminant sources in urban areas include gas stations, dry cleaners, garbage dumps, snow-disposal dumps, and industrial sites. Municipal waste-disposal sites in Carp, Gloucester, and Aylmer have leaked and contaminated aquifers. In rural areas, livestock wastes, pesticides, and fertilizers have polluted

Did you know? ... In 1991, the improper disposal of dry cleaning chemicals in Manotick contaminated about 100 household wells and required development of a water main for local residents at a cost of millions of dollars.

LANDSLIDES: The Earth Can Move



Recipe for Trouble

Deposits of Leda clay, a potentially unstable material, underlie extensive areas of the Ottawa–Gatineau region. Leda clay is composed of clay- and silt-sized particles of bedrock that were finely ground by glaciers and washed into the Champlain Sea. As the particles settled through the salty water, they were attracted to one another and formed loose clusters that fell to the seafloor. The resulting sediment had a loose but strong framework that was capable of retaining a large amount of water. Following the retreat of the sea, the salts that originally contributed to the bonding of the particles were slowly removed (leached) by fresh water filtering through the ground. If sufficiently disturbed, the leached Leda clay, a weak but water-rich sediment, may liquefy and become a 'quick clay'. Trigger disturbances include river erosion, increases in pore-water pressure (especially during periods of high rainfall or rapid snowmelt), earthquakes, and human activities such as excavation and construction.

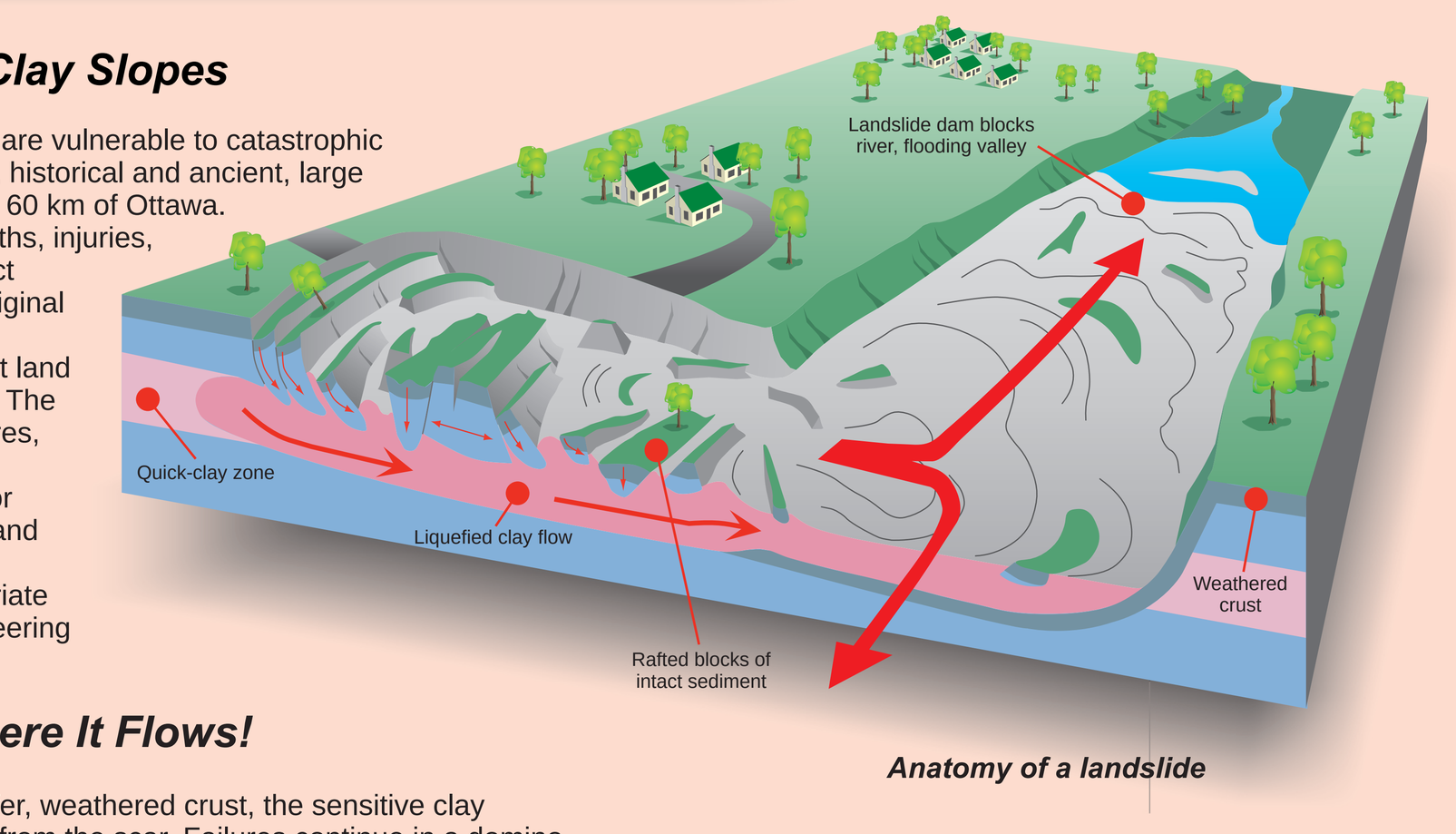
Did you know?... The most disastrous Leda clay landslide in eastern Canada occurred in 1908 at Notre-Dame-de-la-Salette, Quebec, with the loss of 33 lives.

Lemieux Landslide, June 20, 1993

S.G. Evans (GSC 1993-296)

Unstable Clay Slopes

Leda clay slopes in the Ottawa valley are vulnerable to catastrophic landslides. More than 250 landslides, historical and ancient, large and small, have been identified within 60 km of Ottawa. Some of these landslides caused deaths, injuries, and property damage, and their impact extended far beyond the site of the original failure. In spectacular flowslides, the sediment underlying large areas of flat land adjacent to unstable slopes liquefies. The debris may flow up to several kilometres, damming rivers and causing flooding, siltation, and water-quality problems or damaging infrastructure. Geologists and geotechnical engineers can identify potential landslide areas, and appropriate land-use zoning and protective engineering



Anatomy of a landslide

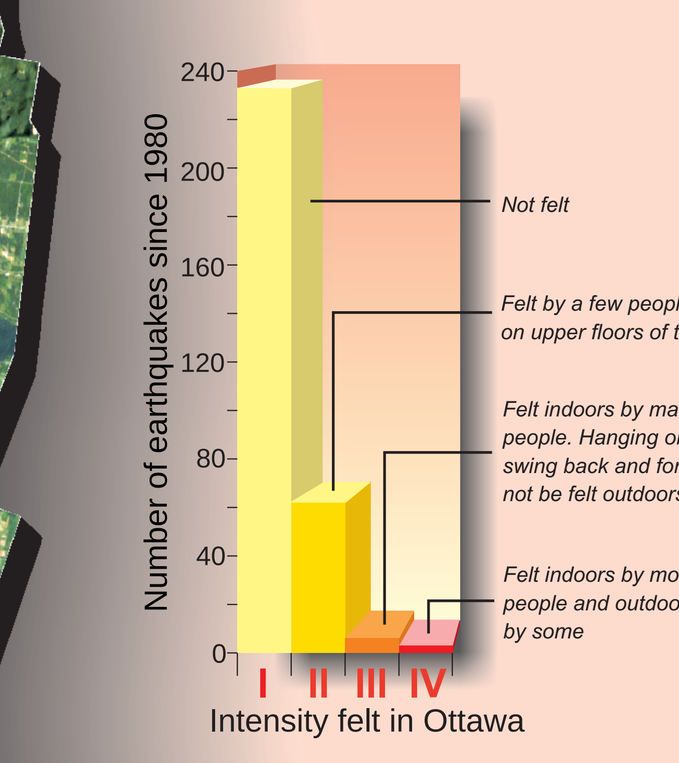
There It Flows!

After an initial failure removes the stiffer, weathered crust, the sensitive clay liquefies and collapses, flowing away from the scar. Failures continue in a domino-like fashion, rapidly eating back into the flat land lying behind the failed slope. The

Lemieux, The Town That Was 'Moved' By Landslides!

Engineering studies, initiated following a large landslide on the South Nation River in 1971, concluded that the town of Lemieux lay within a zone susceptible to large landslides. As a result, the town site was abandoned in 1991 and residents were relocated at government expense. In 1993, only two years later, a large landslide consumed 17 hectares of farmland adjacent to the former town site. Through progressive headward failure, the landslide advanced 680 m from the riverbank in less than an hour. Debris traveled 1.7 km upstream and 1.6 km downstream, completely blocking the river for several days. The costs related to this event were estimated at $12 500 000.

EARTHQUAKES: In Ottawa–Gatineau!

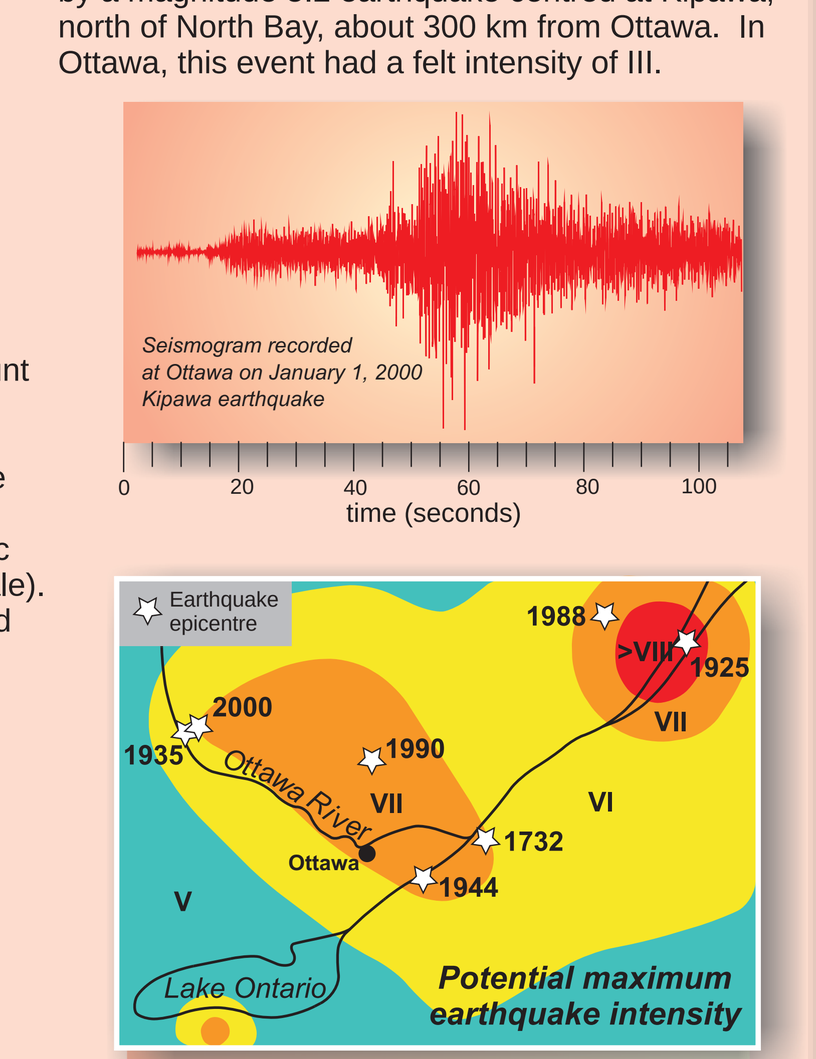


Why Do We Have Earthquakes?

The Ottawa–Gatineau region is located far from active tectonic plate boundaries, the usual source of earthquakes, but it does have a seismic history. Within this region, the Earth's crust is being compressed. Once the accumulated stress exceeds the strength of the crust, it is released by slippage along reactivated faults of the Ottawa–Bonnechere graben. Although this area has a moderate risk of a damaging earthquake, a devastating earthquake is unlikely.

Earthquake for the Millennium

Ottawa–Gatineau was shaken into the year 2000 by a magnitude 5.2 earthquake centred at Kipawa, north of North Bay, about 300 km from Ottawa. In Ottawa, this event had a felt intensity of III.



What We Feel

Magnitude (Richter scale), or size, reflects the amount of fault movement at the source of an earthquake. However, because the strength of shaking generally decreases with distance from the epicentre, what we feel and the amount of damage differ from place to place. Intensity is a measure of shaking at a specific place and ranges from I to XII (modified Mercalli scale). For any earthquake, there will be one magnitude and many intensities.

Did you know?... On average, we feel an earthquake of intensity III or higher once every 3 years in Ottawa–Gatineau.

Over 50 years, there is a 10% chance that a site will experience ground shaking exceeding the intensity shown here.

Intensity VI: *Felt by everyone. People have trouble walking. Objects fall. No structural damage*

Intensity VII: *General alarm. Difficult to stand. Mild to moderate damage to buildings*

Protecting Ourselves

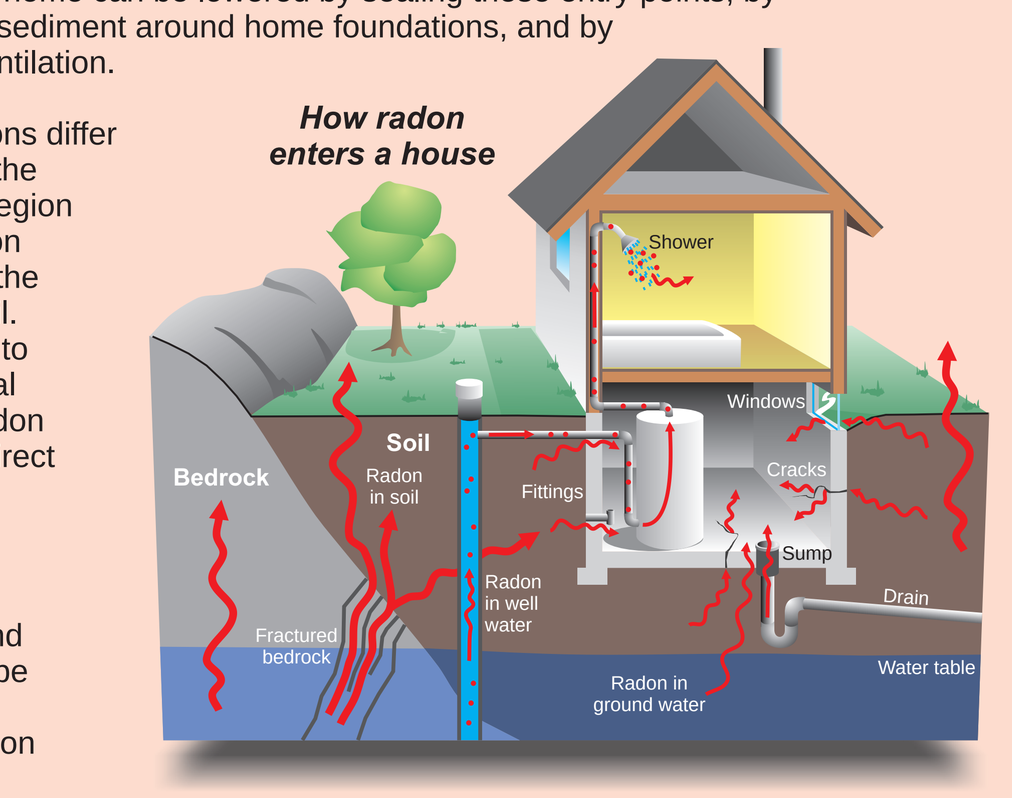
By evaluating the local history of earthquakes and the local geology, seismologists can produce maps predicting maximum ground motion or intensity for a region. Seismological data are used to set our national building codes that specify the engineering design requirements for earthquake-resistant buildings.

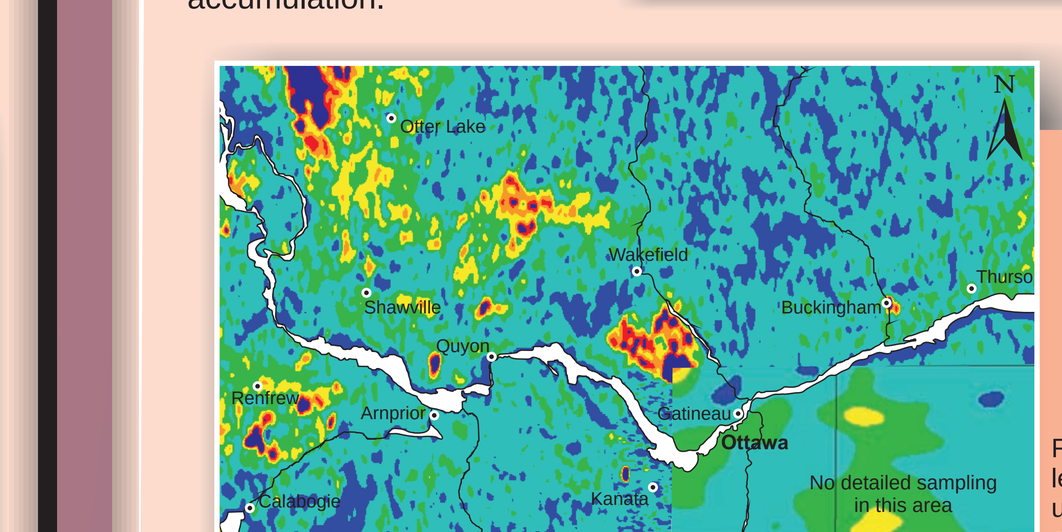
INDOOR RADON: An Invisible Hazard

Radon is an odourless, colourless, and tasteless radioactive gas produced by the natural breakdown of uranium found in some rocks, sediments, and water. Radon moves out of the ground and dilutes to harmless levels in the atmosphere, but it can accumulate to high levels in houses. High radon levels are associated with an increased risk of lung cancer. Radon can enter a home through openings in basement walls and floors. Radon concentrations in a home can be lowered by sealing these entry points, by depressurizing the sediment around home foundations, and by improving home ventilation.

Radon concentrations differ greatly throughout the Ottawa–Gatineau region depending mainly on the composition of the local bedrock or soil. While the only way to determine the actual concentration of radon in a home is by a direct measurement, geological maps showing the concentrations of uranium in rocks and soil at surface can be used to estimate potential indoor radon accumulation.

How radon enters a house





Potential occurrence of radon gas

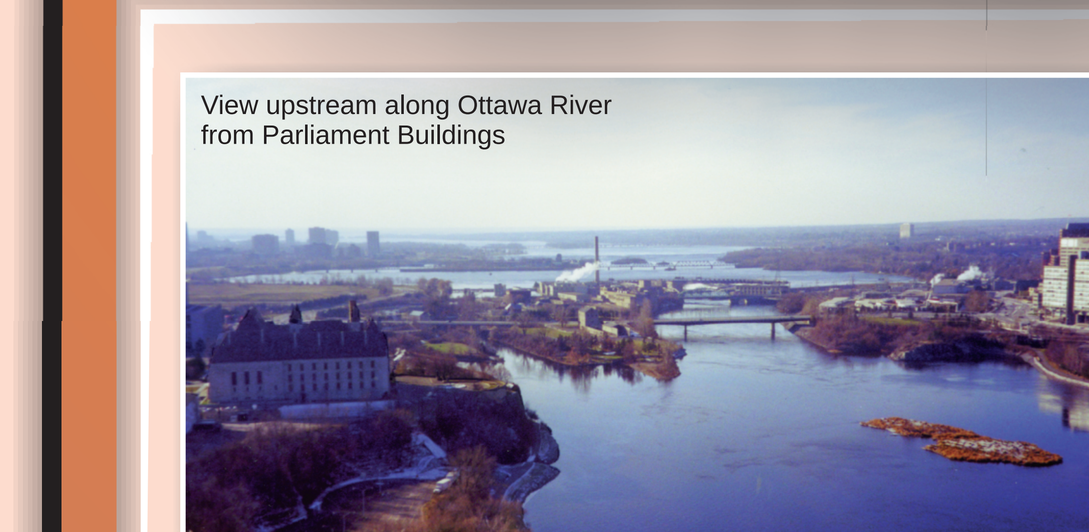
Increasing radon risk potential	
	Elevated levels: direct testing recommended
	Moderate levels: direct testing may be indicated
	Low levels
	Little or no uranium

Radon is estimated from levels of naturally occurring uranium in the top 10 to 30 cm of soil or rock.

Homeowners concerned about indoor radon levels should have their homes tested, regardless of the estimated radon potential shown.

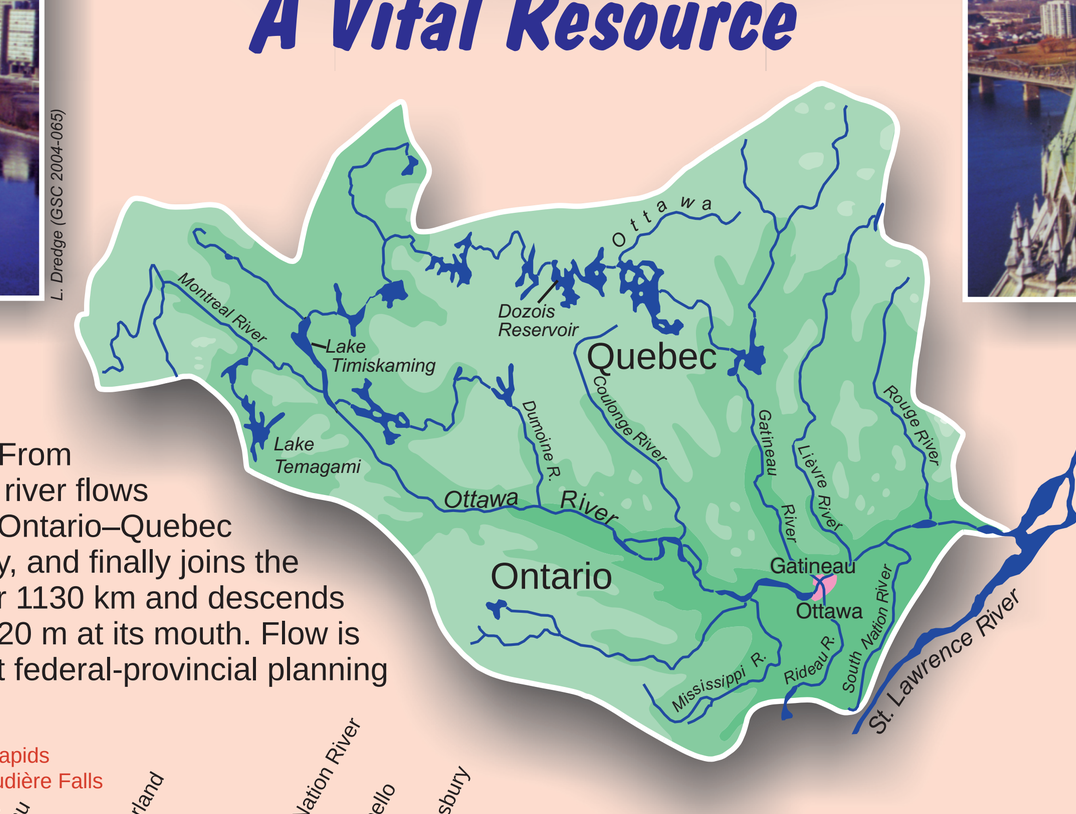
Did you know?... All rocks and sediments are naturally radioactive to varying degrees.

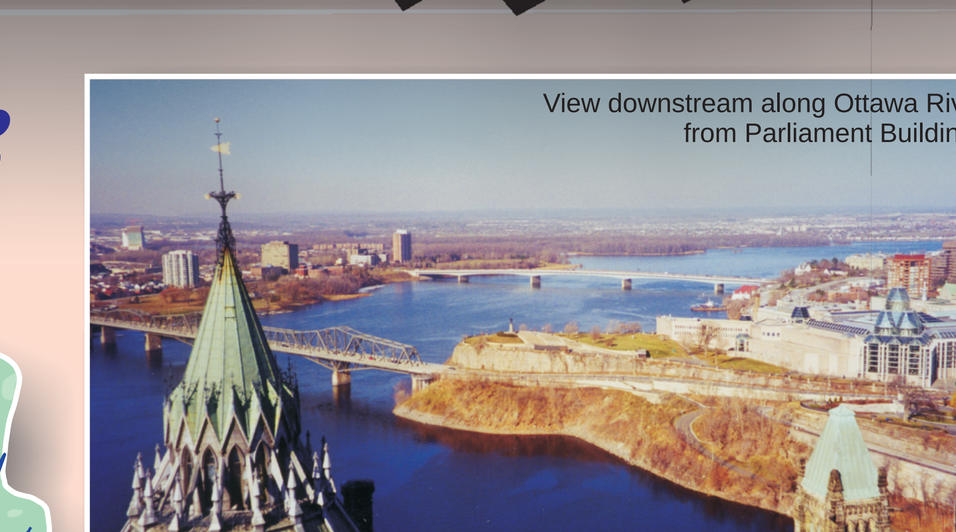
OTTAWA RIVER: A Vital Resource



View upstream along Ottawa River from Parliament Buildings

L. Dredge (GSC 2004-065)



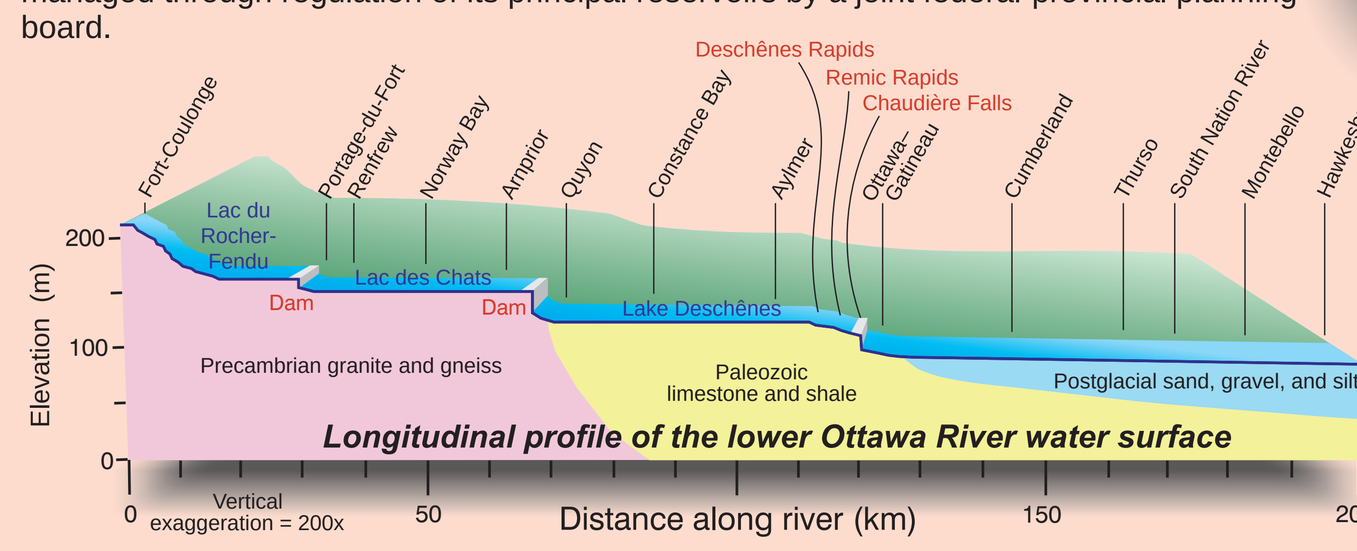


View downstream along Ottawa River from Parliament Buildings

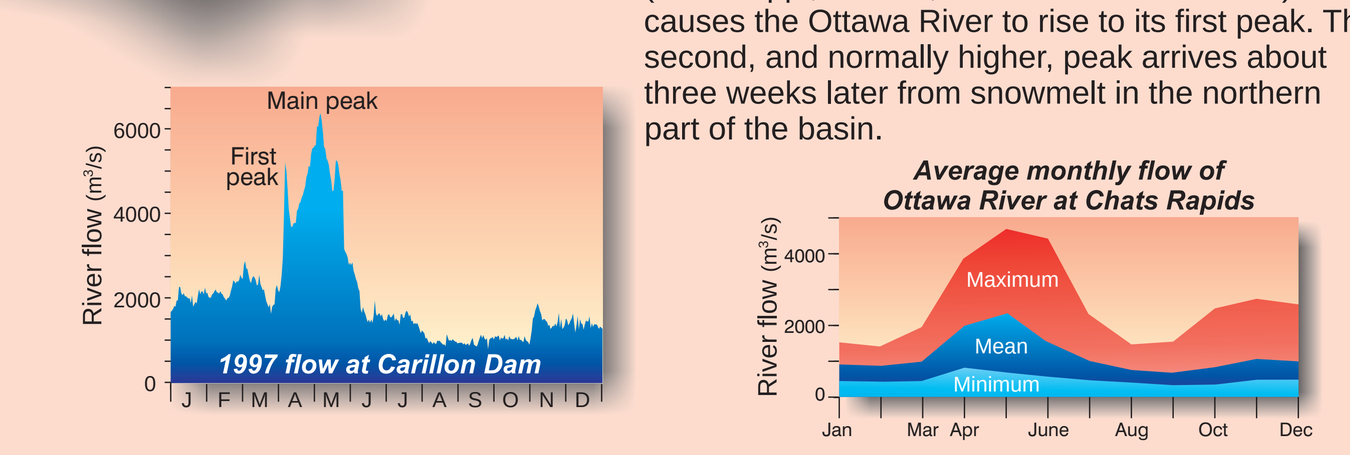
L. Dredge (GSC 2004-066)

The Watershed

The Ottawa River watershed has a total area of 148 000 km^2. From forested, rocky uplands of the Canadian Shield in Quebec, the river flows westward to Lake Timiskaming, then southeastward along the Ontario–Quebec border, through the agricultural lands of the lower Ottawa valley, and finally joins the St. Lawrence River. The river traverses a total distance of over 1130 km and descends about 400 m, from an elevation of 430 m at the headwaters to 20 m at its mouth. Flow is managed through regulation of its principal reservoirs by a joint federal-provincial planning board.



Longitudinal profile of the lower Ottawa River water surface



The Runoff Cycle

Flow varies considerably throughout the year. High runoff during the spring is caused by snowmelt. This is followed by lower flow during the drier summer months, an increase in flow due to fall rains, and fairly steady flow through the winter. The lower Ottawa River experiences two spring flood peaks. Spring arrives earlier along the southern tributaries (Mississippi, Rideau, and South Nation rivers) which causes the Ottawa River to rise to its first peak. The second, and normally higher, peak arrives about three weeks later from snowmelt in the northern part of the basin.

Average monthly flow of Ottawa River at Chats Rapids

Petrie Island beach

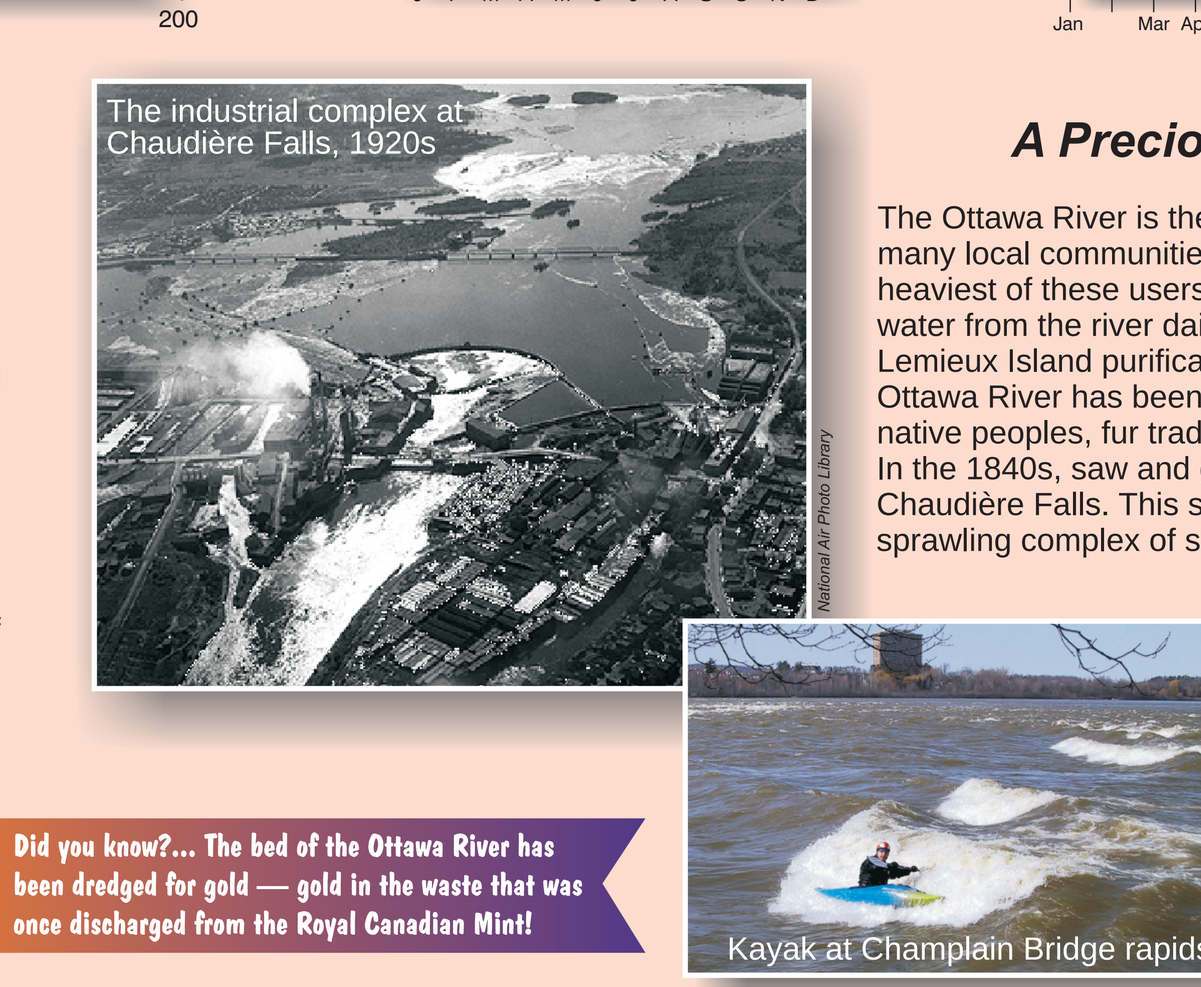
A. Tweddle, Friends of Petrie Island

Petrie Island marsh

A. Tweddle, Friends of Petrie Island

Rapids and Waterfalls, Beaches and Islands!

Falls and rapids occur where the Ottawa River drops over resistant bedrock outcrops. At these locations the river is relatively shallow and swift, and bedrock islands may divide the channel. Hydroelectric dams exploit some of these natural drops near Portage-du-Fort, Fitzroy Harbour, and Chaudière Falls, as well as along many of the tributary rivers (e.g. Gatineau River). Natural and artificial beaches are present in places along the wider, slower-flowing reaches of the Ottawa River (Norway beach, Britannia beach). Downstream of the confluence with the Gatineau River, the Ottawa River flows across Quaternary sediments and the landscape changes. Here, vegetated sandbars form low islands (Kettle Island, Petrie Island) and marshes are common along the shore.



The industrial complex at Chaudière Falls, 1920s

National Air Photo Library

Did you know?... The bed of the Ottawa River has been dredged for gold — gold in the waste that was once discharged from the Royal Canadian Mint!

A Precious Resource

The Ottawa River is the source of drinking water for many local communities. The City of Ottawa is the heaviest of these users, drawing 341 million litres of water from the river daily at the Britannia and Lemieux Island purification plants. Historically, the Ottawa River has been a transportation route for native peoples, fur traders, and the timber industry. In the 1840s, saw and grist mills were located at Chaudière Falls. This site later developed into a sprawling complex of saw, pulp and paper, and carbide mills, and hydroelectric plants, all utilizing the water and exploiting the energy of the falls. Some of these industries remain in operation today. Recreation is now a major use of the river.

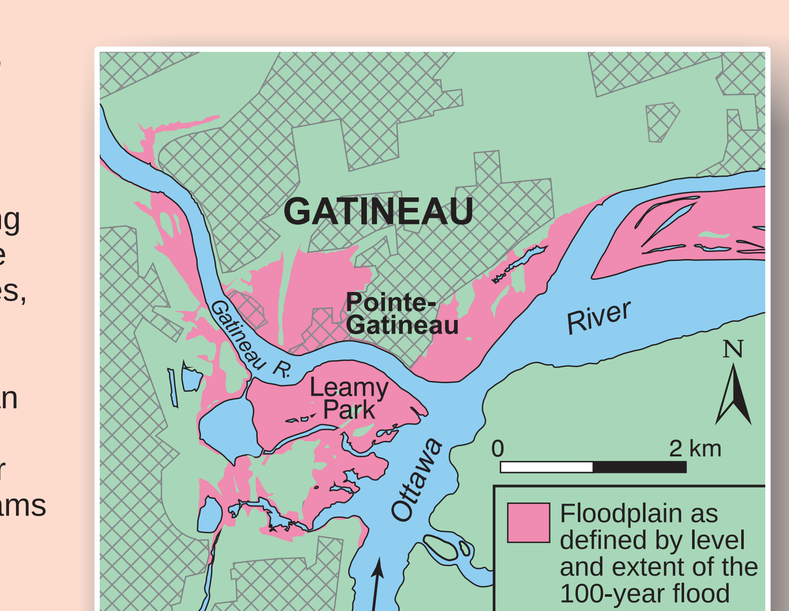
Kayak at Champlain Bridge rapids

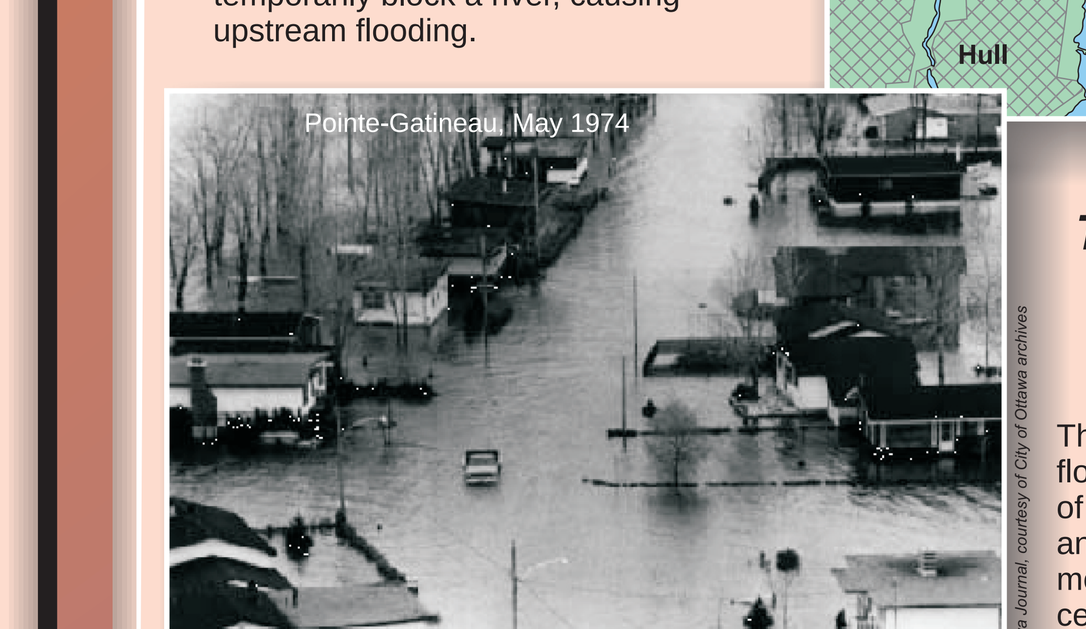
R. Knight (GSC 2004-067)

FLOODING: Just Too Much Water

Why Floods Happen

Flooding is a natural process. It happens when a river overtops its banks and inundates nearby low-lying areas. In communities built on these floodplains, properties, roads, bridges, and railways can be damaged or destroyed by high water levels and sometimes by moving ice. Floods can be caused by rapid melting of large amounts of snow, or rain on snow, or prolonged or torrential rainfall. Ice jams and landslide debris can also temporarily block a river, causing upstream flooding.





Pointe-Gatineau, May 1974

Ottawa Journal, courtesy of City of Ottawa archives

The 100-Year Flood — Not Every 100 Years!

The '100-year flood' refers to the flood level that has a 1% chance of occurring in any given year, and thus may actually occur more often than once in a century or, alternatively, not happen at all. The magnitude of the 100-year flood is commonly used to define flood zones and to design flood-protection structures

Defending Against Floods

Flood damages can be reduced substantially by avoiding development on flood-prone lands. Parks (such as Brewer Park along the Rideau River and Leamy Park in Gatineau), playing fields, and natural areas are appropriate land use for these flood-prone areas. Dikes, elevated embankments that provide a physical barrier between low-lying land and the river, can protect developments on the floodplain. A dike along the Gatineau River protects part of Gatineau. Although the reservoirs are too small to control flood discharge, the many power

Did you know?... To prevent ice-jam floods within Ottawa, the ice on the lower Rideau River is broken up each year during late winter by sawing and blasting, or by an amphibious backhoe.

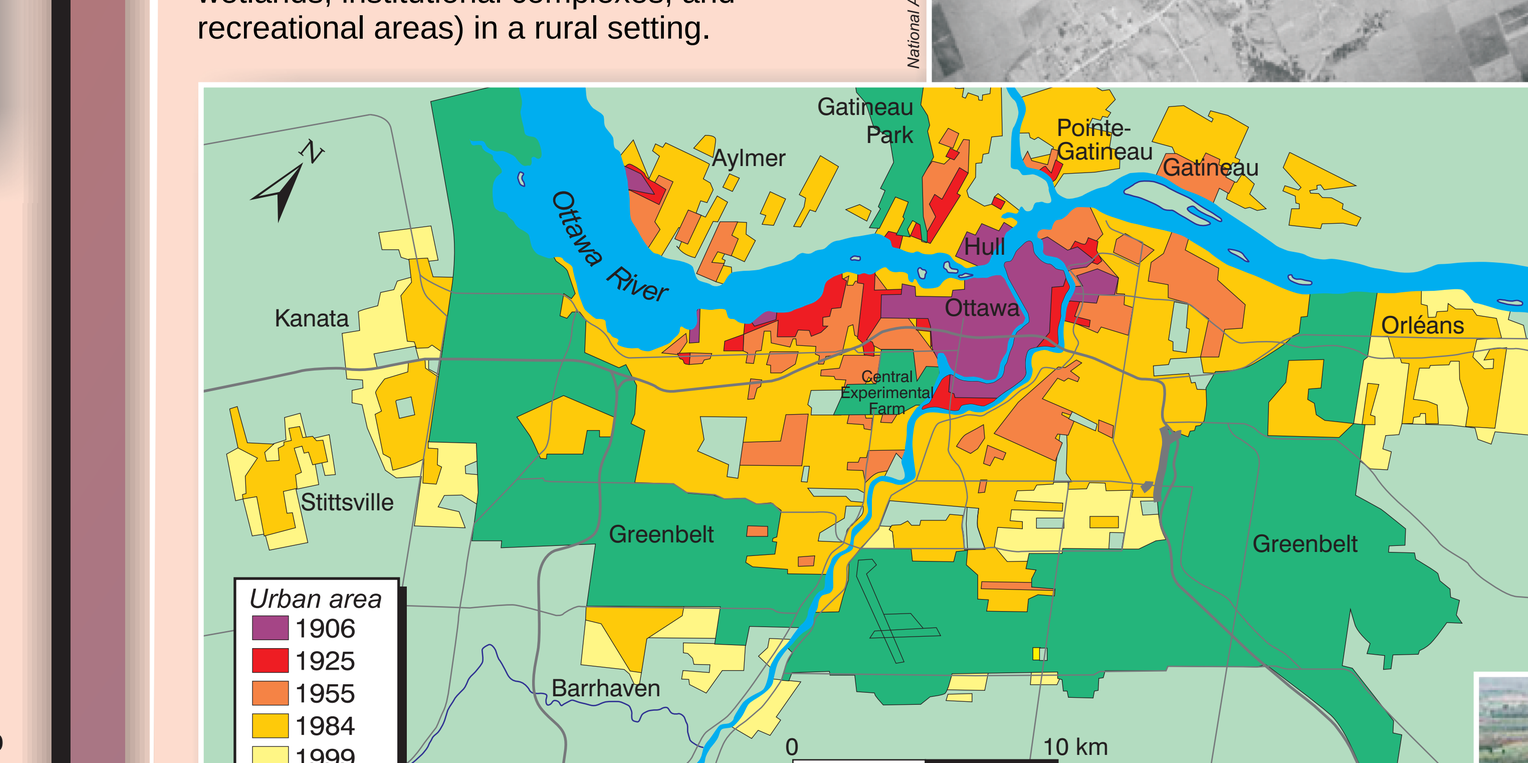
LAND USE: Living on the Land

Changing Times, Changing Use

The local rivers and Rideau Canal, which provided the primary means of transportation for settlers, fur traders, loggers, and the military, defined the early settlement of the region. Most early settlements were along rivers. Extensive logging in the 19th century was followed by development of farms in the lowland areas, and mining, mainly in the Gatineau Hills. In the 20th century, urban areas expanded greatly at the expense of natural areas and agricultural land, so that much of the vacant land within the urbanized area has some form of environmental constraint. Ottawa's growth has also been shaped by the Greenbelt, almost 20 000 hectares of publicly owned lands (farms, forests, wetlands, institutional complexes, and recreational areas) in a rural setting.

National Air Photo Library

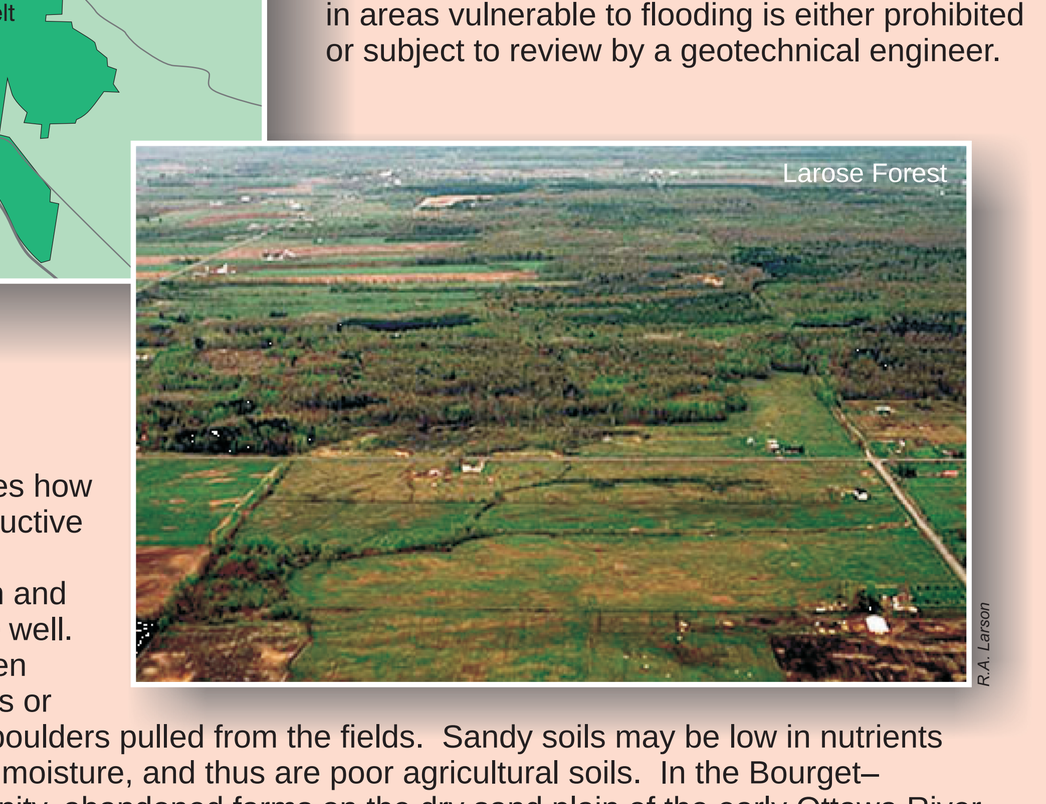
National Air Photo Library



Urban expansion, greater Ottawa area, 1906–1999

Decisions Can Be Hard!

Many of us might like to live in a home on a bluff with a beautiful view of the valley below or perhaps on the banks of a quiet river. Beware! Both may be hazardous. A bluff on Leda clay may be vulnerable to landslides and the riverside home may be prone to flooding. In Ottawa, development on clay slopes, on organic soils, or in areas vulnerable to flooding is either prohibited or subject to review by a geotechnical engineer.



Larose Forest

R.A. Larson

Geology and Agriculture

Soil texture, which is determined by the underlying geological material, determines how suitable the land is for agriculture. Nutrient-rich silt and clay soils are highly productive as long as surface drainage is adequate. Networks of long drainage ditches are common in these areas. Till, which has a fine-grained matrix, is also nutrient-rich and retains moisture well. Farms on till often have rock fences or piles built from boulders pulled from the fields. Sandy soils may be low in nutrients and do not hold moisture, and thus are poor agricultural soils. In the Bourget–Plantagenet vicinity, abandoned farms on the dry sand plain of the early Ottawa River have been returned to pine forest, now the Larose public recreation forest.

Did you know?... About 25% of all urban land is dedicated to our widespread use of vehicles: parking lots, roads, garages, driveways, and gas stations.

Catalogue no. M41-8/85E
ISBN 0-660-19066-4