CHAPTER 13
Part 1 of 2

The Mactaquac Dam generates hydroelectricity from the flow of the Saint John River in New Brunswick. It generates about 20 percent of the province's power needs. RON GARNETT /AIR SCAPE S.CA

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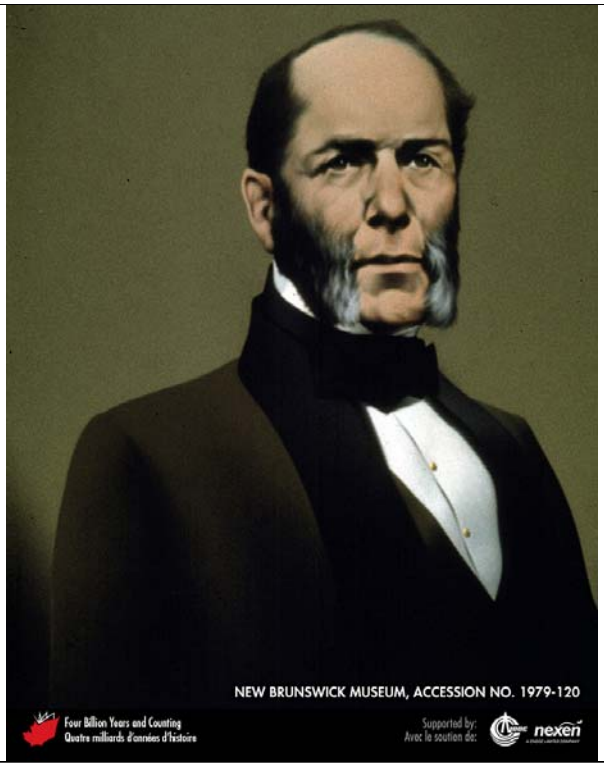
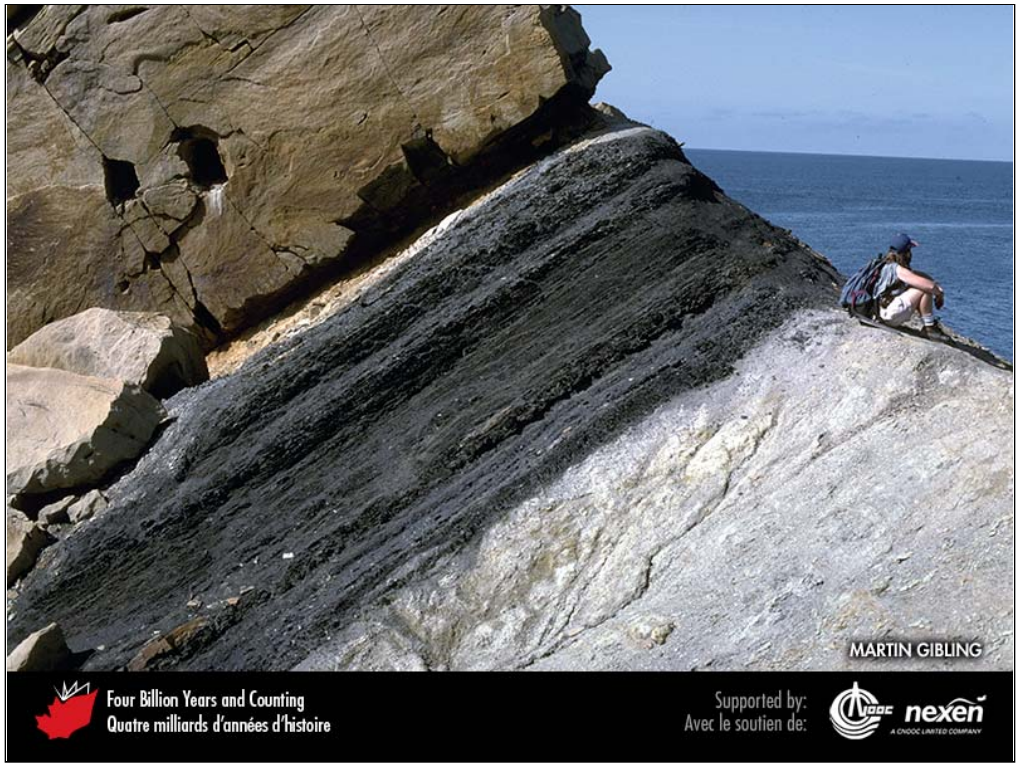


Abraham Gesner is acknowledged as the founder of the petroleum industry. Born in Nova Scotia's Annapolis Valley, Gesner became a medical doctor in Parrsboro and, later, provincial geologist for New Brunswick (the first such post in the British Empire). COURTESY OF THE NEW BRUNSWICK MUSEUM, ACCESSION NO. 1979-120

Black gum, naturally occurring bitumen seeping from the ground at Oil Springs, near Sarnia, Ontario. GRANT WACH.



The dark layer in this sequence of rocks from Chimney Corner, Cape Breton Island, Nova Scotia, is a late Carboniferous coal bed. MARTIN GIBLING.

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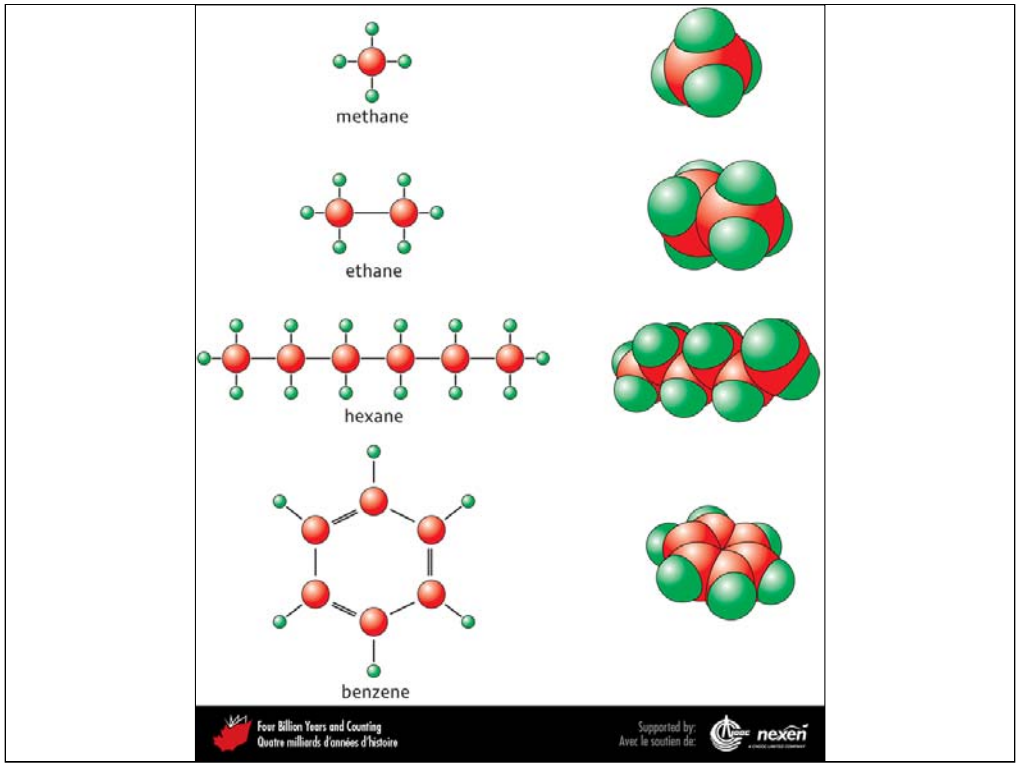
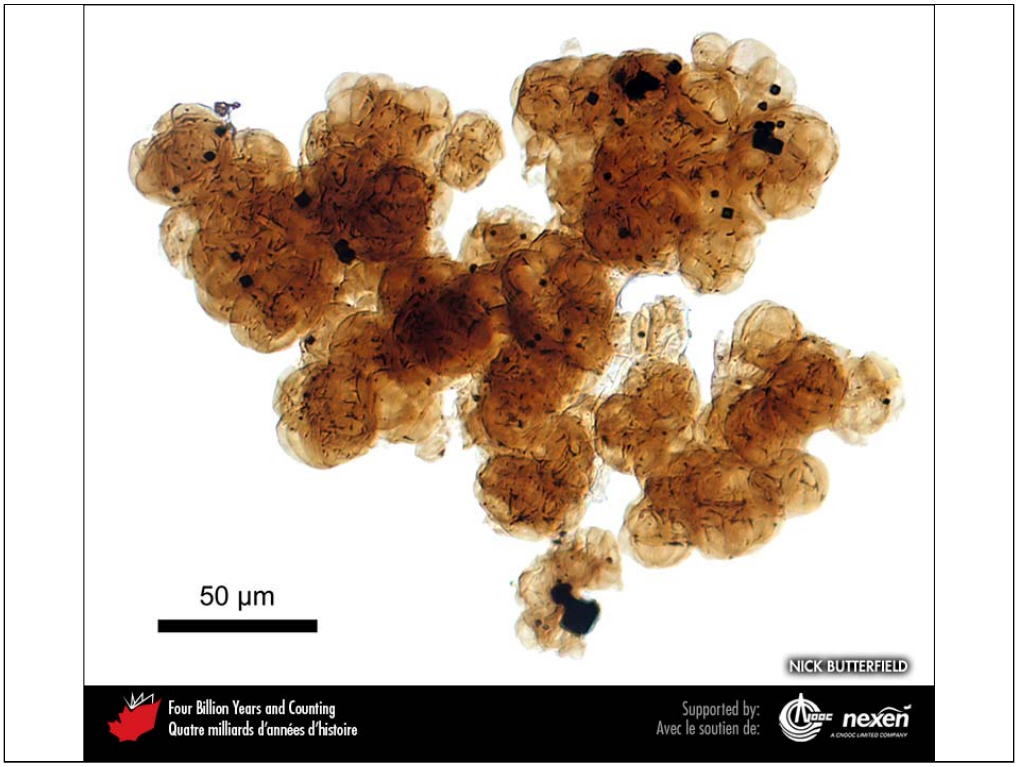
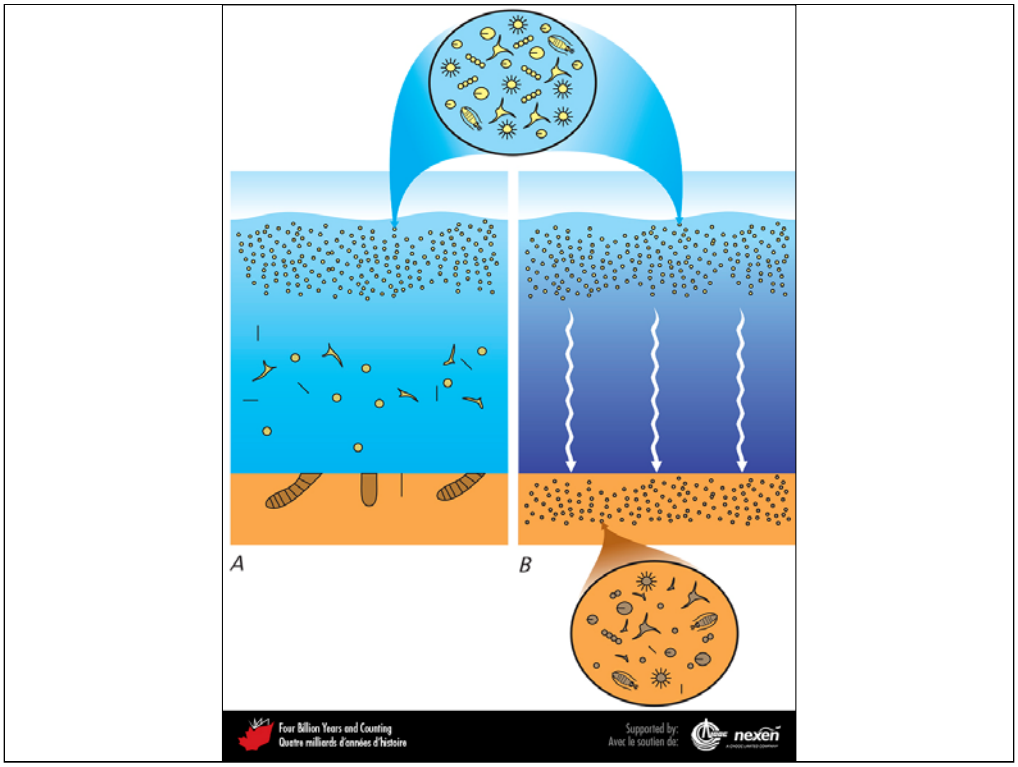
Open-pit coal mine, Sparwood, British Columbia. Coal in this part of southeastern British Columbia is of Cretaceous age and was deposited in the foreland basin to the east of the advancing Rocky Mountains thrust-and-fold belt (Chapter 9). RON GARNETT / AIRSCAPES.CA.



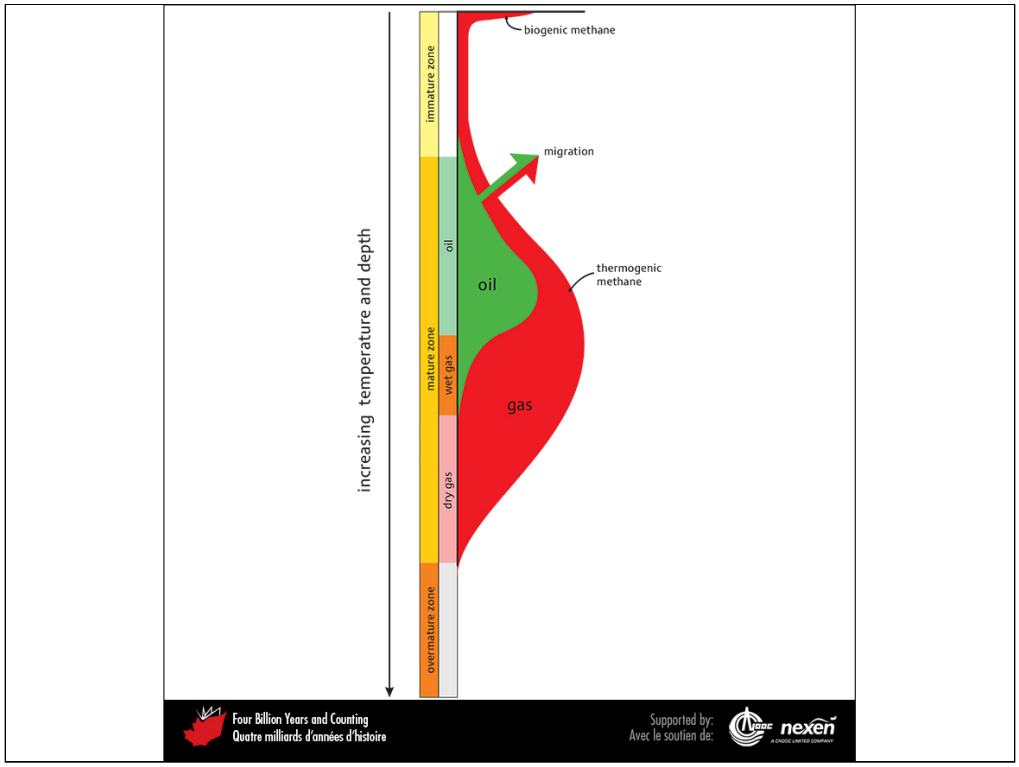
Molecular structure of some of the lighter petroleum compounds. The larger atoms, coloured red, represent carbon and the smaller atoms, coloured green, represent hydrogen. Figures on the left show molecular structure schematically and those on the right, representing the same compounds, show the true relationships of the atoms within each molecule, with the hydrogen and carbon atoms in direct contact. All the molecules shown, except benzene, have a linear structure and single bonds between carbon atoms. Methane is a gas, ethane is a wet gas, and hexane is a condensate. Molecules of benzene are formed of a ring of six atoms and have double bonds between some of these atoms.



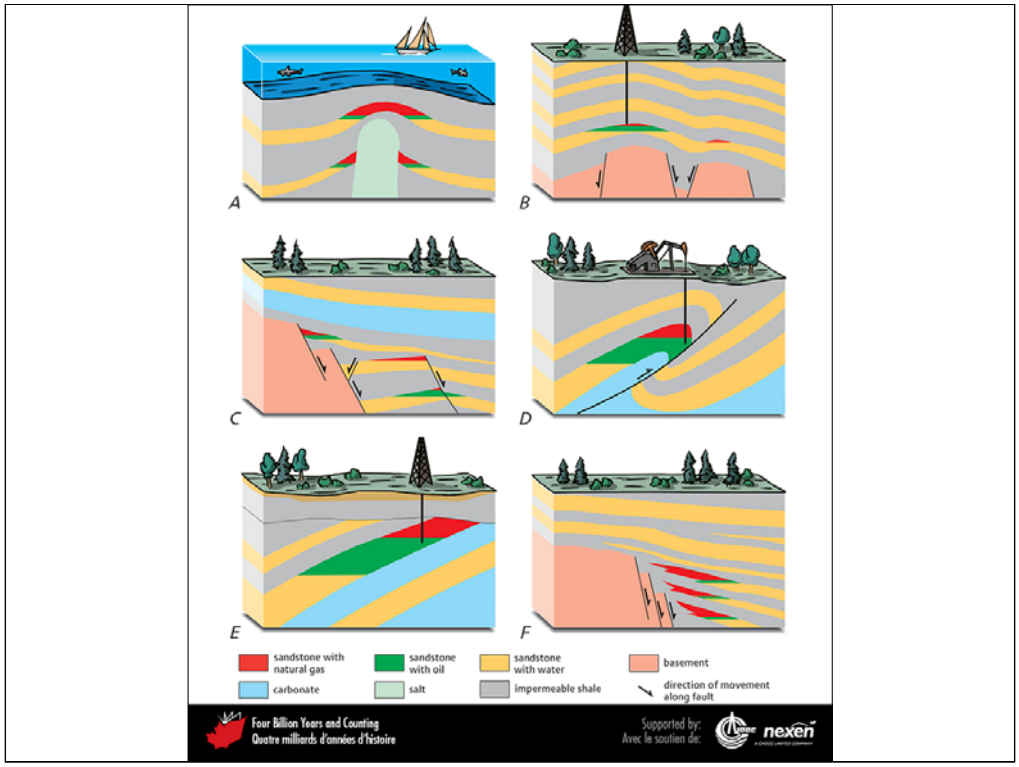
Cluster of organic-walled fossils of *Gloecapsomorpha*, an organism thought to have been a source of petroleum in early Paleozoic rocks. This specimen is from Cambrian rocks in the Saskatchewan subsurface and is about 0.27 millimetres wide. NICK BUTTERFIELD.



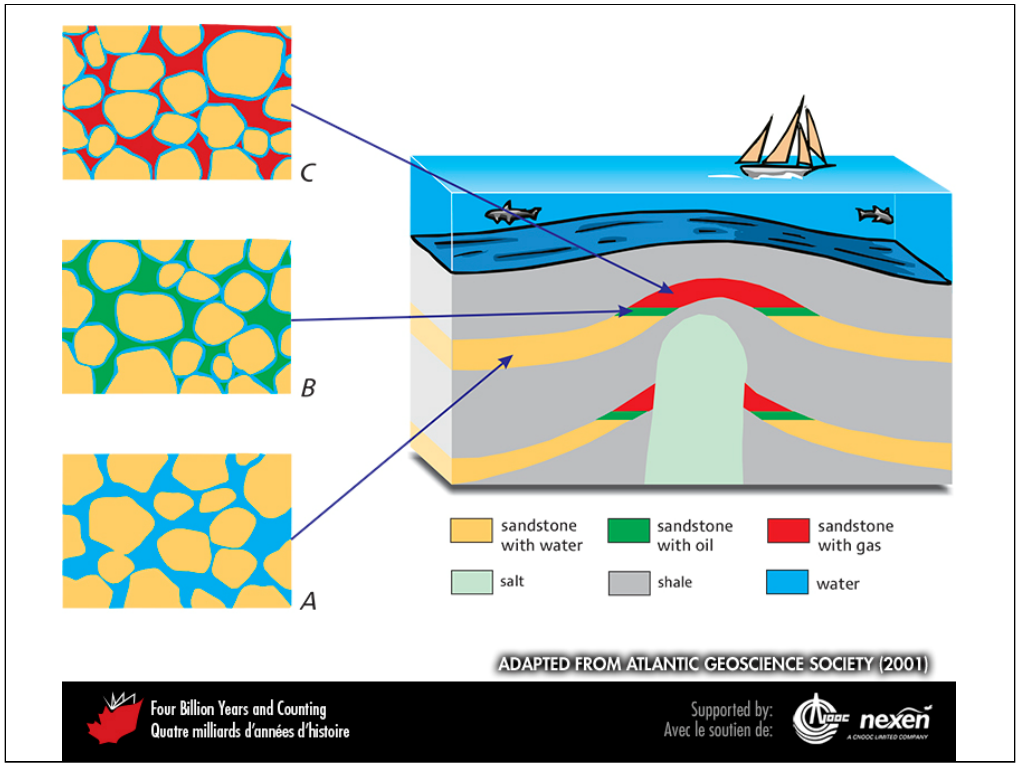
Trillions of microscopic marine organisms can live in a cubic metre of water within the photic zone (where sunlight penetrates). When the organisms die, their bodies sink. If the waters are rich in oxygen, as in *A*, the remains are not preserved. But if the water has low levels of oxygen, as in *B*, a large proportion of the organic remains is preserved and buried in the bottom sediments. Within the upper circle are some of the micro-organisms, greatly magnified, that live in the photic zone. Within the lower circle are some of the remains of the micro-organisms preserved in the sediments.



Conversion of organic matter to different kinds of petroleum over time and with increasing temperature and depth. The mature zone denotes where oil and thermogenic gas form. At low temperatures and minimal burial, only biogenic methane is produced. As organic matter matures, oil may be produced along with thermogenic methane and other gases. At still deeper horizons and higher temperatures, all oil has been expelled or is broken down into simpler molecules and only thermogenic methane is produced. The variation in width of the oil (green) and gas (red) curves reflects the relative amounts of each produced at different depths and temperatures.



Some types of hydrocarbon traps. Most of the traps shown are structural (*A* to *D*) and involve folding and/or faulting of strata. One trap (*E*) is a combined structural and stratigraphic trap. The last trap (*F*) is stratigraphic—the rock changes in character laterally. ADAPTED FROM VARIOUS SOURCES.



Porosity in sandstone. Liquids and gases occupying the spaces between grains in sandstone are able to migrate upwards until their movement is stopped by an impervious layer, such as shale. In *A*, pore spaces are filled with water. In *B* and *C*, a thin film of water coats each grain, but the rest of the spaces is filled with oil and gas, respectively. ADAPTED FROM ATLANTIC GEOSCIENCE SOCIETY (2001).

Cretaceous deltaic and marine strata tipped up around a diapir of Carboniferous evaporite, Ellef Ringnes Island, Nunavut. Below the surface, petroleum is commonly trapped in structures created by salt domes. CAROL EVENCHICK.

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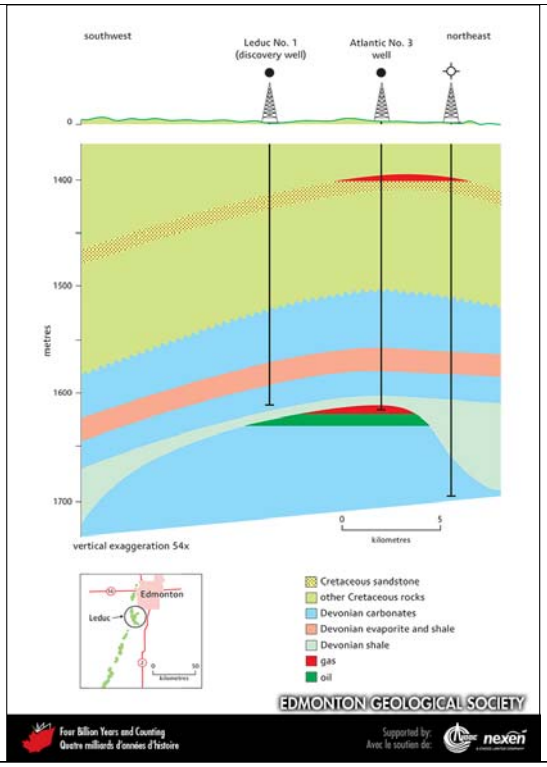
Part of the cairn in front of the Geological Survey of Canada office in Calgary. The rock is from a late Devonian carbonate reef at White Man Gap near Canmore, Alberta, in the Front Ranges of the Rocky Mountains. Its high porosity is typical of many Devonian oil and gas reservoirs beneath Alberta. The holes represent the former positions of stromatoporoids, now dissolved. GODFREY NOWLAN.



Cross-section through the Leduc Oil Field southwest of Edmonton, Alberta. What became the discovery well for this field (Leduc No. 1) was “spudded” (started) in the fall of 1946 and struck oil in a relatively small Devonian coral reef (not shown) in early 1947. Subsequent wells at Leduc that reached slightly older, but much more substantial, reefs that yielded large volumes of oil and gas. ADAPTED AND USED WITH PERMISSION FROM THE EDMONTON GEOLOGICAL SOCIETY.

Derelict equipment used when oil was being produced at Parson's Pond, western Newfoundland. Between 1907 and 1909, some 800 to 900 barrels of oil were shipped from there to St. John's. MARTIN FOWLER.

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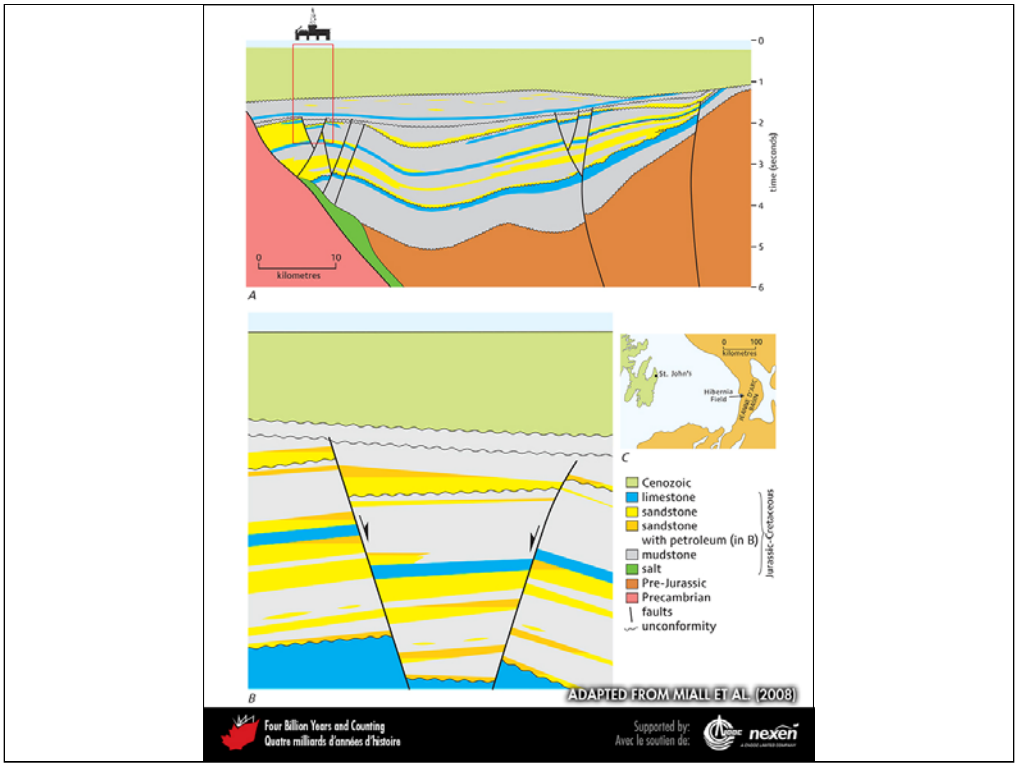
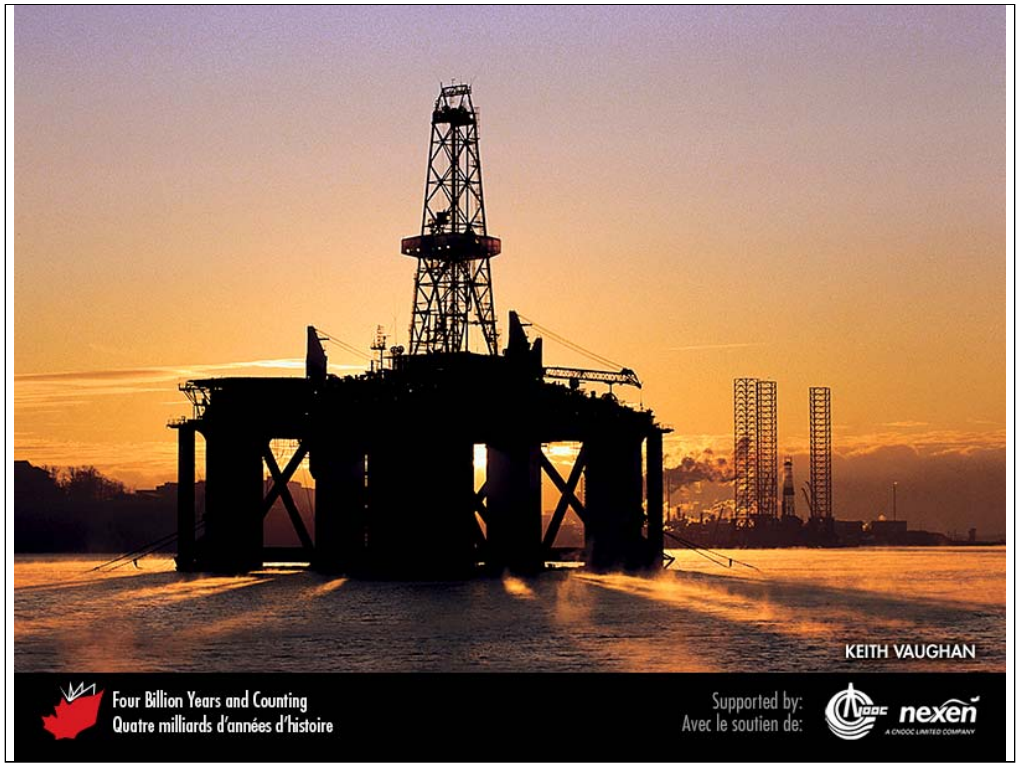
CHAPTER 13
Part 2 of 2

Oil well at Lake Ainslie on Cape Breton Island around 1913. PROVIDED BY GRANT WACH, SOURCE UNKNOWN.



A. Generalized section across the Jeanne d'Arc Basin on the Grand Banks off Newfoundland, in which there are several oil fields, including Hibernia. *B.* Detail of the Hibernia Oil Field (as approximately shown in red in *A*); the geology in *B* is idealized and so does not exactly match that shown in *A* as the sections are slightly offset. The vertical scale represents the time it takes for seismic waves to travel down to a particular surface, then back up again to the recording instrument. ADAPTED FROM MIALL ET AL. (2008), WITH HELP FROM MICHAEL ENACHESCU.



Semi-submersible rig in the foreground and jack-up rig in the background, Halifax Harbour, Nova Scotia. KEITH VAUGHAN.

The Deep Panuke Platform off Nova Scotia. COURTESY OF ENCANA.

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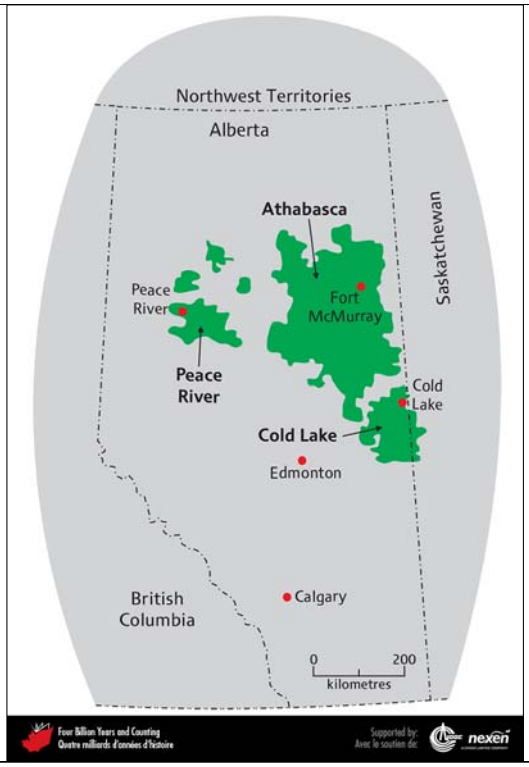
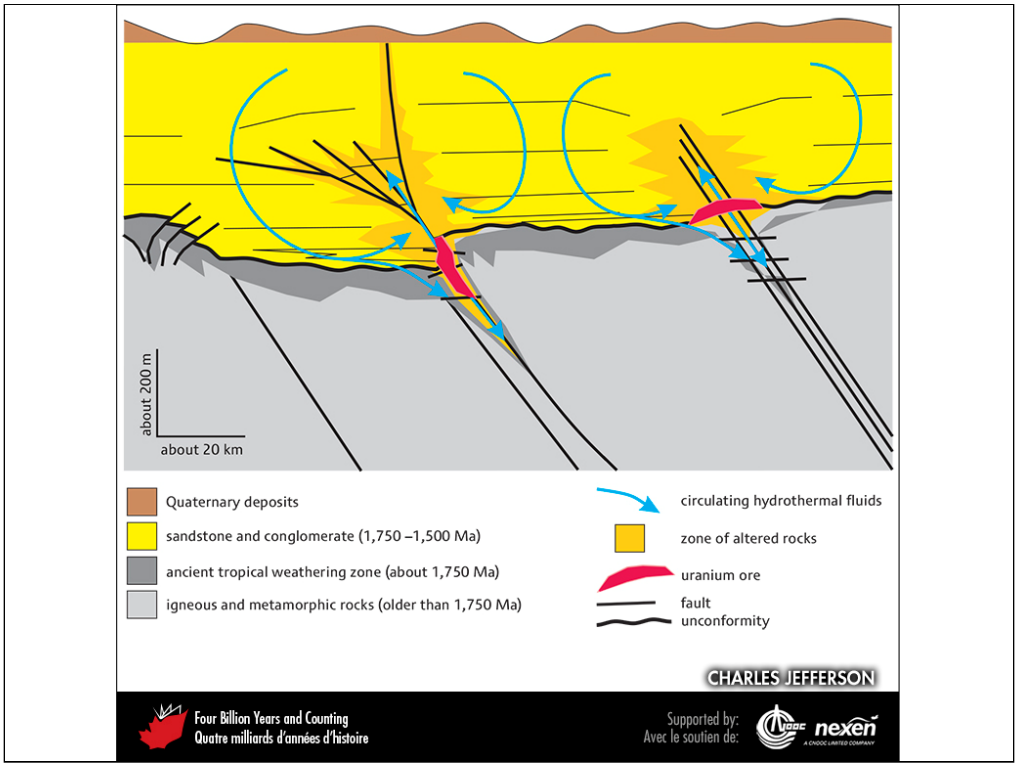
Remnants of a 4-inch (10.5-centimetre) diameter pipeline laid during the Canol Project in the 1940s, near Norman Wells, Northwest Territories. HANS WIELENS.

Jackpine Mine oil sands operation, about 110 kilometres north of Fort McMurray, Alberta. RON GARNETT / AIRSCAPES.CA.



Location of the three major oil-sands deposits: Athabasca, Cold Lake, and Peace River. ADAPTED FROM VARIOUS SOURCES.

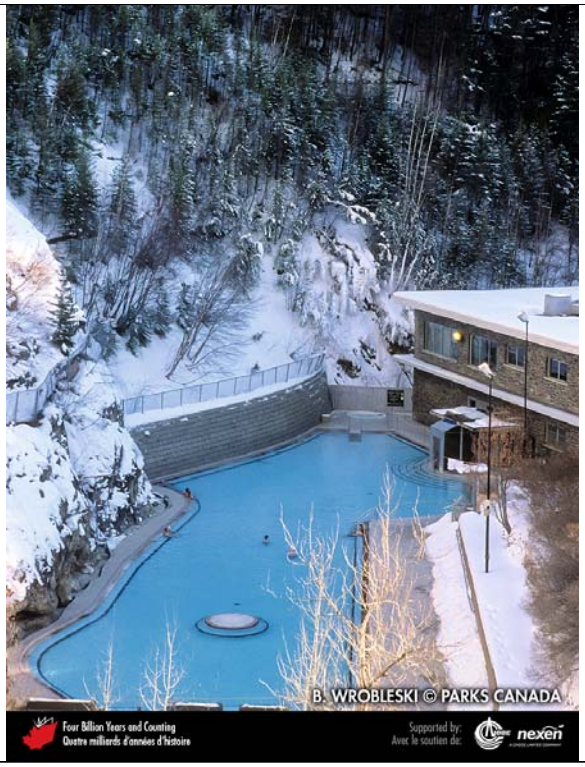


A simplified model of uranium deposits associated with unconformities in the Athabasca Basin of northern Saskatchewan and Alberta. Arrows show the interpreted paths of hydrothermal fluids that dissolved and carried the uranium to the deposit site. The hot waters also altered the surrounding rocks, providing clues to the discovery of these deposits. Hot water flow was driven by temperature differences (convection) and by repeated movements along the faults.

Headframes at the Cigar Lake Mine, a uranium mine in northern Saskatchewan. CHARLES JEFFERSON.

Sue C open uranium pit at the McClean Lake Mine, just west of Wollaston Lake, northern Saskatchewan. CHARLES JEFFERSON.

Powering with wind, the modern way: wind turbines at North Cape, Prince Edward Island. RON GARNETT / AIRSCAPES.CA.



The pool at Radium Hot Springs, Kootenay National Park of Canada, British Columbia, is heated to 39°C by geothermal energy; the water moves upward to the surface along a fault. B. WROBLESKI, COPYRIGHT PARKS CANADA.
