AN OVERVIEW OF SOILS IN QUÉBEC: FORMATION, VARIABILITY AND CHALLENGES

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SOIL CLASSIFICATION

- **Nine Mineral Orders and one Organic Order** – based on the nature of the soil environment and the effects of the dominant soil forming process examples **Podzols, Brunisols etc**
- Note that 90% of Canadian soils are unlikely to be cultivated.
- The Canadian system classifies soils found only in Canada and is not meant to be comprehensive.

RELATIONSHIP OF CANADIAN SYSTEM TO OTHER SOIL CLASSIFICATION SYSTEMS

Canadian	USA	FAO
Regosolic	Entisol	Fluvisol, Regosol
Brunisolic	Inceptisol, some Psamments	Cambisol
Podzolic	Spodosol, some Inceptisols	Podzol
Luvisolic	Boralfs & Udalfs	Luvisol
Gleysolic	Aqy-suborders	Gleysol, Pansol
Chernozemic	Boroll, some Vertisols	Kastanozem, Chernozem
Solonetzic	Mollisol & Alfisol,Natric great group	Solonetz
Vertisolic	Verticals	Vertisol
Cryosolic	Pergelic subgroups	Gelic
Organic	Histosol	Histosol

GEOLOGIC EVENTS IN SOUTHERN QUÉBEC - SOURCE OF THE PARENT MATERIAL

METAMORPHIC ROCKS FROM THE GRENVILLE PROVINCE ARE FROM A MOUNTAIN RANGE 3,500 MILLION YEARS TO 900 MILLION YEARS OLD

Covers a surface area of 600,000 km² in Québec

Early Precambrian rocks – oldest rocks – sediments and volcanic - granite and gneiss and schist bedrock

There is disagreement about the age of these rocks which underlie (at a 1 km depth) all of Montreal

NEXT MAJOR EVENT

- The limestone beds found on the Montreal Island and Ile Jesus were part of the continental shelf of the "Lapetus" ocean from 600 million years ago when this area was located near the equator
- These limestone beds of mud, fossils and sand or "The St Lawrence Platform" were laid down on part of the Grenville province and now underlie most of the St Lawrence Lowlands
- One of the soil series (Farmington) found on the Mac Campus formed on top of the St Lawrence platform

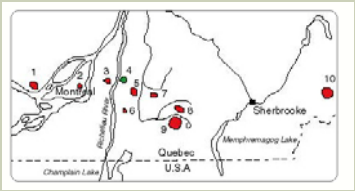
STE LAWRENCE PLATFORM

500 million years ago the rocks of the St. Lawrence Platform formed in a tropical sea. At that time, the region was located at a much milder latitude.

7

TIME LINE OF GEOLOGICAL EVENTS

- 135 million years to 6.5 million years ago – igneous rock (magma) intrusions cooled under the earth surface. These alkaline intrusions formed Mount Royal, Rougemont, Mount St Bruno, Mont St-Hilaire and others.



8

MONTEREGIAN HILLS

- Mount Royal, Mount St Hilaire, Rougemont, and others of the Monteregian Hills were formed by slow cooling igneous intrusions – this magma cooled under the surface – unique minerals found in some of the quarries
- There were some volcanoes but these have all disappeared leaving only the magma chambers and conduits

THE GLACIERS

- Between 1.6 million years and 10,000 years ago there were successive glaciations covering all of this region
- The weight of the glaciers, between 2 to 3 km thick depressed the crust of the earth
- Note: the glaciers also eliminated all of the earthworm species in Quebec – what exists came with the European settlers. The spread and increase in earthworm population has accelerated soil formation and removed the forest organic surface layer

Ice coverage of North America during the Wisconsinan Ice Age, at about 18,000 years before present.

http://opinicon.wordpress.com/physical-environment/quaternary/

11

CHAMPLAIN SEA

- 12, 00 to 9,500 years ago –after the glaciers left, the land was depressed by the weight of the glaciers and the Atlantic Ocean moved in forming the Champlain Sea which deposited clay sediments 25 to 30 m thick

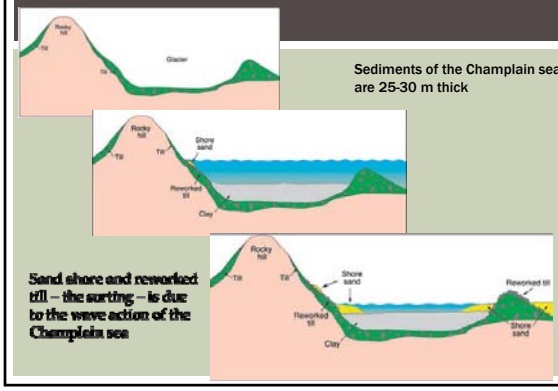
12

EXTENT OF THE CHAMPLAIN SEA

REMAINS OF THE CHAMPLAIN SEA

- 9,500 to the present – as the land rebounded (increased in height above sea level) the Champlain sea retreated, and the river started to erode the clay sediments.
- This "Isostatic rebound" left behind– Lake Saint Francois is a part of this glacial lake

GLACIERS AND THE CHAMPLAIN SEA

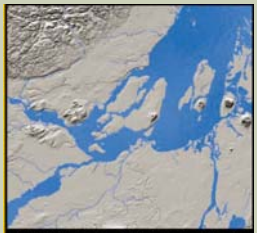


Sediments of the Champlain sea are 25-30 m thick

Sand shore and reworked till – the sorting – is due to the wave action of the Champlain sea

11,500 AND 9,000 YEARS AGO

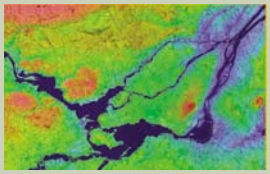
Approximately 11 500 years ago, the tops of the Monteregian Hills emerged from the Champlain Sea. Then, as the continent gradually rebounded, the islands formed by the hills grew larger and larger.



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.

PRESENT TIME

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.



The high areas of the Laurentians and the Monteregian Hills appear red, and the lowlands or terraces, which are at lower altitudes, are depicted in ochre, green, and blue.

COMMON SOIL ORDERS IN EASTERN CANADA

Profiles and description

GLACIAL TILL PARENT MATERIAL :

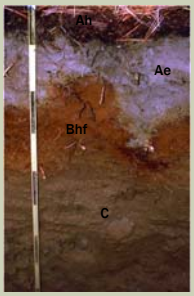
LANDSCAPE - BRUNISOL

BRUNISOL

Good to imperfect drainage, moderate oxidizing conditions developed under forest or grass – Ah, (Ae) and only a Bm - brownish or structured, C but not a Bt or Podzolic B

LANDSCAPES- PODZOL

PODZOL



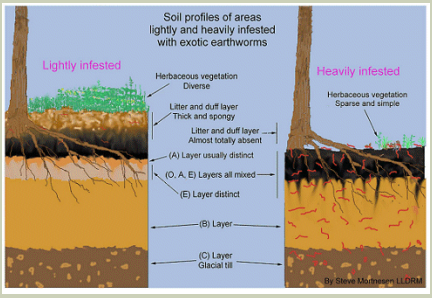
- well to imperfectly drained soils that have developed under conifers, mixed forests - dominate conifers, mostly in cold and temperate climates on acid parent materials
- the soils have a podzolic B horizon in which characteristic accumulation products are organic matter (fulvic acid) combined with iron (Fe) and aluminum (Al). The materials form coatings on the sand and silt sized particles
- podzolic B consists of one or more Bh,Bhf or Bf (h = humus and f = iron)

LANDSCAPE- LUVISOL

LUVISOL

- well to imperfectly drained soils, developed under either deciduous, mixed deciduous - conifers or boreal forests - the dominate vegetation is forest
- moderate and cool climates, moist, parent material neutral to alkaline
- have an eluviated Ae and an illuvial textural Bt (deposition of silicate clay)
- LFH, Ah, Ae, Bt, C

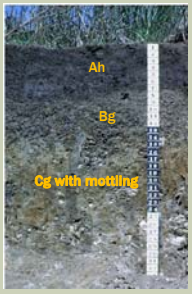
EFFECT OF EARTHWORMS ON SOIL FORMATION



LANDSCAPE- GLEYSOL

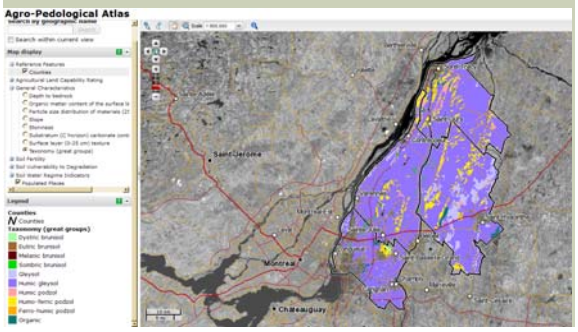
these soils need sub-surface drainage to improve the water movement - otherwise they cannot be easily cultivated

GLEYSOL

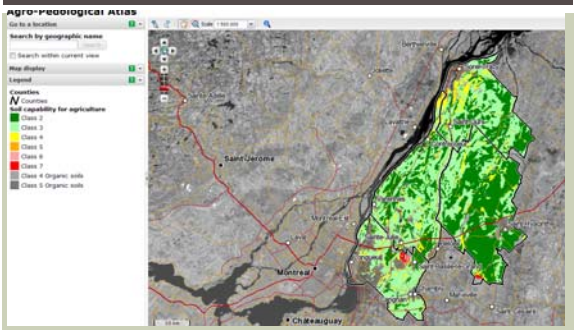


- these soils are saturated with water and are under reducing conditions continuously or during some part of the year unless they are artificially drained
- original vegetation can vary
- but the B and C horizons will show signs of "gleying" - reducing conditions - mottling have to have a Bg and a Cg
- LFH, Ah, (Ahe) Bg (Btg), Cg

EAST OF MONTREAL – GENTLE SLOPE, CLAYS, INTENSIVE AGRICULTURE



SOIL CAPABILITY FOR AGRICULTURE MAIN RESTRICTION IS EXCESSIVE WATER



ORGANIC SOILS OR MUCK SOILS

ORGANIC SOILS - FORMED FROM ORGANIC MATTER AS THE PARENT MATERIAL

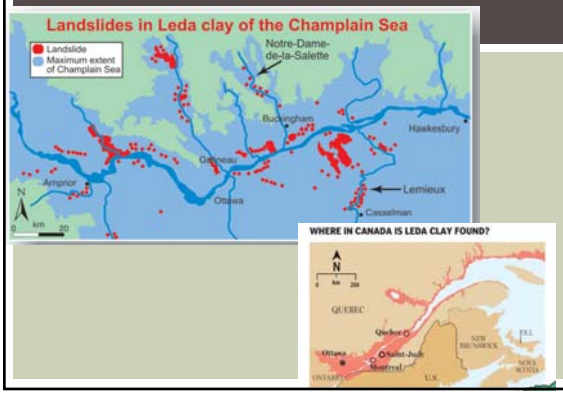
- Organic material can be from various sources and the source (tree, bush, swamp grass etc) can vary over time depending on the environmental conditions
- These soils are not old, about 10,000 years, formed after the river eroded away much of the Champlain clay
- For these soils to form organic matter accumulation must exceed decomposition

GLACIERS AND LANDSLIDES -

LANDSLIDES

- Parts of Quebec and Ontario along the old edges of the Champlain sea are prone to landslides – the St Lawrence and Ottawa valleys
- Within 60 km of Ottawa there have been 250 landslides and more around Montreal
- These landslides are caused by potentially unstable material called “Leda clay” – HOWEVER the “clay” part is incorrect

EXTENDS ALONG THE ST LAWRENCE VALLEY AS WELL



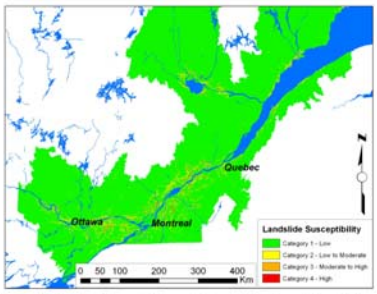


Figure 2. Updated landslide susceptibility map for large landslides in sensitive clay in the Saint Lawrence Lowlands.

http://petequinnramblings.wordpress.com/2012/05/12/sensitive-clay-landslide-risk-in-eastern-canada-draft-paper/

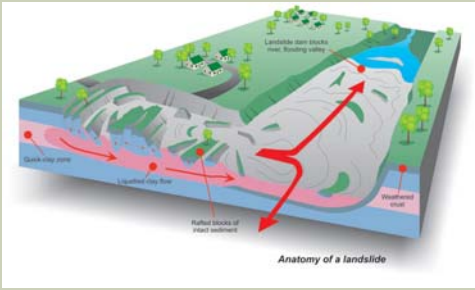
LEDA CLAY

- This material is comprised of clay and silt sized particles of bedrock (silt between 0.05-0.002 mm and clay is less than 0.002 mm)
- This material has not been chemically altered
- It settled to the bottom of the Champlain Sea and due to the salt content of the water, the particles were attracted to each other.
- They formed a loose but strong framework that holds a large amount of water – salts (charged) were essential to the structure

AFTER THE SEA RETREATED

- After the sea retreated these materials were subject to steady removal of the salts by water moving through the system
- If disturbed these leached Leda "clays" which still hold a large amount of water, will suddenly liquefy and flow – (the structural stability given by the salts is gone)
- Disturbances can be river erosion, high rainfall or snow melt, earthquakes (and these are common in this region) and human activities such as construction

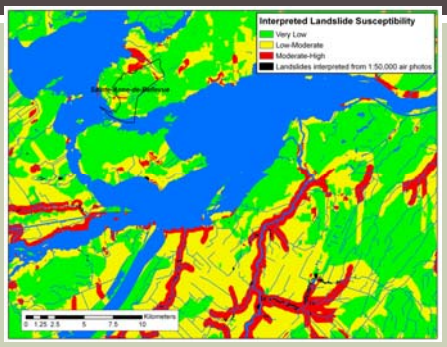
A FAMILY AND HOUSE WERE LOST TO A LANDSLIDE IN ST JUDE IN MAY 2010



Anatomy of a landslide

Aerial view of the 1993 Lemieux landslide, Ontario taken 4 days after the event. The flood waters of the South Nation River, which rose 12 m to overtop the debris dam, have inundated the mouth of the landslide scar. The town of Lemieux was abandoned in 1991 because of instability below ground

LANDSLIDE POTENTIAL AROUND MONTREAL



CHALLENGES

- Climate change – extreme events – warming weather will change soil dynamics
- Loss of Land to urbanization
- Intensification of land use
- Land Classification for agriculture – limited amount in Québec
- Leaching loss of nutrients through the subsurface drains