

THIS CLASS

1. Remnants from Class 4

- **Mercury**

2. Geology and Cities



Early treatment for syphilis and leprosy

Cinnabar HgS



Cinnabar lacquerware
Qing dynasty



Rouge



Vermillion Red



Ivan IV Vasilyevich
From Ivan to Ivan The Terrible

- In 1547 Ivan *Tsar of Russia*.
- Wise ruler but later in life Ivan became harsh, paranoid. He tortured and killed even close friends. In one outburst he murdered his son.
- Historians: **Body exhumed: highly contaminated with mercury. Syphilis was treated with mercury**

Mercury

- Uses



Hg switches



Thermometers



Hg gas lamps



1865 Lewis Carrol novel and films 1903-1999



Mercurochrome
Merthiolate, etc.



Calomel
 Hg_2Cl_2



DANGEROUS!
Cosmetics With
High Mercury
Levels



Gold amalgam



Dental amalgam



Batteries



Neon lights



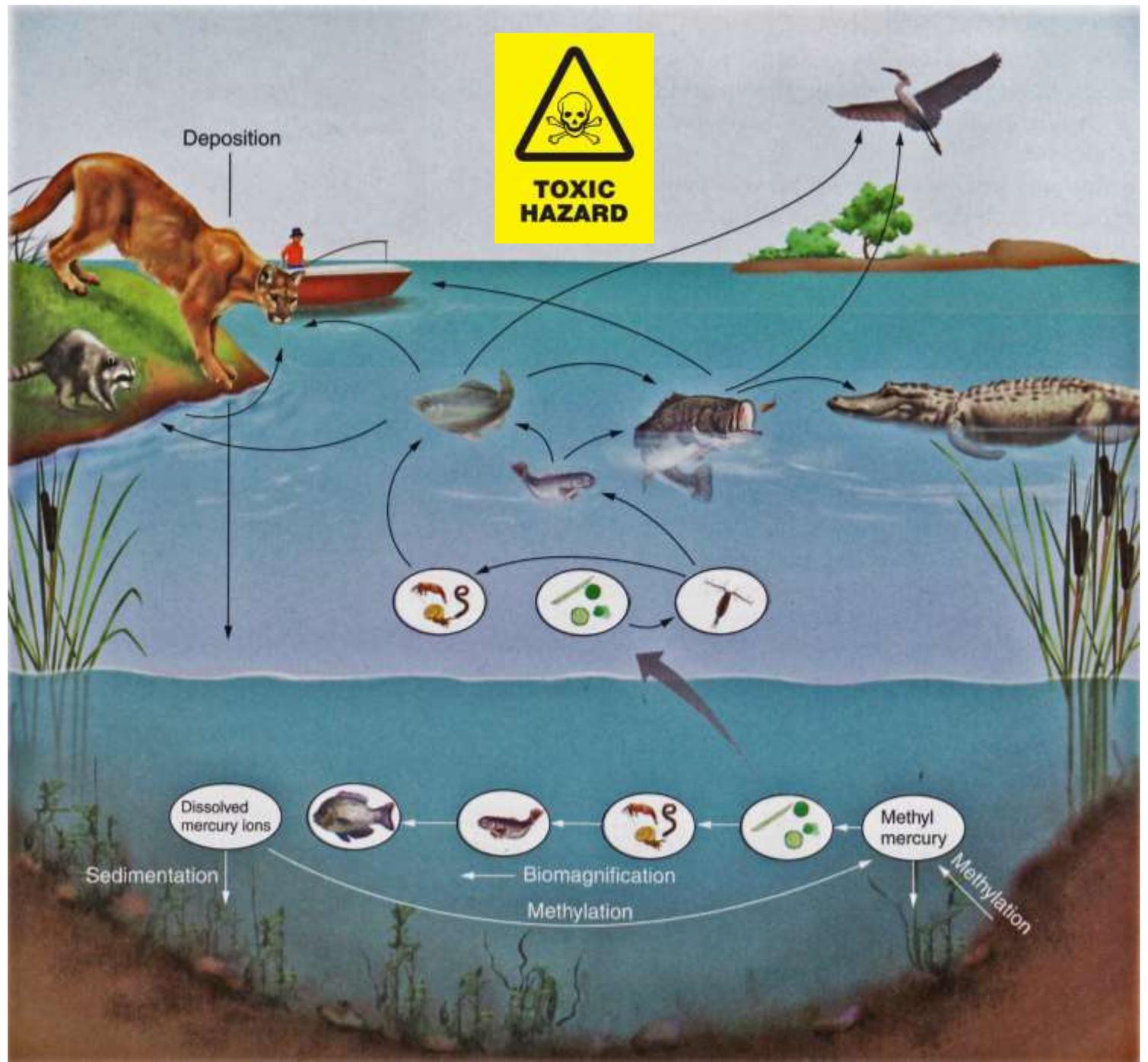
Bleach



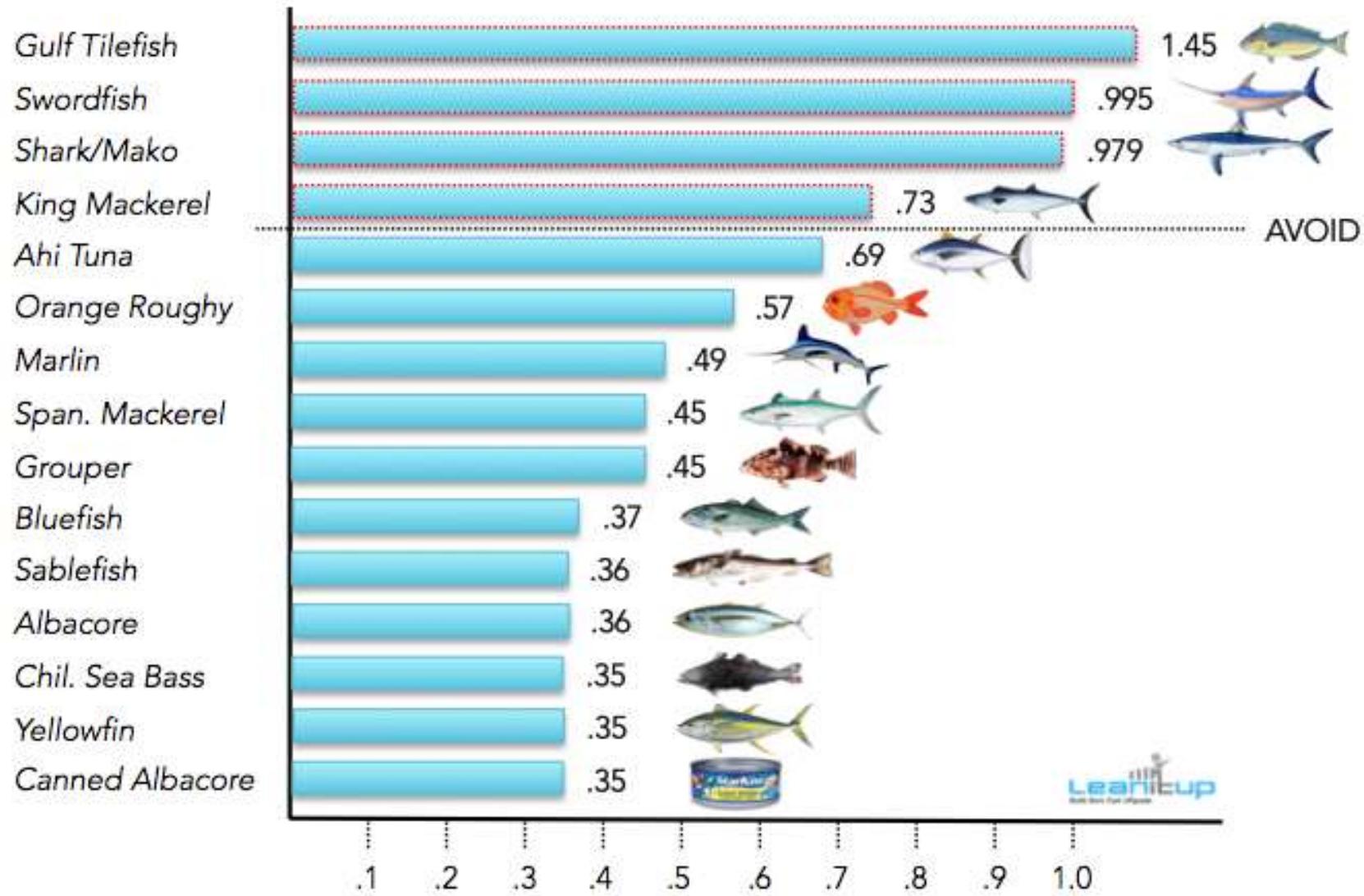
Methylmercury

CH_3Hg^+

- **Bioaccumulation and Biomagnification**
- **Methylation** addition of methyl generated by methane produced by bacteria (from CO_2) in mud
- Marine algae contain up to 100 times the mercury in water
- Small organisms eaten by larger organisms and so on



Top 15 Fish — Mercury Levels



Mercury Content, PPM/Oz.

Minamata Bay, Japan, Mercury Poisoning

- Chemical **Chisso Corporation**. **Wastewater 1908 - 1960s**
- Discovered 1956. **Methylmercury**, which bioaccumulated in fish and shellfish.
- “Dancing cat” disease in animals
- More than 10,000 people affected
- Ataxia (loss of full control of bodily movements), numbness in the hands and feet, general muscle weakness, loss of peripheral vision, and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms.
- Affects fetuses in the womb; legacy to this day



Mercury in Nova Scotia

- 85% of mercury pollution comes from burning coal (EPA)
- Earlier 50% of mercury use for making caustic soda and chlorine bleach. Caustic soda for paper industry to achieve whiter paper
- Area around Kejimikujik National Park in Nova Scotia a mercury hotspot. Affects loon reproduction



The Precautionary Principle (Better Safe than Sorry)

- *“Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation”*

UN Rio Declaration 1992

- When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm. Morally unacceptable harm refers to harm to humans or the environment that is
 - threatening to human life or health, or
 - serious and effectively irreversible, or
 - inequitable to present or future generations, or
 - imposed without adequate consideration of the human rights of those affected.

GEOLOGY AND CITIES

- **Granite**
 - Radon
- **Limestone**
 - Coral reefs
 - Limestone
 - Marble
 - Sinkholes



St. Mary's Basilica (Halifax)
Granite, 120 years



Verona amphitheatre for 30,000 people
Limestone 2100 years



Sinkhole, Guatemala City
Ash, Limestone 2007

Granite

- Igneous rock formed by magma that cooled (crystallized) at great depth
- Very hard, with abundant quartz (can scratch glass) and feldspar, black or dark mica.
- Very strong, durable as construction stone, kitchen counters
- Abundant in Nova Scotia (South Mountain)
- Purcell's Cove Quarries



No wheel, no steel,
No mortar

Machu Picchu, Peru 1450 AD 2,420 m.a.s.l.

Magma

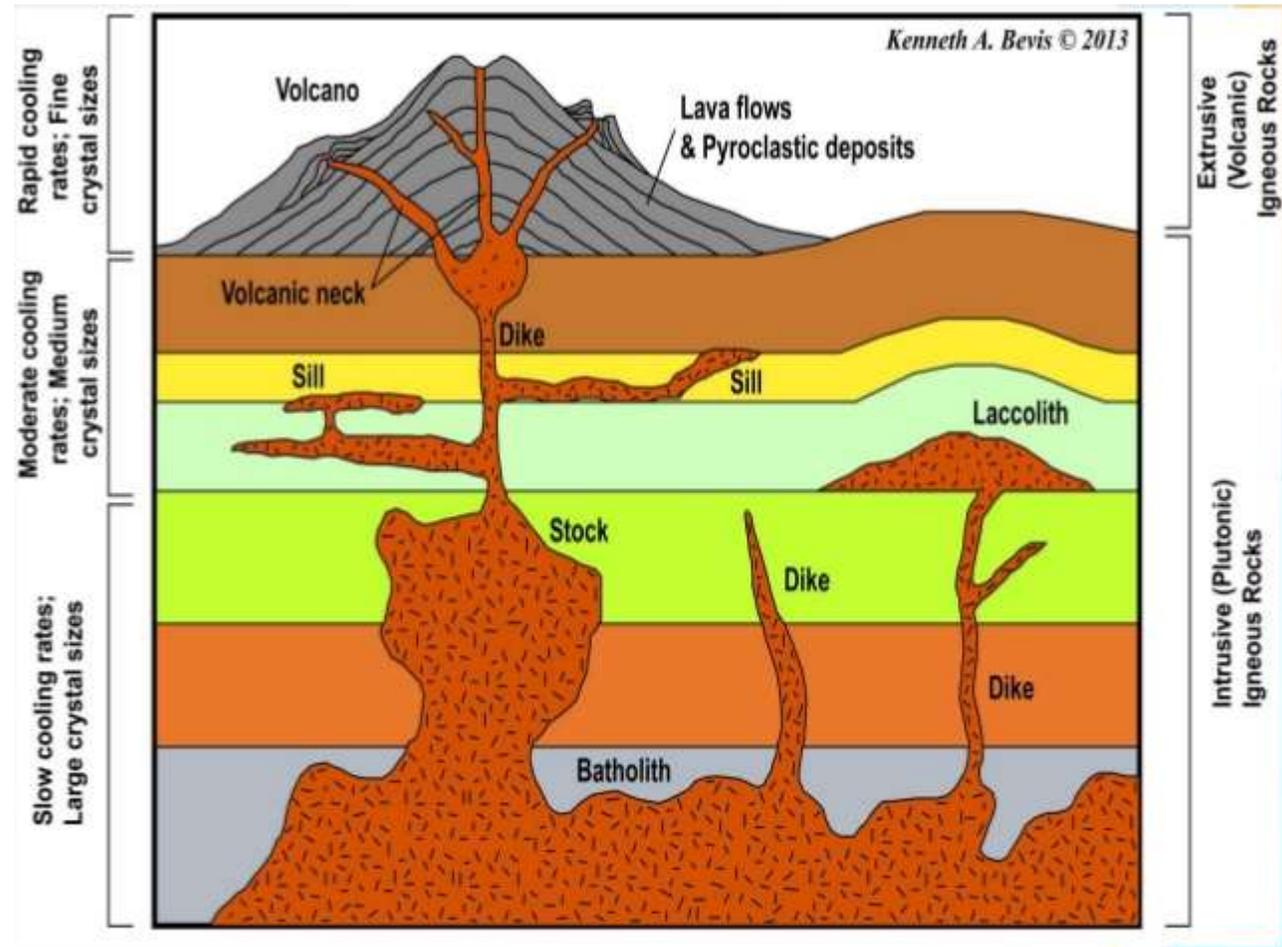
Magma is the molten or semi-molten natural material from which all igneous rocks are formed



Granite

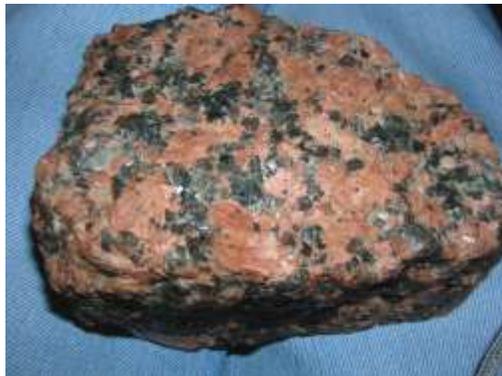


Lava



Magma

Magma is the molten or semi-molten natural material from which all igneous rocks are formed

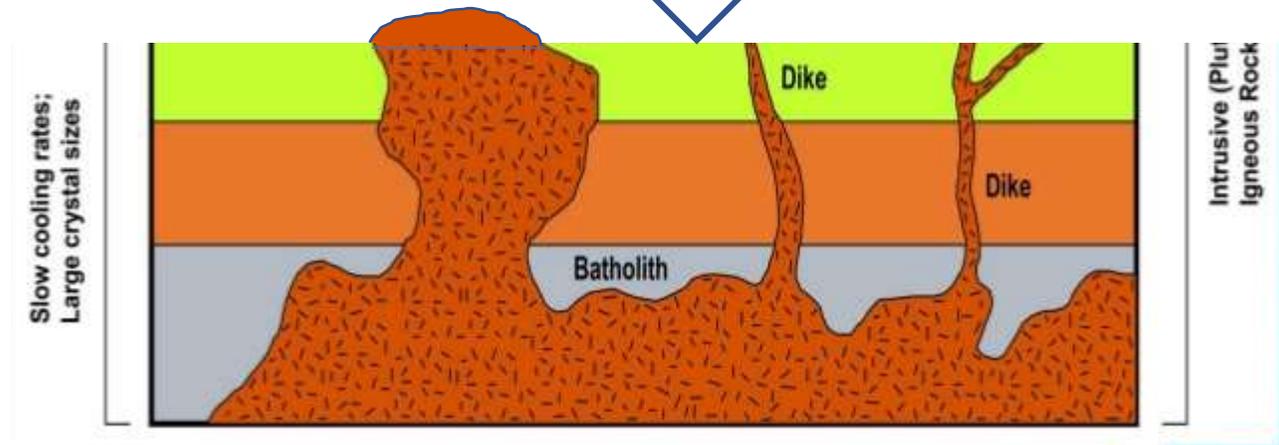


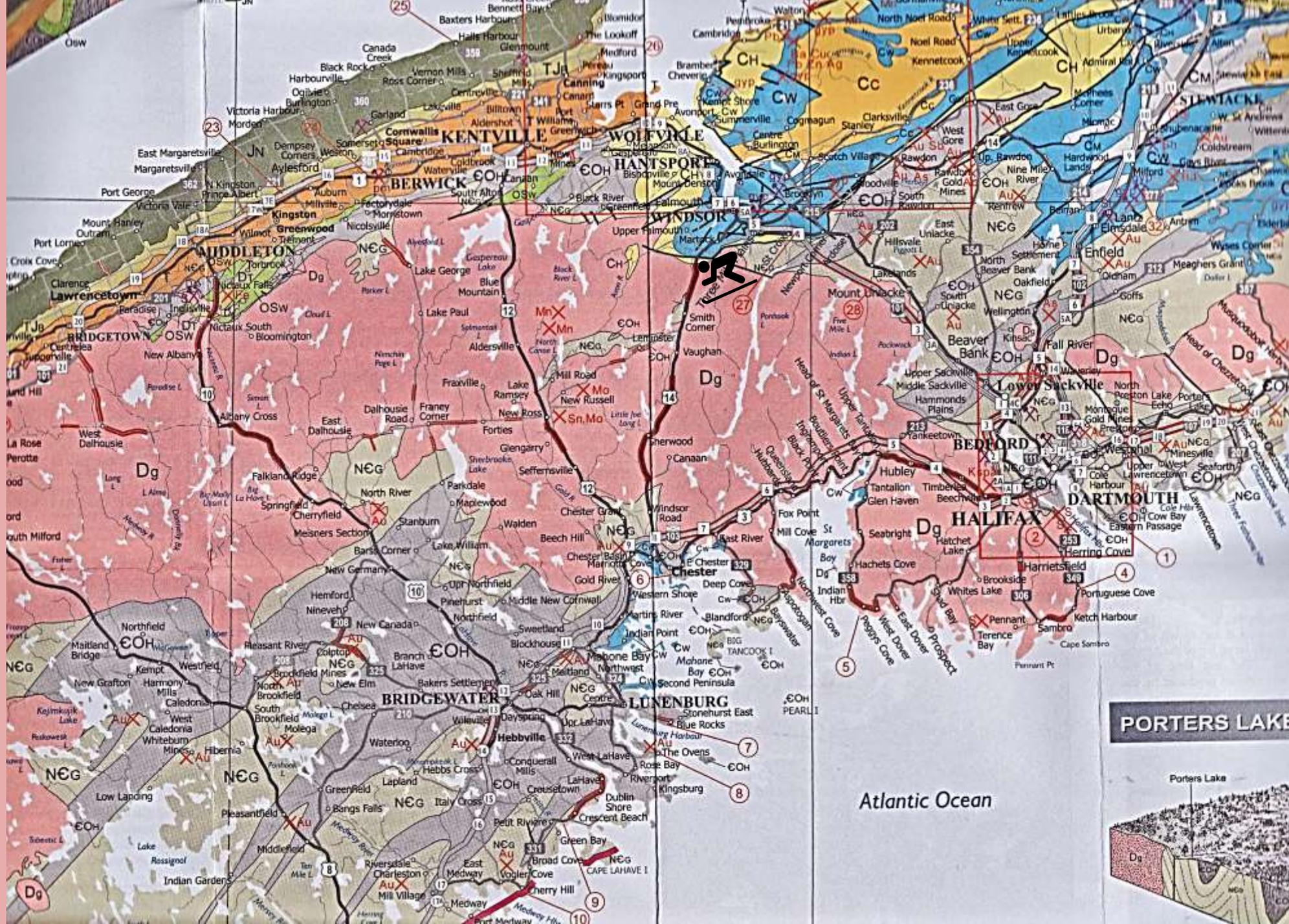
Granite



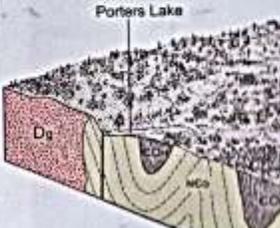
Martock Ski hill

Erosion



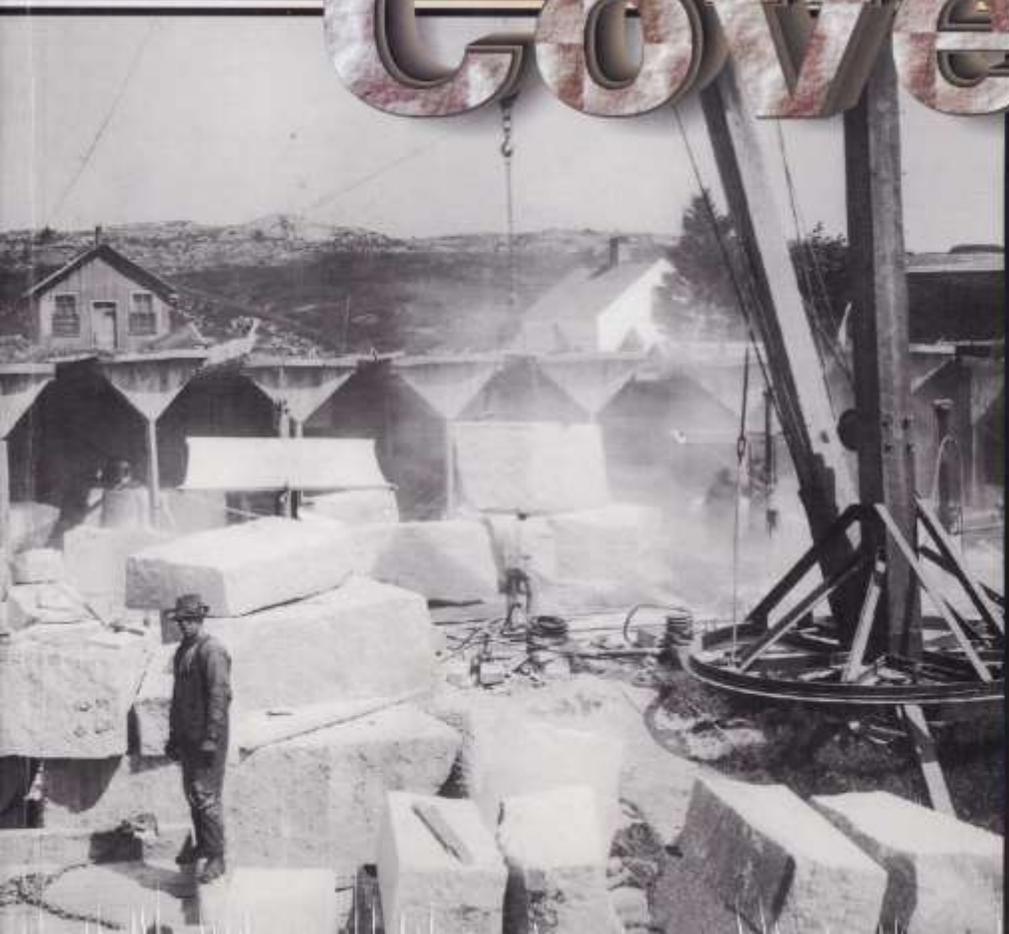


PORTERS LAKE



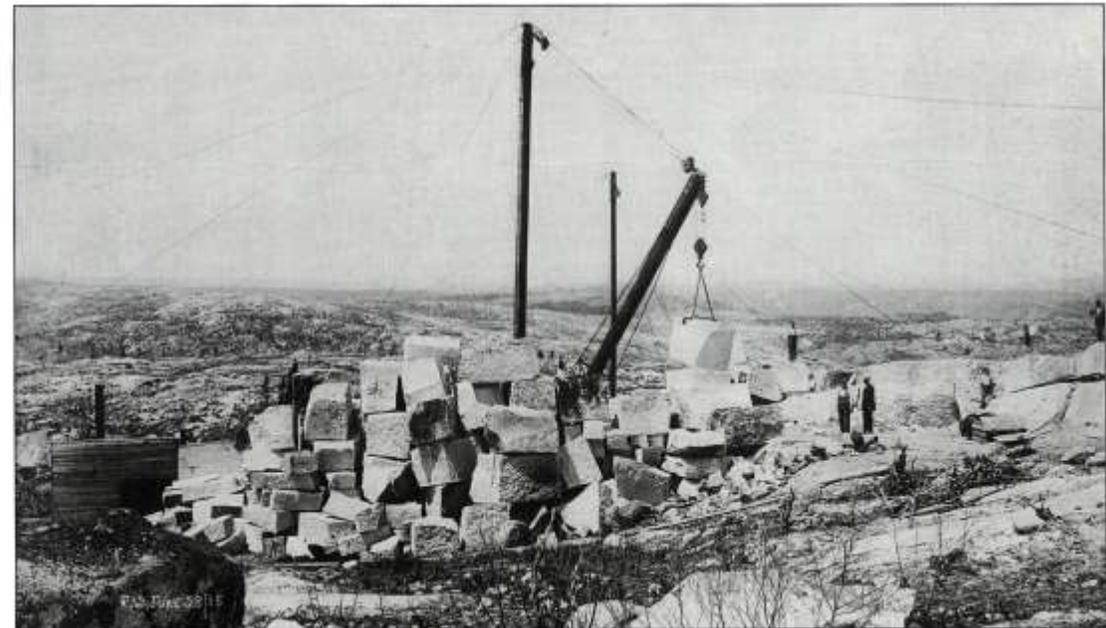
Atlantic Ocean

Purcell's Cove



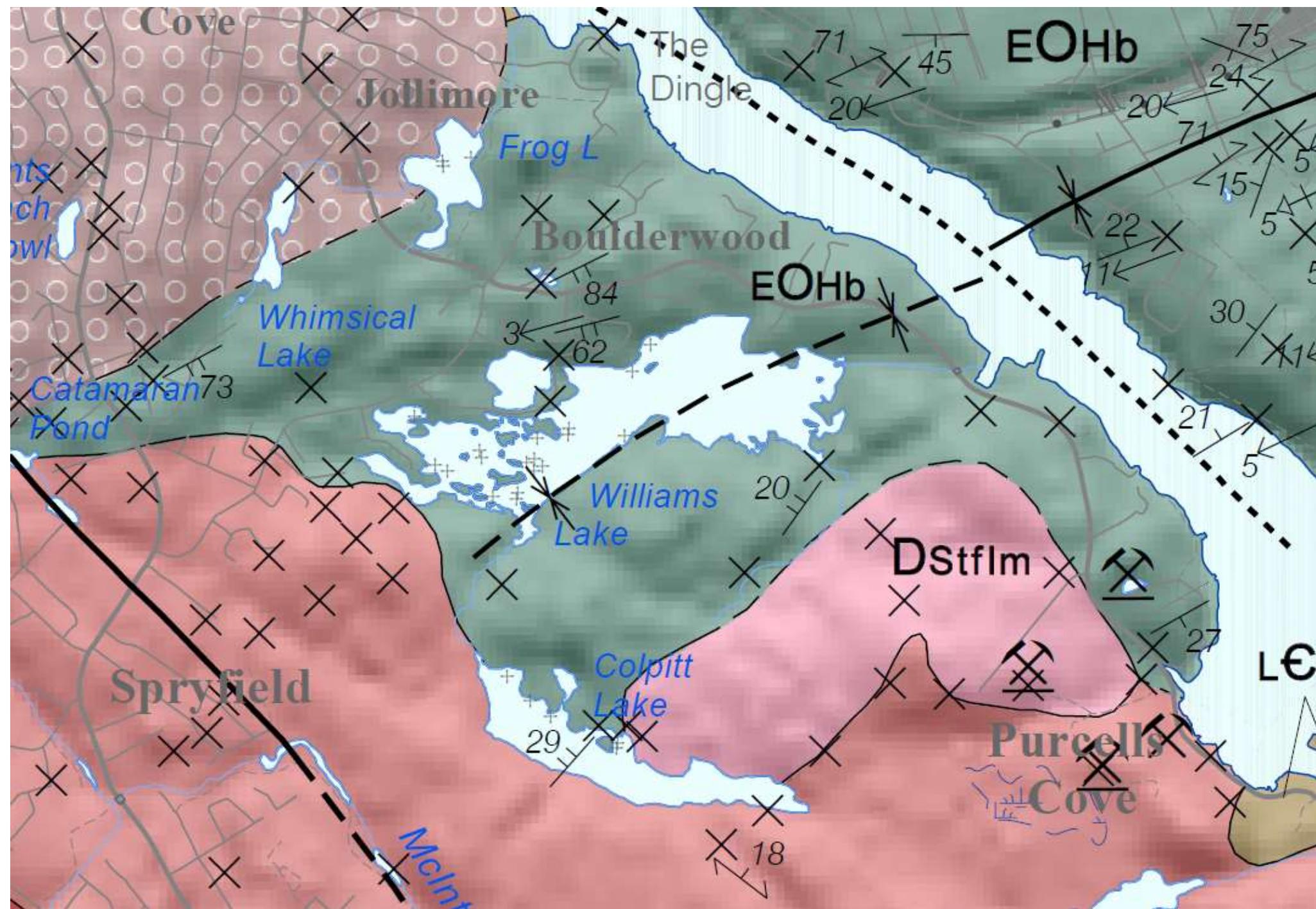
**The Little Place
that Helped Build
Halifax City**

Elsie (Purcell) Millington



Probably the first railroad in Nova Scotia, later known as the Trolley Track.

(PANS)



Slate
Ironstone

Granite

Leucomonzogranite
Granite poor in quartz)

Meguma Supergroup
Halifax Group
Bluestone Formation
Gray to blue-gray slate

Prince of Wales Martello Tower
Point Pleasant Park - 1796-97



Blue Rocks

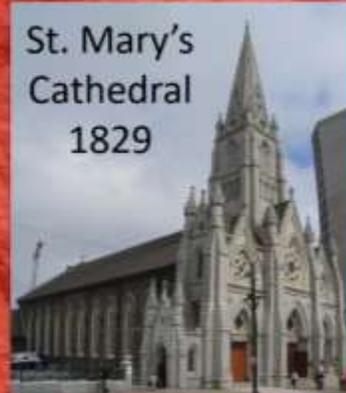
Rusty walls
York Redoubt
1793 +



Citadel Hill 1828-1856



St. Mary's
Cathedral
1829



Halifax Group
Cunard Formation
Rust brown slate
with iron sulphides

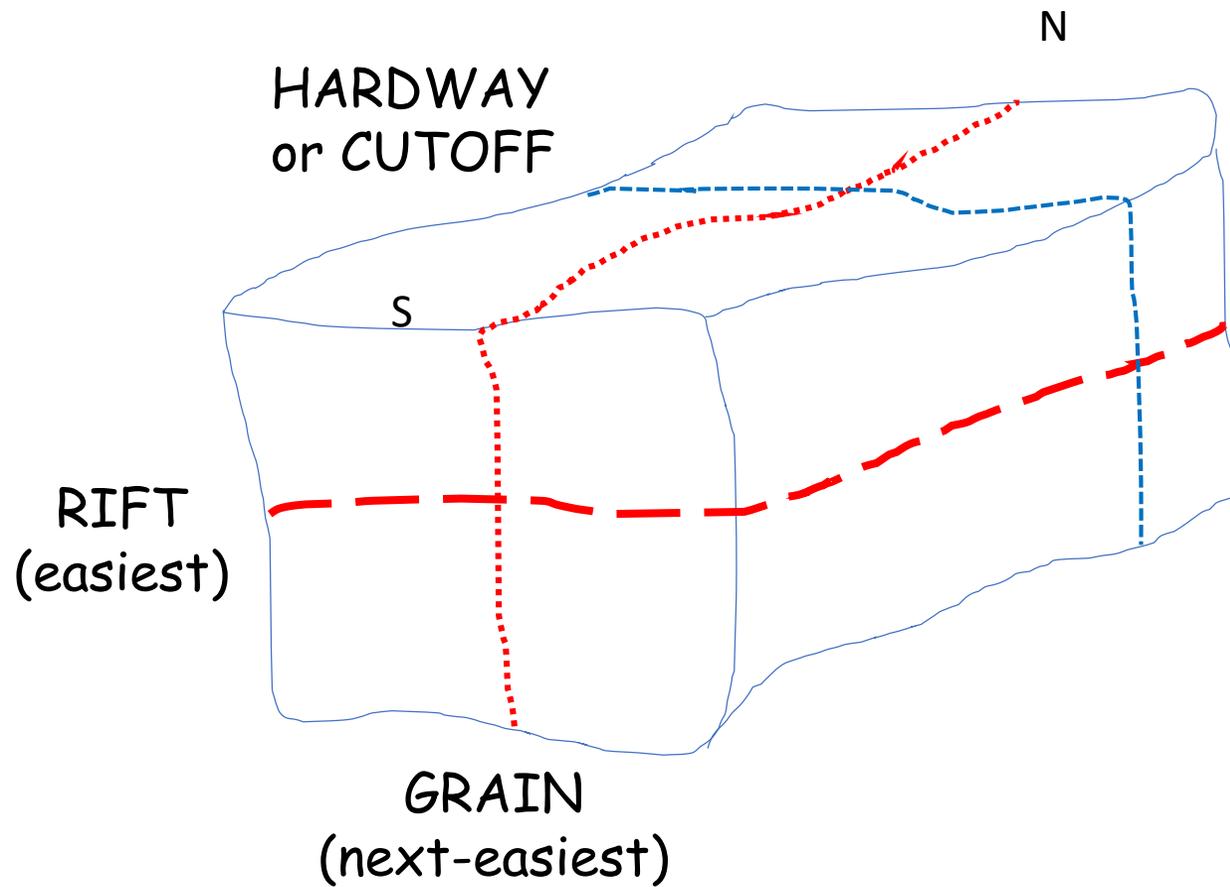
Lunenburg
Bank of Montreal



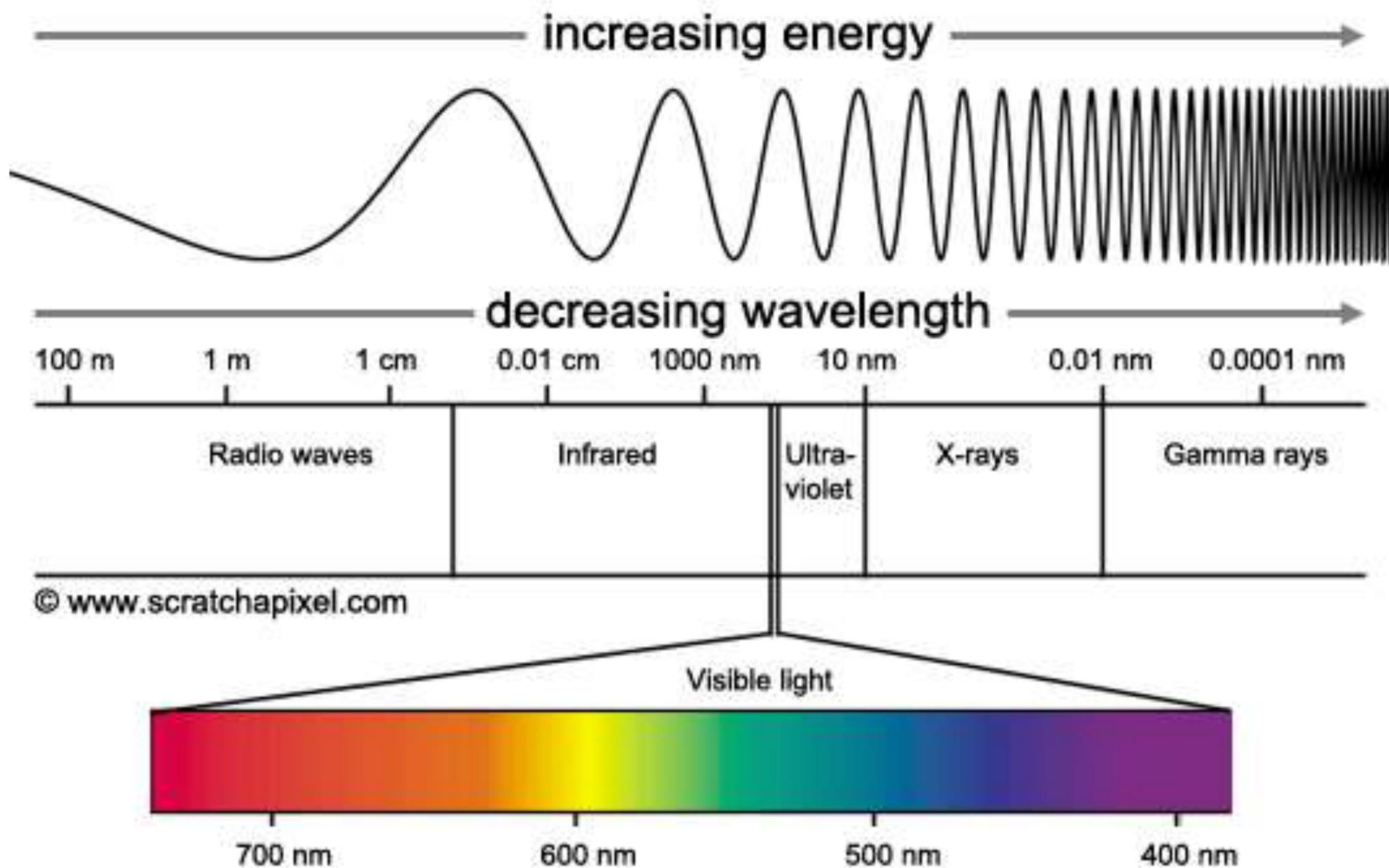
Monzogranite
Granite rich in black mica (biotite)

1 km



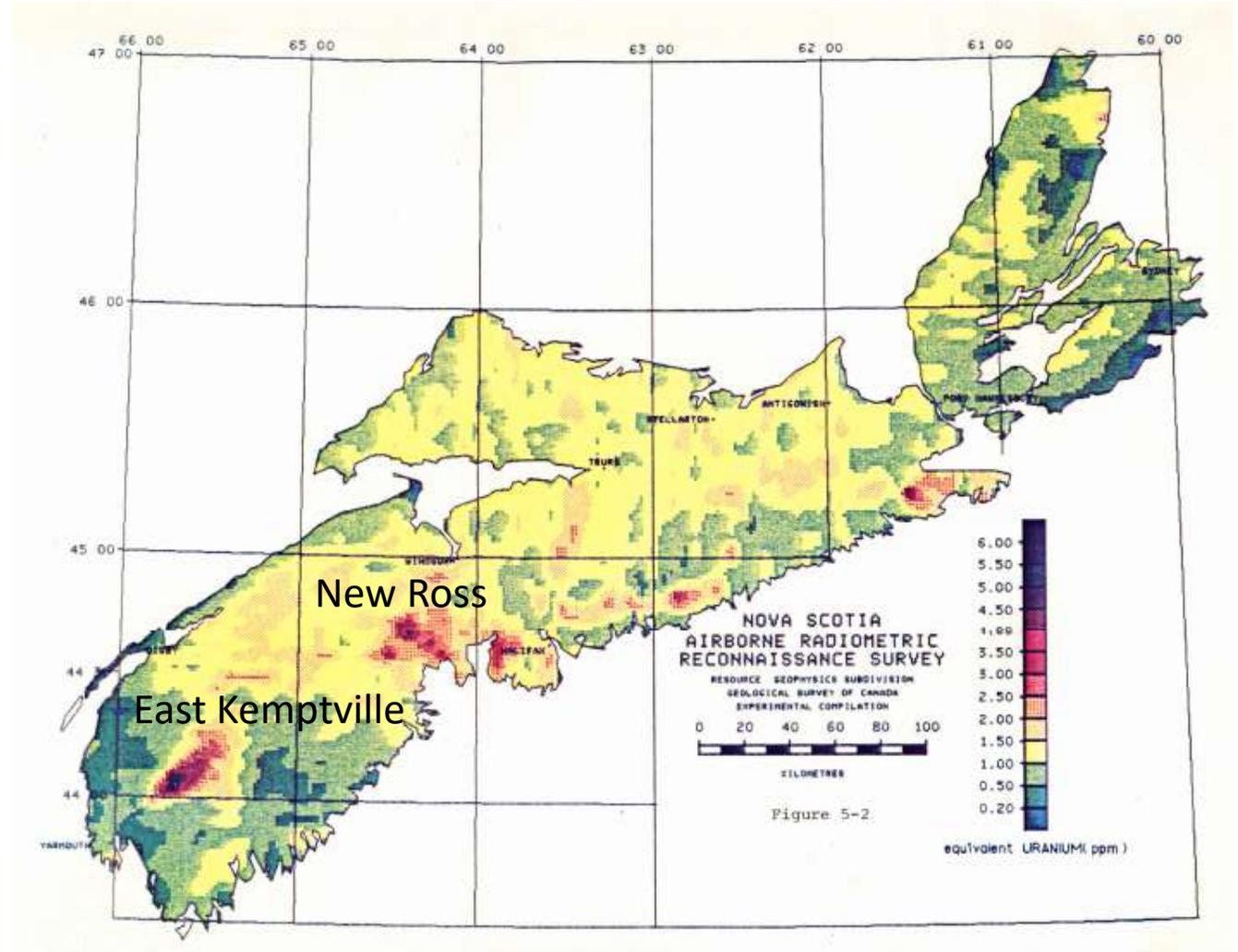


Feathers (Shims) and Wedges



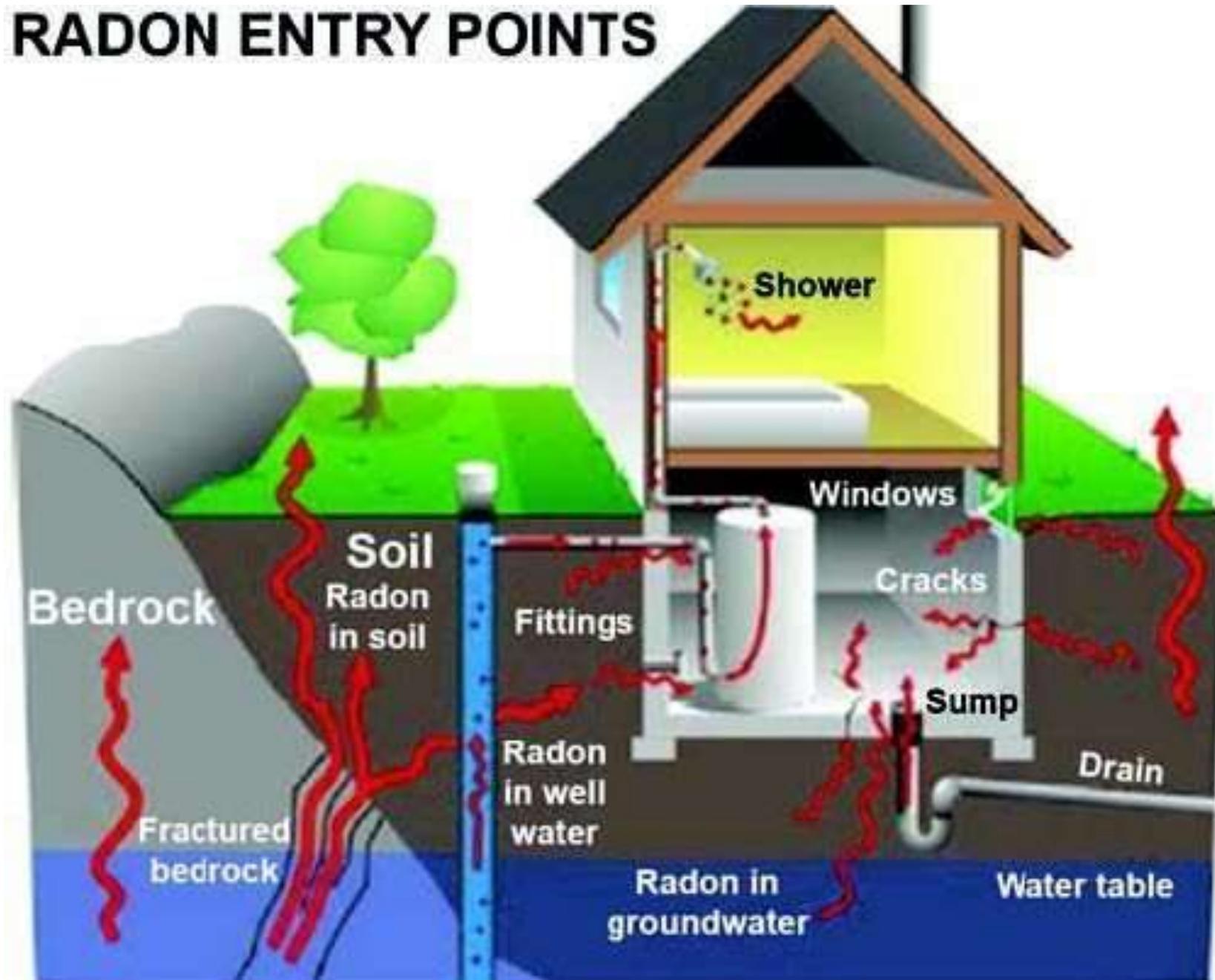
Uranium²³⁸ and Radon²²²

- Uranium²³⁸ is radioactive
- Decays over time to Radium²²⁶ (**Solid**) and Radium²²⁶ to Radon²²² (**Gas**)
- Radon²²² gas is radioactive, reduced to ½ in 3.8 days, ¼ in 7.6 days, 1/8 in 11.4 days...to **solid** radioactive particles Polonium²¹⁸
- Breath in a gas, exhale and radioactive solids stay put. Also skin cancer (Swiss study)



URANIUM IN NOVA SCOTIA :
A BACKGROUND SUMMARY FOR THE
URANIUM INQUIRY - NOVA SCOTIA

RADON ENTRY POINTS

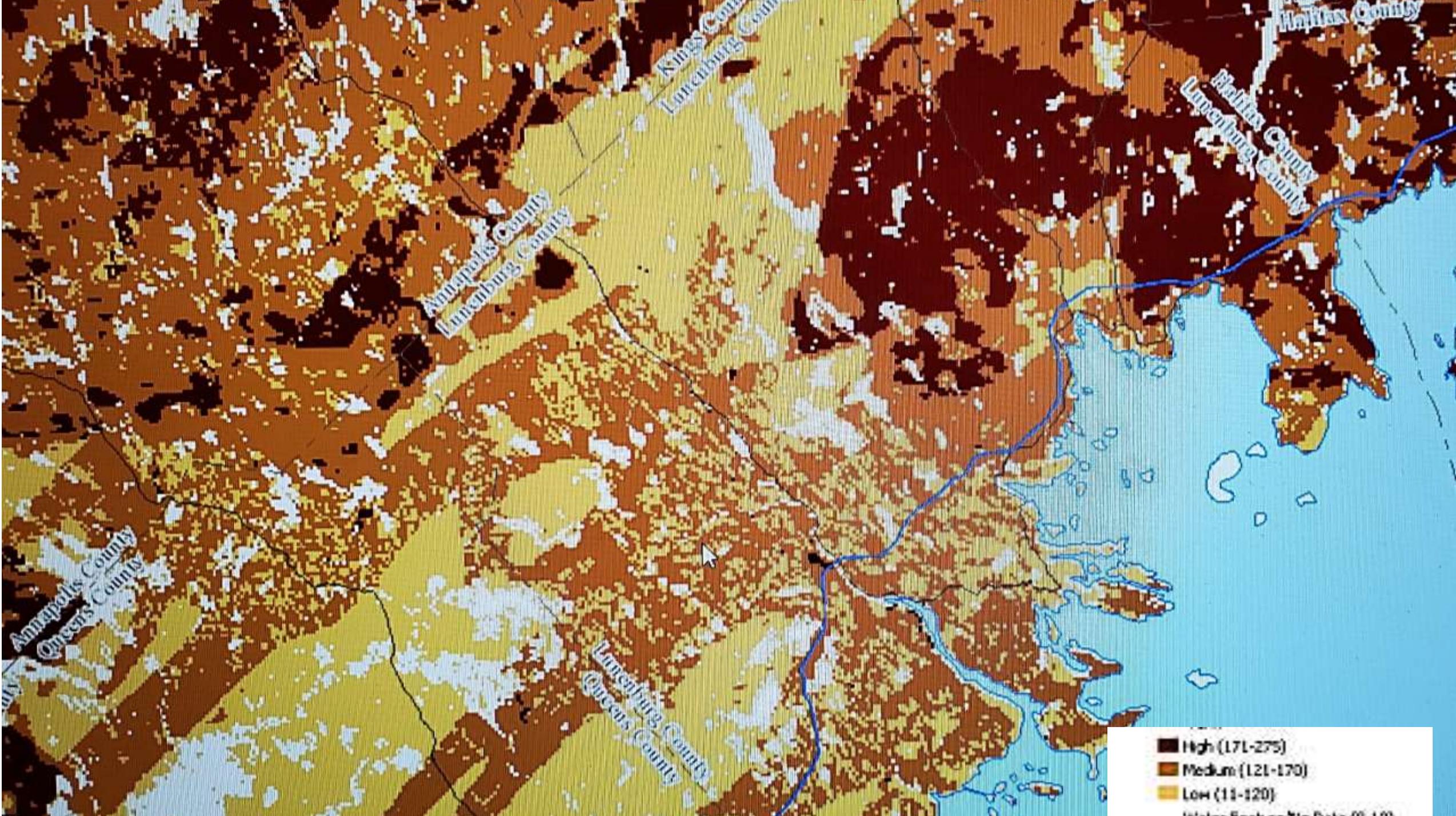


Uranium Decay



Breathing radon over time increases your risk of lung cancer. Second leading cause of lung cancer. Nationally, 21,000 people die each year from radon-related lung cancer in USA (EPA). Only smoking causes more lung cancer deaths.

3,200/year radon related deaths in Canada



www.takeactionradon.ca

RADON

GAS IS IN YOUR HOME

Radon is the #1 cause of lung cancer in non-smokers.
TEST to find out if you have a dangerous level.

1

ORDER



Order a long-term radon test from
www.takeactiononradon.ca

2

TEST



Follow the instructions provided to properly place the test kit in your home.

After 3 months send your radon test to the lab to be analysed using the return packaging and instructions provided.

You will receive your result within a few weeks.

3

TAKE ACTION



If your radon levels are below 200* no action is required.

For radon levels above 200* take action to reduce, call **1-866-225-0709** or visit **Canada.ca/radon**.

* Radon is measured in Becquerels per metre³ (Bq/m³)



Health
Canada

Santé
Canada

Canada

<https://ns.lung.ca/lung-health/radon-gas>

Call NS Lung Association 1-888-566-5864

Bedford: (902) 424-7773

Halifax: (902) 424-3600

Alpha Track Detector

special plastic or film inside a container with a filter-covered opening. Air being tested diffuses through a filter covering a hole in the container. Alpha particles from radon and its decay products strike the detector, cause damage tracks. At the end of the test period the container is sealed and returned to a laboratory

Labs that test for radon in drinking water:

QEII Health Sciences Centre

Environmental Chemistry Laboratory, Halifax

(902) 473-8466

Maxxam Analytics Inc., Bedford

(902) 420-0203

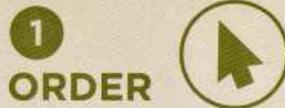
Aerator (ca. \$3000)



Canada.ca/radon

RADON GAS IS IN YOUR HOME

Radon is the #1 cause of lung cancer in non-smokers.
TEST to find out if you have a dangerous level.



1 ORDER

Order a long-term radon test from
www.takeactiononradon.ca



2 TEST

Follow the instructions provided to properly place the test kit in your home.

After 3 months send your radon test to the lab to be analysed using the return packaging and instructions provided.

You will receive your result within a few weeks.



3 TAKE ACTION

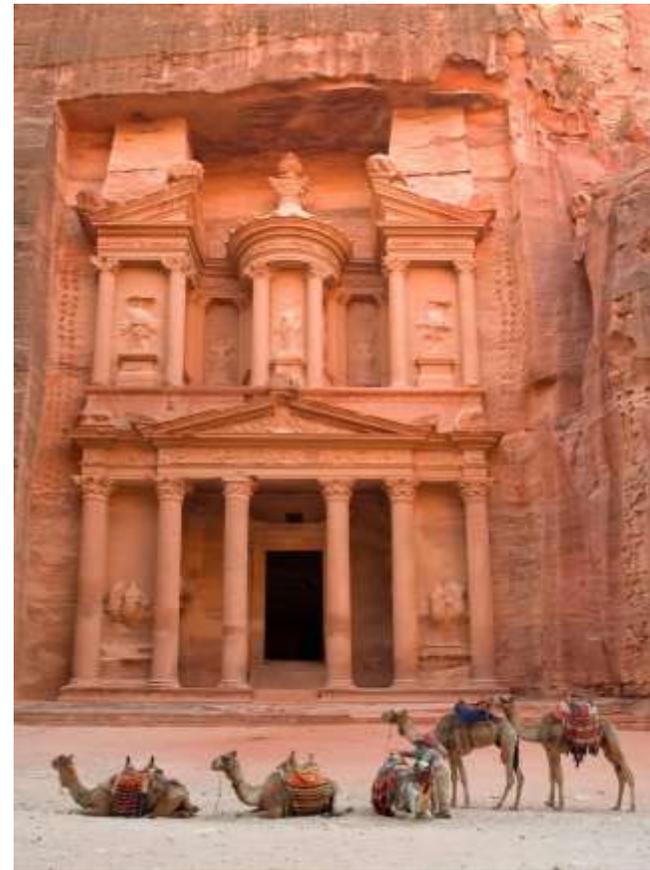
If your radon levels are below 200* no action is required.

For radon levels above 200* take action to reduce, call **1-866-225-0709** or visit **Canada.ca/radon**.

* Radon is measured in Becquerels per metre³ (Bq/m³)

SANDSTONE

- **Sandstone** is a clastic sedimentary rock composed mainly of sand-sized (0.0625 to 2 mm) mineral particles or rock fragments
- Mostly quartz and feldspar, minerals resistant to weathering
- Often water, oil and gas in the pores between grains
- Cemented by minerals: e.g. carbonate
- Strong and durable for construction



Petra, Jordan, Temple ~500 BC



Bank of NS, Halifax 1930



F Sporer 1770 Freiburg

Geology and Architecture

- Building stone is heavy and expensive to transport; generally local, or transported by water
- You can map the geology of a region by looking at major historical buildings



Abu Simbel, Egypt, 1264 BC

Heidelberg Castle, Germany



Buntsandstein
Quarry





Blue Rocks, Lunenburg County

LIMESTONE and MARBLE

- **Limestone** a carbonate sedimentary rock that is composed of the skeletal fragments of marine organisms such as **coral**, foraminifera, and mollusks.
- Minerals **calcite and aragonite** calcium carbonate (CaCO_3). Related to rock **dolomite** with $\text{CaMg}(\text{CO}_3)_2$.
- The **solubility** of limestone in water and weak acid solutions leads to **karst** landscapes. Ancient **cave systems**, sinkholes
- **Building material**, an essential component of concrete (Portland cement), white pigment or filler in products such as toothpaste or paints, as a chemical feedstock for the production of lime, as a soil conditioner
- Metamorphosed turns into **Marble**



Great Barrier Reef



Grand Bahama Coast



Pont du Gard, France >2000 y old



The Dolomite Mountains, Italian Alps,



Algarve coast, Portugal



The Cliffs of Dover, UK



Banff National Park, Alberta

100% Marine Organisms or residues “Organic Rock”



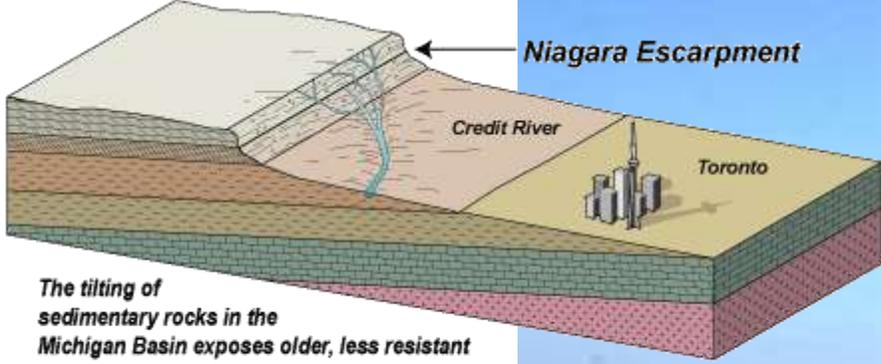
Nummulitic limestone



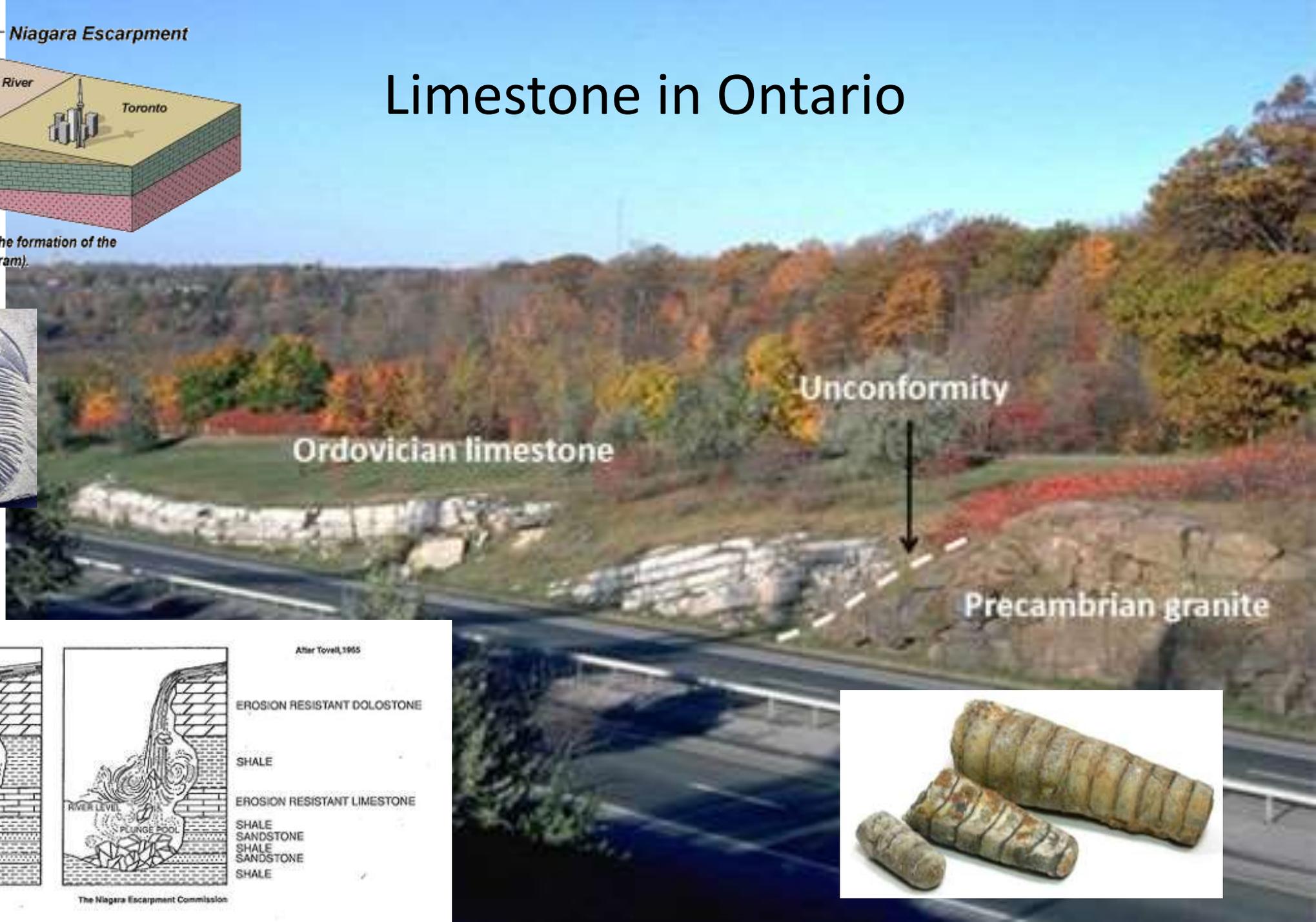
Giza Pyramid, Egypt



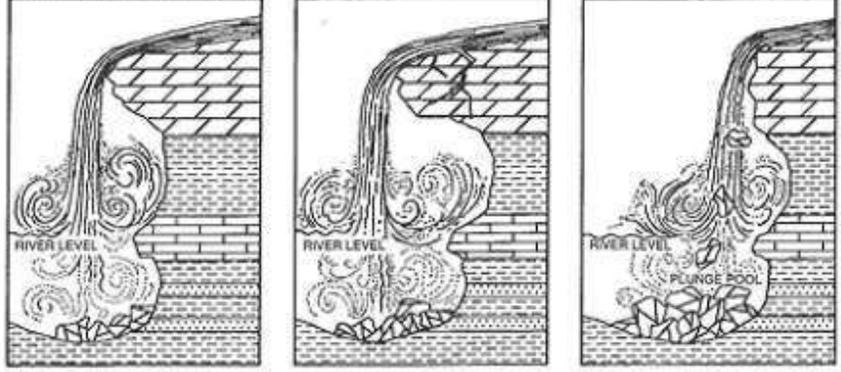
Limestone in Ontario



The tilting of sedimentary rocks in the Michigan Basin exposes older, less resistant layers of shale to weathering. This is the key to the formation of the Niagara Escarpment (see 'sapping process' diagram).



PHYSIOGRAPHIC FEATURES - 30



After Tovell, 1965

EROSION RESISTANT DOLOSTONE

SHALE

EROSION RESISTANT LIMESTONE

SHALE

SANDSTONE

SHALE

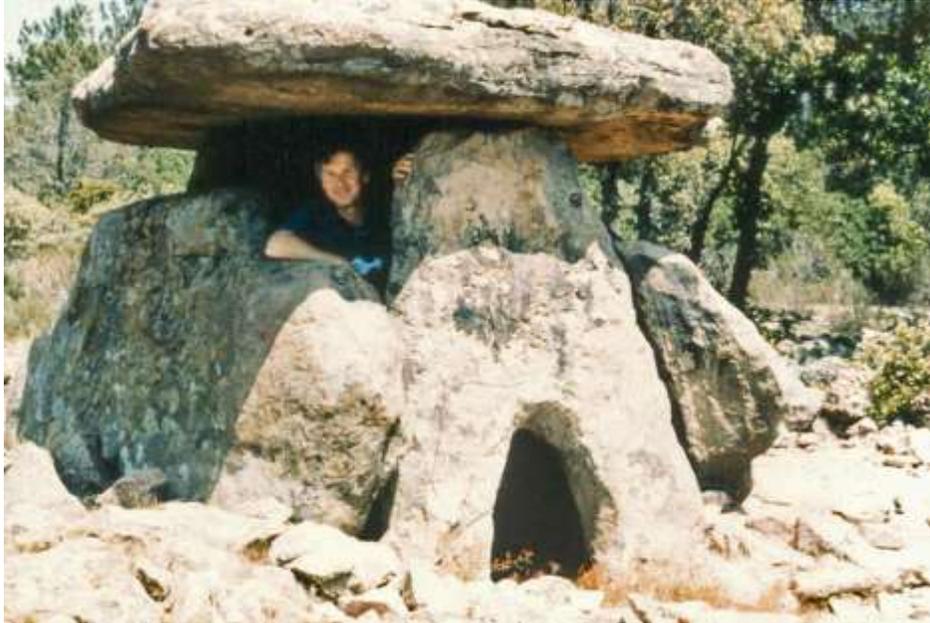
SANDSTONE

SHALE

The Niagara Escarpment Commission



Can be Cut with Carpenter's Saw



Dolmen, Lodève, 1986 Neolithic (4000–3000 BC)



Limestone buildings, Kingston, Ontario



Chichen Itza, Yucatán, Mexico



Bories, Gordes, Provence, France. Celtic to 19th Century



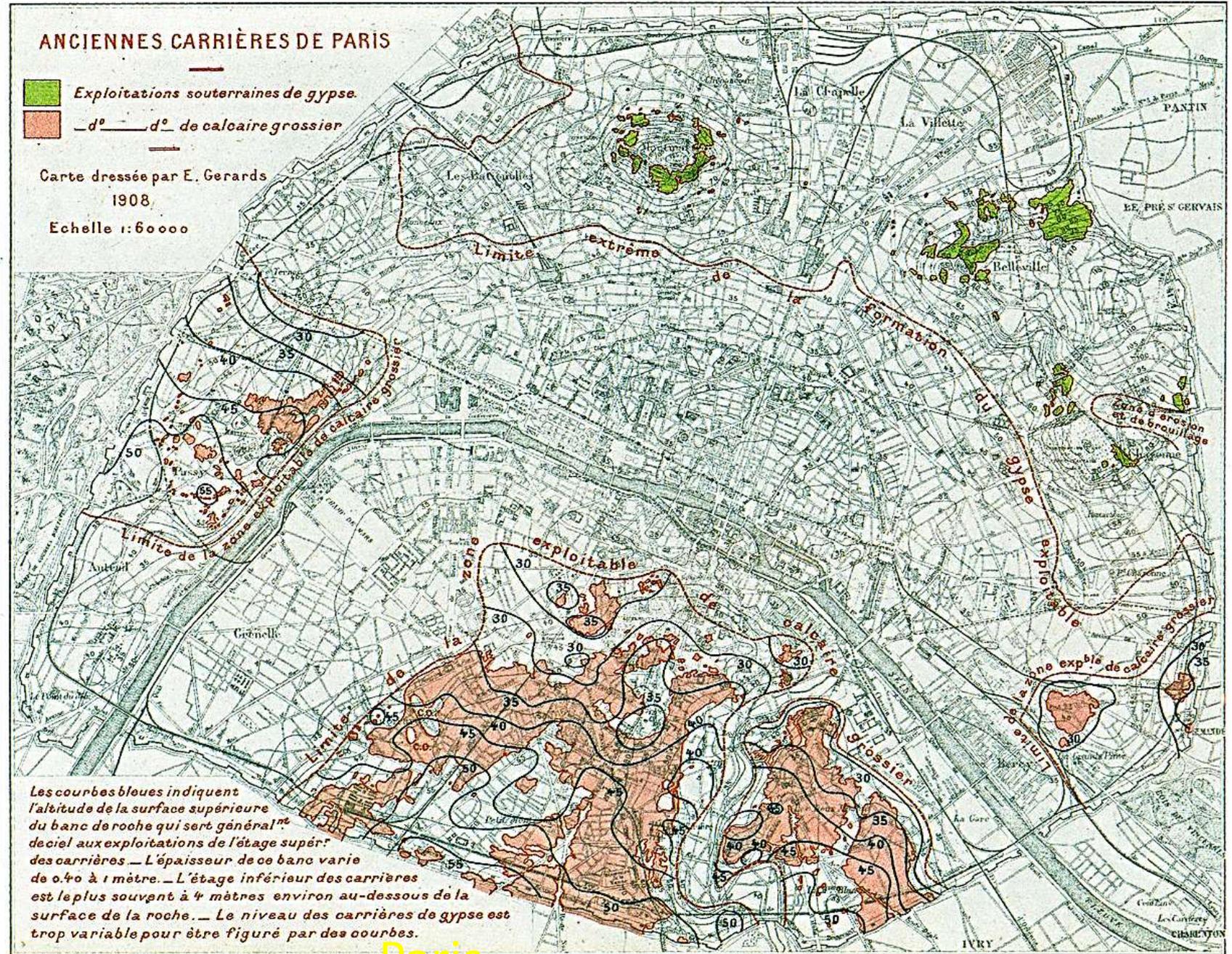
Cuba, limestone quarry, near Varadero



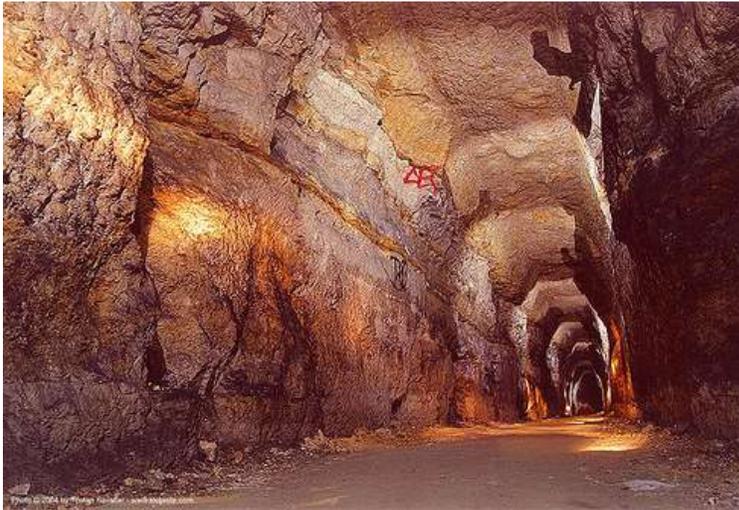
ANCIENNES CARRIÈRES DE PARIS

- Exploitations souterraines de gypse
- d° -d° de calcaire grossier

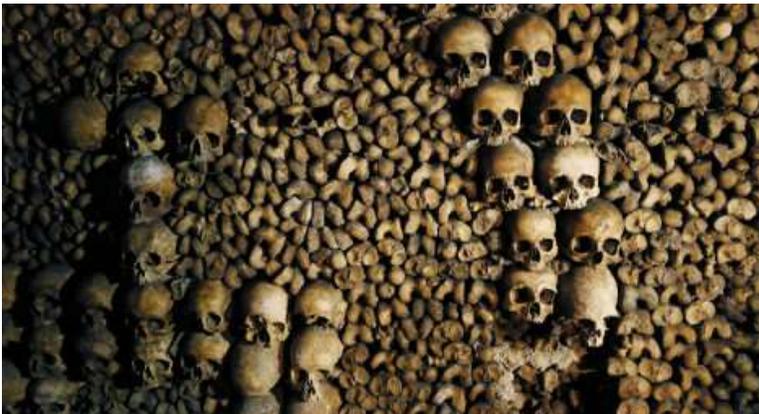
Carte dressée par E. Gerards
1908
Echelle 1:60000



Paris



Paris Limestone Quarries



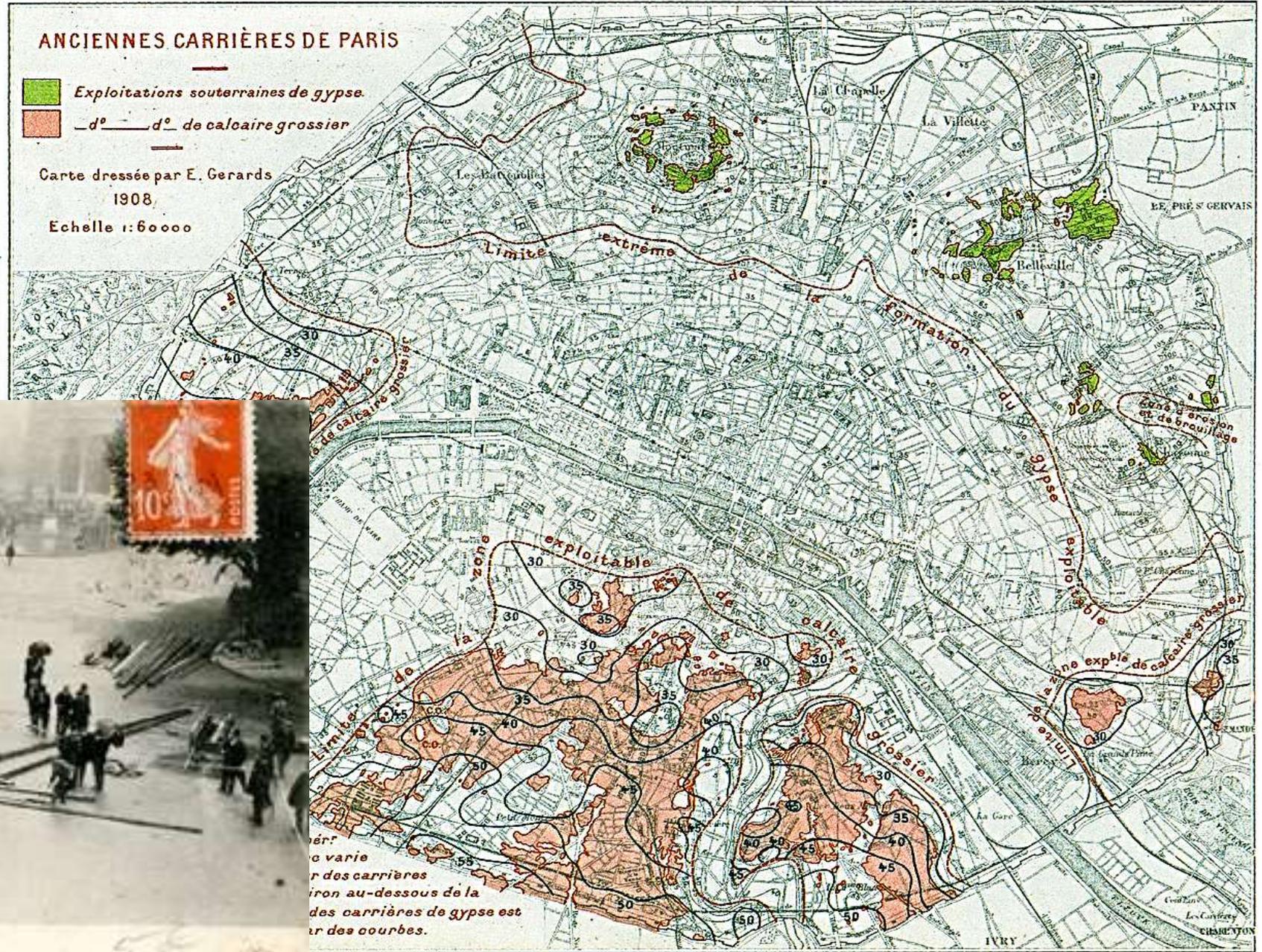
Paris ossuary



ANCIENNES CARRIÈRES DE PARIS

- Exploitations souterraines de gypse.
- d° — d° de calcaire grossier

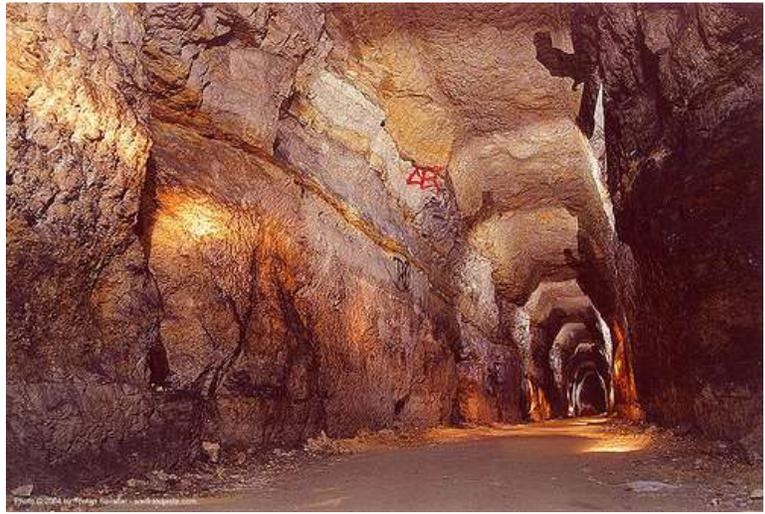
Carte dressée par E. Gerards
1908
Echelle 1:60000



Les courbes de niveau de la zone d'érosion et de broutillage des carrières de gypse est au-dessous de la zone exploitable de calcaire grossier.

Courbes de niveau d'après les repères antérieurs à 1907 (à diminuer de 0^m.61)

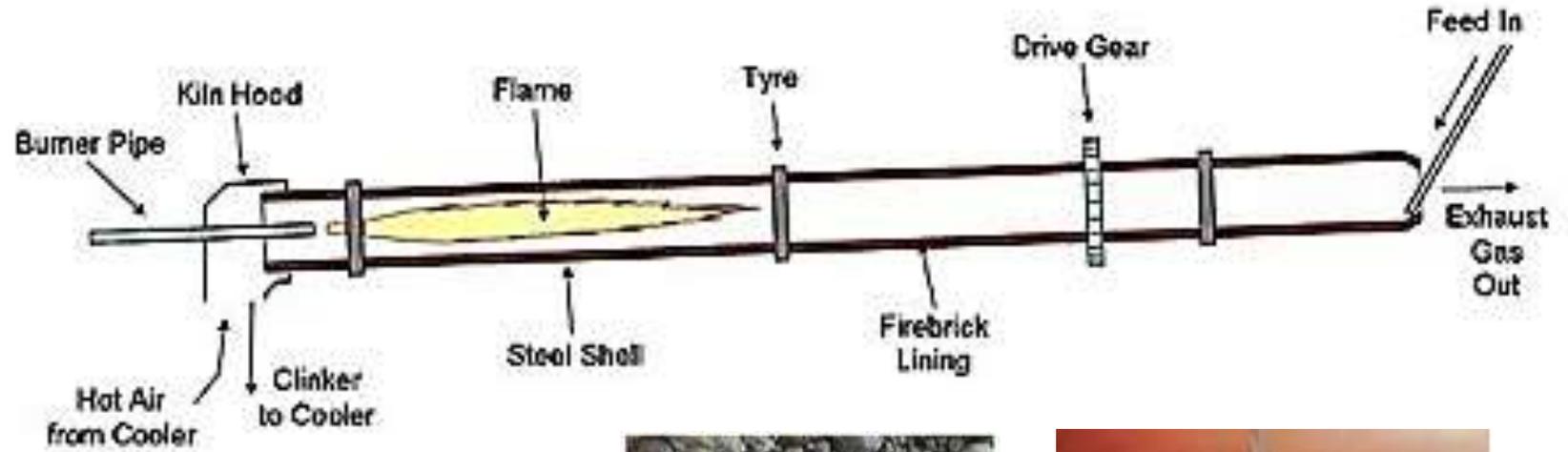
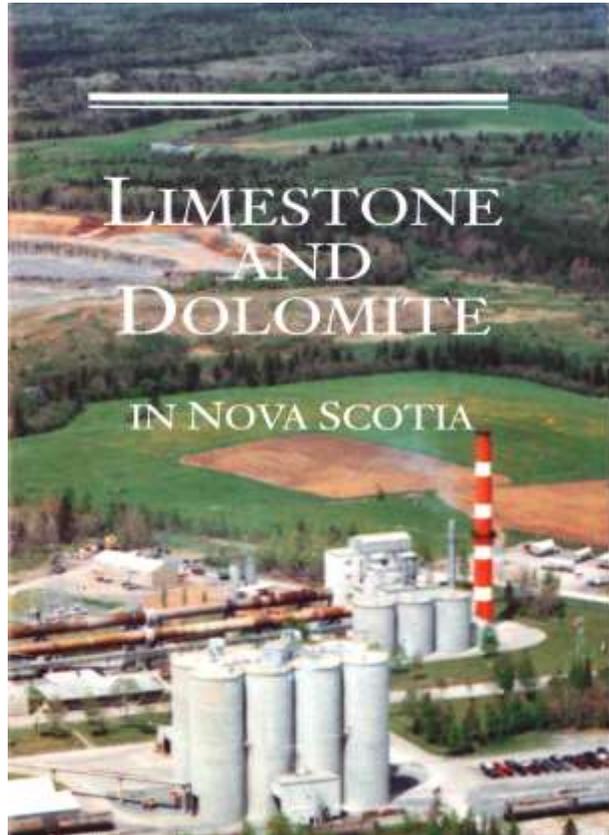
Imp^e Dufrenoy - PARIS



L'ORAGE DU 15 JUIN A PARIS
Place Saint-Augustin

Paris

Limestone used to make Portland Cement



Add Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) +



10 cm
Clinker



Portland Cement



Sydney Opera House, Australia



Confederation Bridge



Chemistry



4% of global total CO₂ emissions



Quick Lime

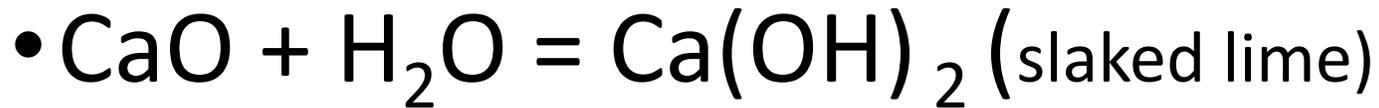
Very Thirsty

PH

NEUTRALIZES ACID



Hydrochloric acid



• Whitewash

• Scrubber



Santorini, Greece



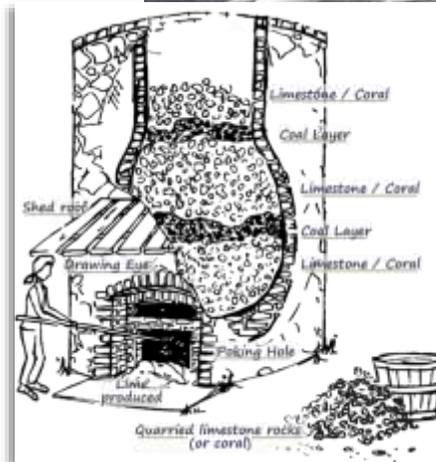
Soil conditioner



Limestone Quarry, Quebec



Limestone Quarry, Nova Scotia





Acid on Limestone CaCO_3

Acid on Calcite CaCO_3



Limestone vulnerable to acids

- Acidic rain or groundwater will dissolve calcite
- Karst topography
- Caves
- Sinkholes

Eggshells are
calcite CaCO_3



Karst Topography, South China



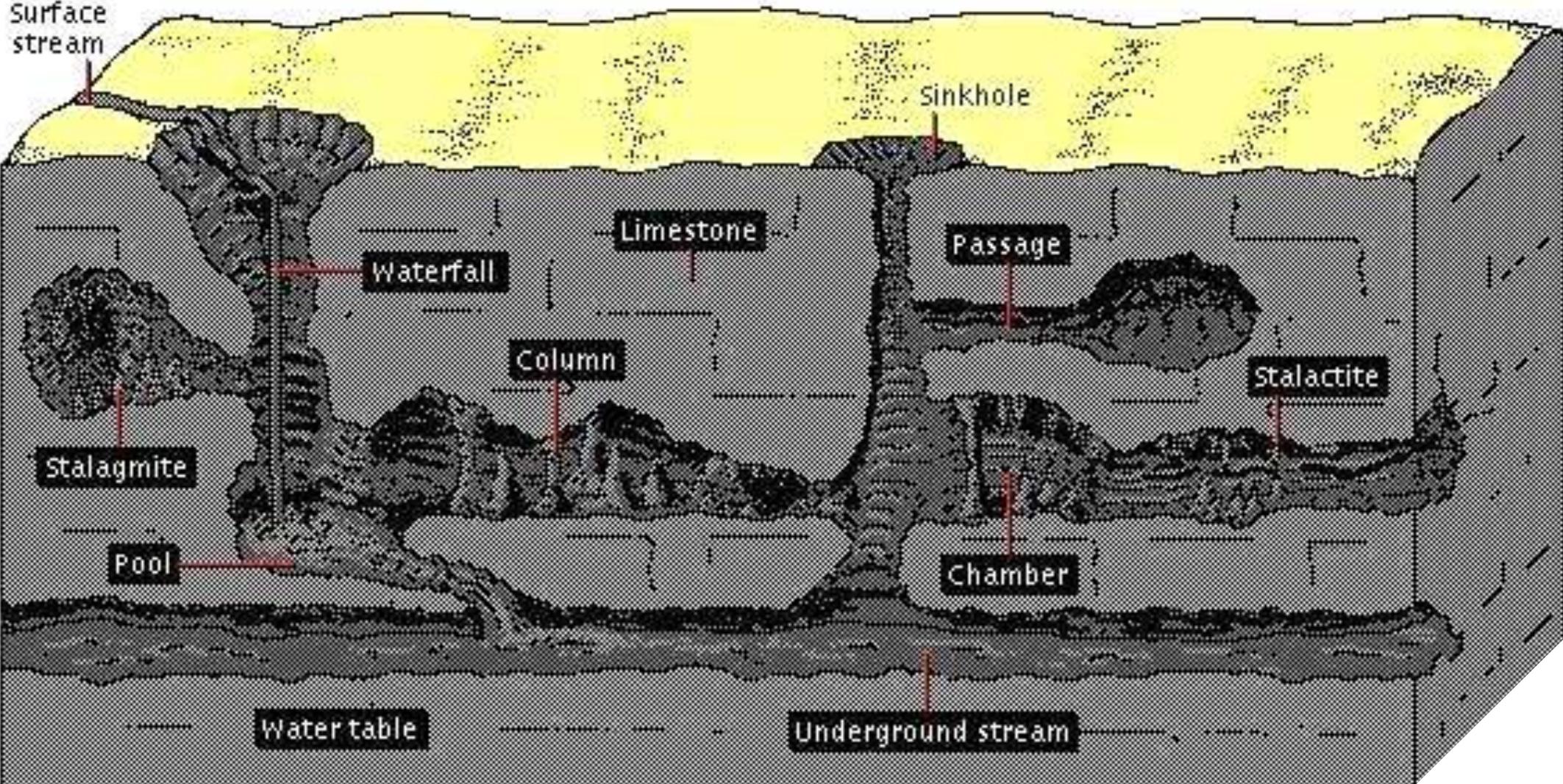
In Praise Of Limestone

Poem by WH Auden (1907-1973)



"If it form the one landscape that we, the inconstant ones, are consistently homesick for, this is chiefly because it dissolves in water. Mark these rounded slopes with their surface fragrance of thyme and, beneath, a secret system of caves and conduits; hear the springs that spurt out everywhere with a chuckle, each filling a private pool for its fish and carving its own little ravine whose cliffs entertain the butterfly and the lizard; examine this region"

If you see Limestone, look for Caves

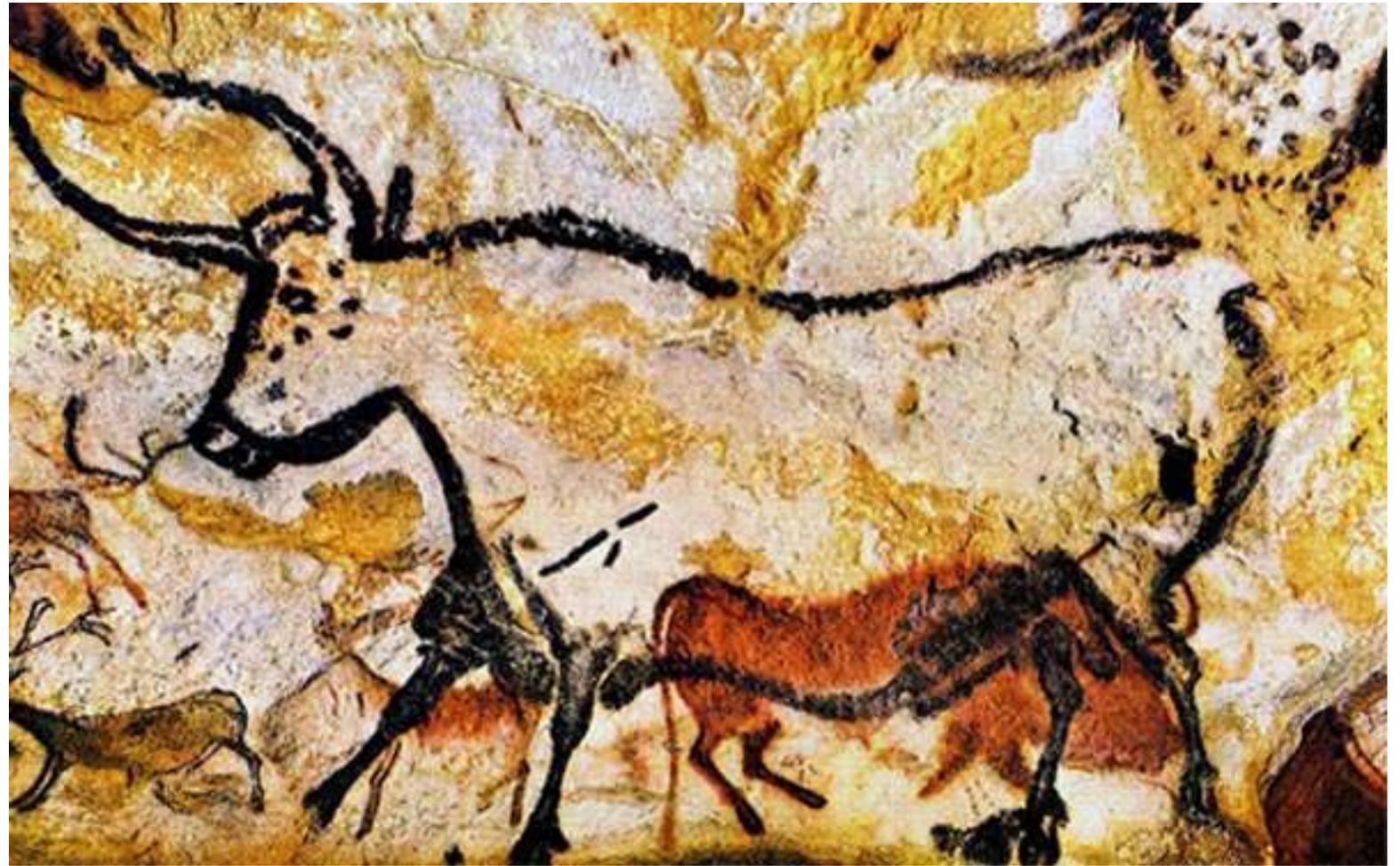




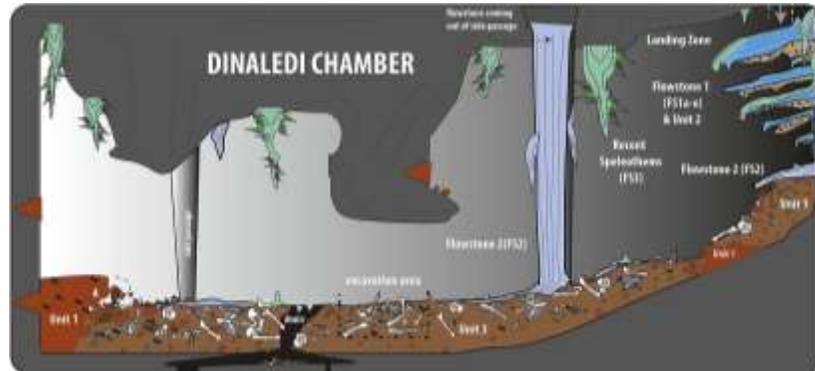
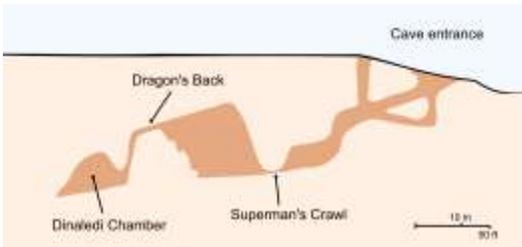
Crete



Carlsbad Caverns, New Mexico



Lascaux, France 17,000 y



Dinaledi caves, RSA bones
335,000–236,000 years old

THAILAND CAVE RESCUE

4,186FT
(1275M)

TEAM FOUND 2.5 MILES (4KM)
FROM ENTRANCE

ENTRANCE

NARROW FLOODED PASSAGE

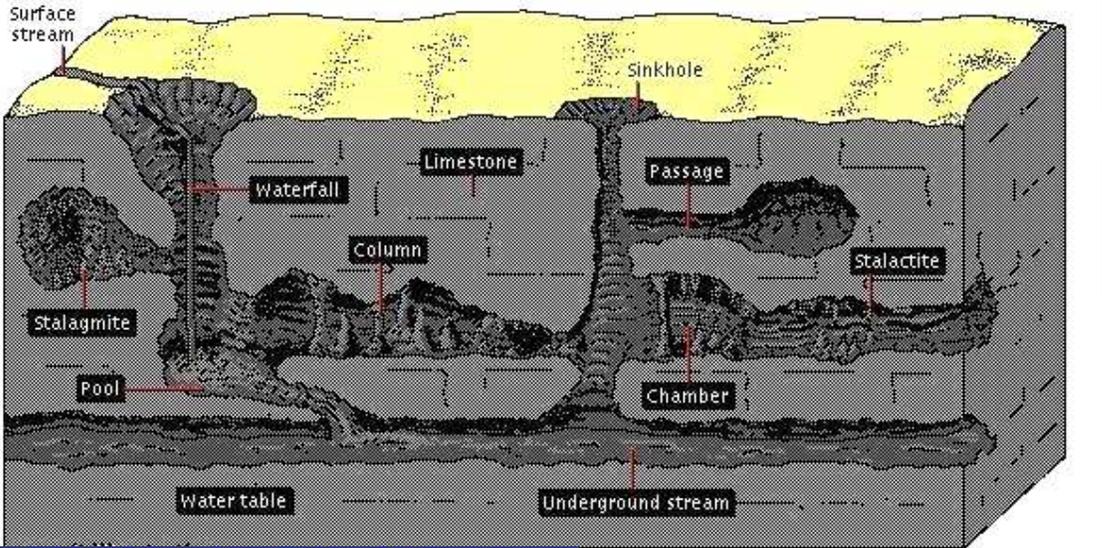


AFP



Tham Luang cave during rescue operations during 26–27 June 2018. Screen capture from NBT news report.

SINKHOLES



Cenote in Chichen Itza
Yucatan, Mexico

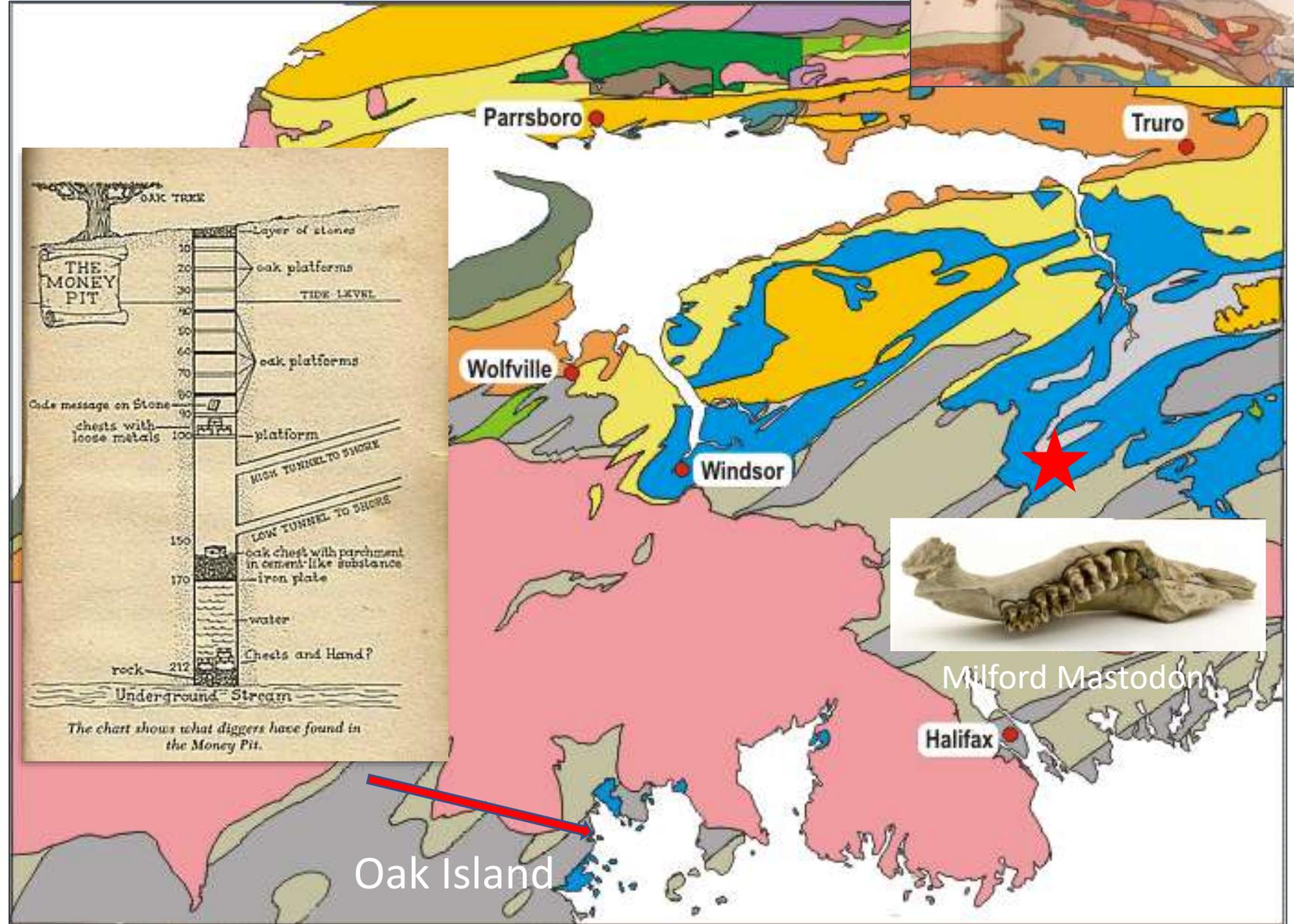
Sinkhole 2019, Florida

Nova Scotia

Oxford NS sinkhole, Gypsum



Oak Island



Oxford

Oak Island

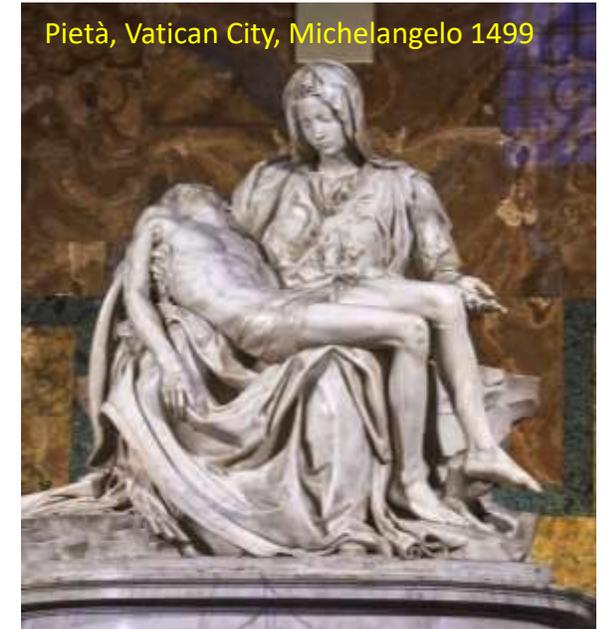
Marble is Naturally Baked Limestone



Chartres Cathedral 1194 to 1220



Carrara Marble Quarries, Italy



Pietà, Vatican City, Michelangelo 1499



Elgin Marbles From Parthenon, Greece



David, Michelangelo, 1504



Marble

“A veiled Vestal Virgin” by Raffaele Monti
(1818-1881).

It was commissioned by the sixth Duke of Devonshire on 18 October 1846 and the piece can be dated to 1847.

Sculpture Gallery at Chatsworth, UK



Marble

Portrait Sculpture by
Philippe Faraut
France



Verona Arena, Italy 30 AD



Sat 30,000



Taj Mahal, Agra, India, 1643; Tomb for favourite wife of Shah

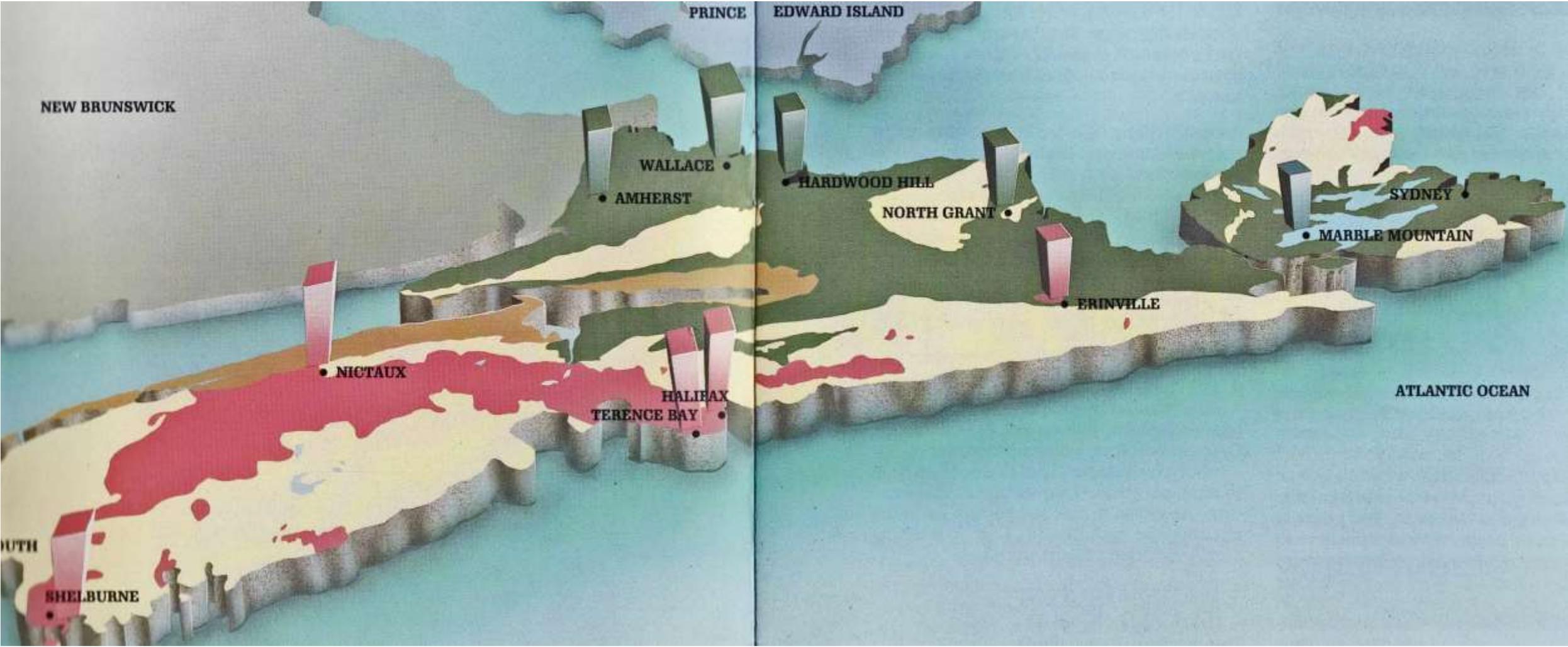


Marble caves, Aysén, Patagonia, Chile

Red: GRANITE

Green: SANDSTONE

Blue: MARBLE



Summary

- **Mercury in the environment: Mad Hatter, Methyl Mercury to Loons**

GEOLOGY AND CITIES

- Building stone generally local
- Sandstone
- Granite, Purcell's Cove Quarries, and **RADON Gas**
- Thank You, Limestone, the Organic rock
 - Beautiful Mountains
 - Dissolves in acidic water
 - Caves and early humans
 - Paris built on air
 - Sinkholes
- Marvellous Marble