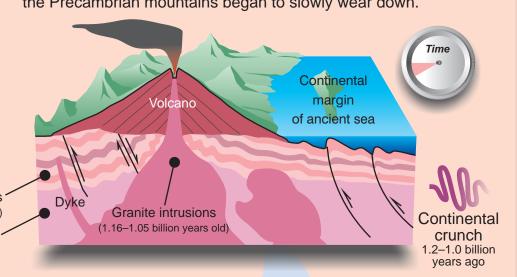
## DEEP TIME: Ancient Rocks It's All About Time The Earth formed about 4.6 billion years ago. Geologists have broken this enormous length of time into major divisions using fossil assemblages and radiometric dating of rocks. During the vastness of Precambrian time, the Earth's crust developed, and early 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. The late Precambrian, early Paleozoic, and late Cenozoic (Quaternary) are interlude of erosion spanning hundreds hat we see as a gap

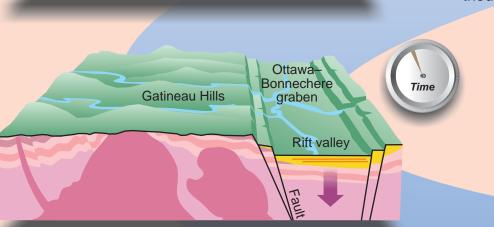
## **Ancient Mountains**

The oldest rocks in the region are the **Precambrian** marble. guartzite, 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



### Tropical Ottawa-Gatineau

arm tropical sea flooded the region. (We were near the equator then!) The oldest Paleozoic rock (the Nepean sandstone) was an ancient Camprian beach. In the Orgovician, 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 Ouring 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.

ed peat is vacuumed from bog surface

Peat is plant material that slowly accumulates and

resource for the horticultural industry, is extracted at

decomposes in bogs. Peat moss, an important

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).

mportant role in the history of

local mining. The stones in

many buildings in Ottawa are

the east of Kanata, near Hwy

face the Parliament Buildings

and the Museum of Nature.

ushed limestone, from quarries such as those

Gatineau, supplied lime for the production of cement

near Carlington Hill in Ottawa and the casino in

valley, an impervious

blanket (aquitard) of

lay limits aquifer

recharge. Excessive

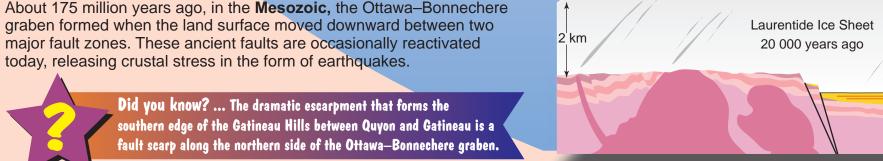
an deplete aquifers.

Champlain Sea silt and

pumping of groundwater

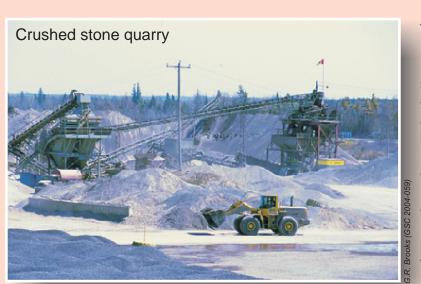
rom local quarries. Quarries to

17, provided the sandstone to



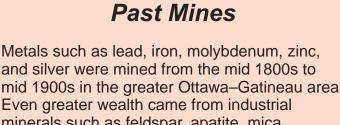
## WEALTH FROM THE LAND

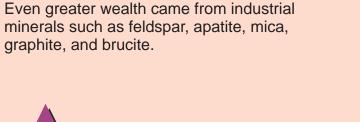
Mining Today for Aggregates and Peat



region are crushed













### Geoscape Ottawa–Gatineau Living With Our Geological Landscape Geological Survey of Canada, Miscellaneous Report 85, 2004

he following agencies and organizations participated in the planning, preparation nd/or production of Geoscape Ottawa-Gatineau: eological Survey of Canada and Canada Centre for Remote Sensing, Natural Resources anada; Canadian Museum of Nature; Department of Geography and Environmental Studies nd Department of Earth Sciences, Carleton University; Department of Earth Sciences, Iniversity of Ottawa; Environment Canada; Écomusée de Hull; Friends of Petrie Island; lational Capital Commission; Ottawa-Carleton District School Board; Ottawa-Carleton Cathol hool Board; Commission scolaire des Draveurs; Ontario Ministry of Natural Resources; City of Ottawa; Rideau Valley Conservation Authority; South Nation Conservation Authority. ext and figures were contributed by J.M. Aylsworth, A.L. Bent, G.R. Brooks, D. Corrigan, a. Donaldson, B.J. Dougherty, L.A. Dredge, C.R. Harington, S. Heenan, D. Irwin, I.M. Kettle

. Lawrence, B.E. Medioli, F. Michel, J.B. Percival, M. Poirer, H.A.J. Russell, 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 2004: Geoscape Ottawa-Gatineau; Geological Survey of Canada, Miscellaneous

3303-33rd Street N.W. 101-605 Robson Street Ottawa, Ontario K1A 0E8 Calgary, Alberta T2L 2A7 Vancouver, B.C. V6B 5J Web site: www.nrcan.gc.ca/gsc

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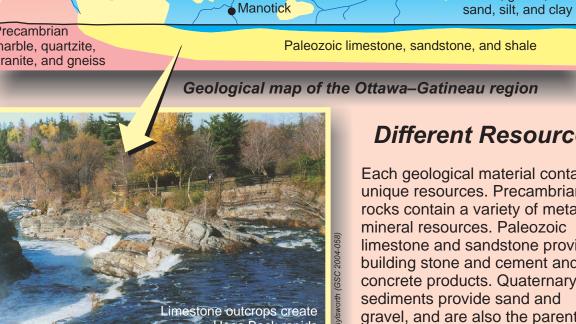
# website at <u>www.geoscape.nrcan.gc.ca</u>

# Geoden 20 Offange Gatineau

## DIFFERENT ROCKS he Gatineau River drains the rugged Canadian Shield

Ottawa–Gatineau region is underlain by three different geological granitic and metamorphic rocks of the Canadian Shield form highland areas t 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).



ach geological material contains ocks contain a variety of metal and nineral resources. Paleozoic imestone and sandstone provide building stone and cement and concrete products. Quaternary ediments provide sand and

CHANGING LANDSCAPE: The Recent Past

landscape reflects this glacial heritage. For example...

tony soils have developed on till, the

nixture of clay, silt, sand, pebbles and

oulders carried by, and deposited from,

Huge isolated boulders, left behind by

Ice Sculpts the Land

Great ice sheets flowed over the Ottawa–Gatineau region several times during the last 1.6

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

million years. The last one covered the region from 20 000 to 11 000 years ago. Our

eroded by particles embedded in the base of the moving ice sheet

## 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.

# Unstable Clay Slopes eda clay slopes in the Ottawa valley are vulnerable to catastrophic andslides. 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 ailure. 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

LANDSLIDES: The Earth Can Move

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 dominolike fashion, rapidly eating back into the flat land lying behind the failed slope. The

# Salette, Quebec, with the loss of 33 liv Lemieux, The Town That Was

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

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

to the bonding of the particles were slowly removed (leached) by fresh water filtering through the ground. If

high rainfall or rapid snowmelt), earthquakes, and human activities such as excavation and construction.

## '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 ir 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

## EARTHQUAKES: In Ottawa—Gatineau!

damaging infrastructure. Geologists and

potential landslide areas, and appropriate

land-use zoning and protective engineering

geotechnical engineers can identify

on upper floors of tall building Felt indoors by many people. Hanging objects swing back and forth. May not be felt outdoors

What We Feel 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



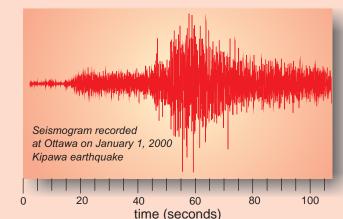
**Protecting Ourselves** 

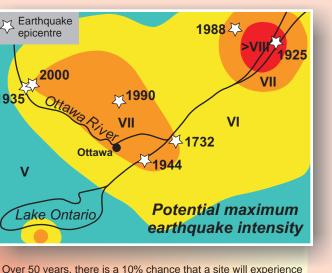
By evaluating the local history of earthquakes and the local geology, seismologists can produce maps predicting maximum ground motion or intensity for a region. Seismological data are used to set our national building codes that specify the engineering design requirements for earthquake-resistant

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.





Objects fall. No structural damage tensity VII: General alarm. Difficult to stand. Mild to

## INDOOR RADON: An Invisible Hazard

oreakdown 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 igh 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 mproving home ventilation.

### reatly throughout the depending mainly on

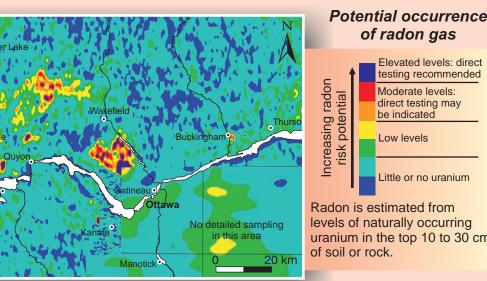
Anatomy of a landslide

the composition of the While the only way to determine the actual concentration of radon in a home is by a direct geological maps

Radon concentrations differ

showing the uranium in rocks and

soil at surface can be used to estimate ootential indoor rad



indoor radon levels should have their homes tested regardless of the estimated radon potential shown.

Did you know?... All rocks and sediments are

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

Ancestral Ottawa River channels

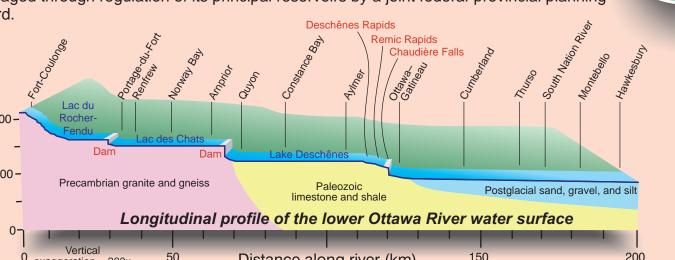
# A Vital Resource

OTTAWA RIVER:

## The Ottawa River watershed has a total area of 148 000 km<sup>2</sup>. From

iew upstream along Ottawa Rive

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



# A Precious Resource

The Runoff Cycle

Flow varies considerably throughout the year. High

runoff during the spring is caused by snowmelt. Thi

is followed by lower flow during the drier summer

months, an increase in flow due to fall rains, and

Ottawa River experiences two spring flood peaks.

Spring arrives earlier along the southern tributaries

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

Mississippi, Rideau, and South Nation rivers) which

Average monthly flow of

Ottawa River at Chats Rapids

fairly steady flow through the winter. The lower

## ne Ottawa River is the source of drinking water for

carbide mills, and

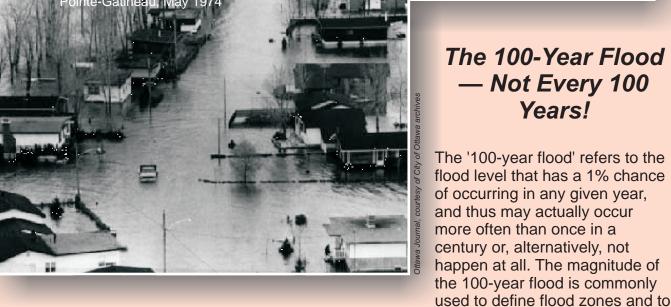
and exploiting the energy of the falls. Some of these industries remain in operation today. Recreation is now a

nany local communities. The City of Ottawa is the neaviest of these users, drawing 341 million litres of water from the river daily at the Britannia and emieux 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 prawling complex of saw, pulp and paper, and hydroelectric plants, all utilizing the water

### nappens 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

FLOODING: Just Too Much Water



Landsat TM 7 Data collected by

USGS EROS Data Center and

provided courtesy of Canada Centre

Flooding is a natural process. It

upstream flooding.

The 100-Year Flood Not Every 100 The '100-year flood' refers to the

Floodplain as

defined by level

100-year flood

of occurring in any given year, and thus may actually occur more often than once in a entury or, alternatively, not appen 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

too small to control

### Changing Times, LAND USE: Living on the Land

provided the primary means of transportation for 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

wetlands, institutional complexes, and

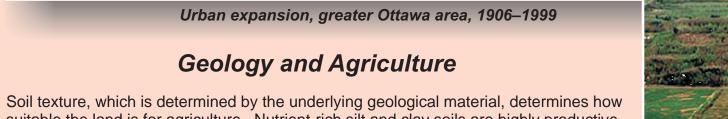
recreational areas) in a rural setting.

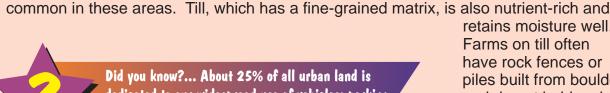


### Many of us might like to live in a home on a bluf with a beautiful view of the valley below or perhaps on the banks of a quiet river. Beware!

Decisions Can Be Hard

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.





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-

## lots, roads, garages, driveways, and gas stations

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.

12 000 years ago

Groundwater provides much of the water used or residential and recharge of bedrock and agricultural purposes in rural parts of the region. It also moves nutrients to vegetation and provides flow to streams. Ground water 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

hard water. Municipal waste-disposal sites in Carp, Gloucester, and Aylmer have leaked and contaminated **)id you know? ...** In 1991, the improper disposal of dry cleaning chemicals aguifers. In rural areas, livestock wastes, pesticides, and fertilizers have polluted pment of a water main for local residents at a cost of millions of dollar

## GROUNDWATER: Vital but Vulnerable

Seaside Ottawa-Gatineau

valley. The great weight of the ice sheet depressed he land surface by hundreds of metres, and, as the

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

containing fossils ranging from tiny seashells to whale

a widespread blanket of marine mud (Leda clay)

bones, are evidence of this sea in the present

Present Ottawa River

Ocean flooded the Ottawa valley, forming the Champlain Sea. As the glacially depressed lands

glacier retreated, about 12 000 years ago, the Atlantic

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

'ink Lake, Gatineau Park, and 'red' trout, a

Vulnerable!

Groundwater can be contaminated. Contaminant sources in urban areas includ gas stations, dry cleaners, garbage dumps, snow-disposal dumps, and industrial sites.

### alls 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

Rapids and Waterfalls

Beaches and Islands

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, Did you know?... The bed of the Ottawa River has vegetated sandbars form low islands (Kettle Island, Petrie Island) and marshes are common along the shore.

### Pid you know?... To prevent ice-jam floods within Ottawa, the ice vinter by sawing and blasting, or by an amphibious backho

flood discharge, the many power

the reservoirs are