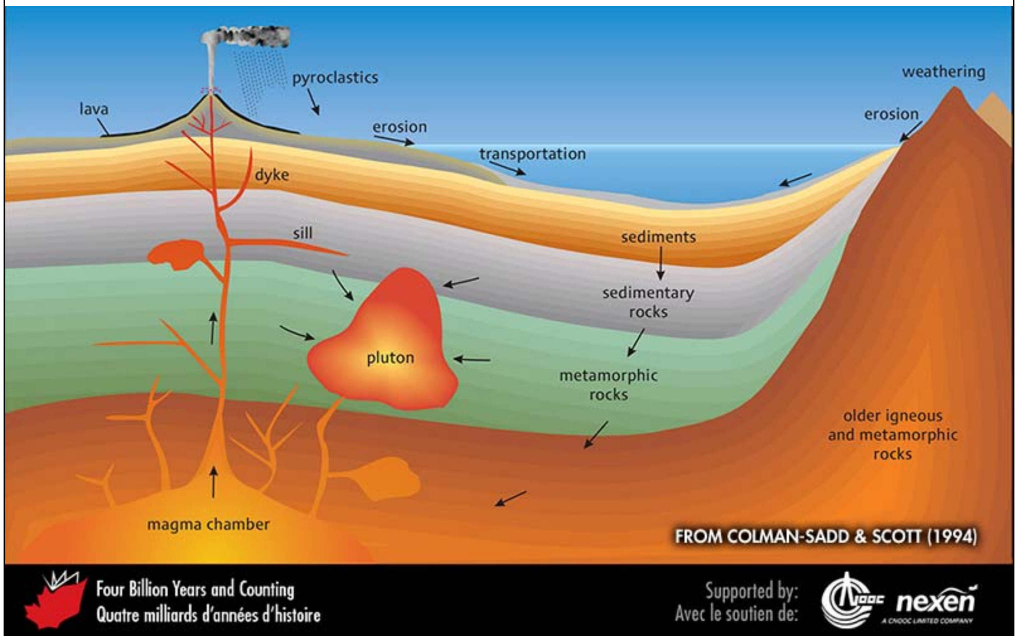
CHAPTER 1
Part 1 of 3

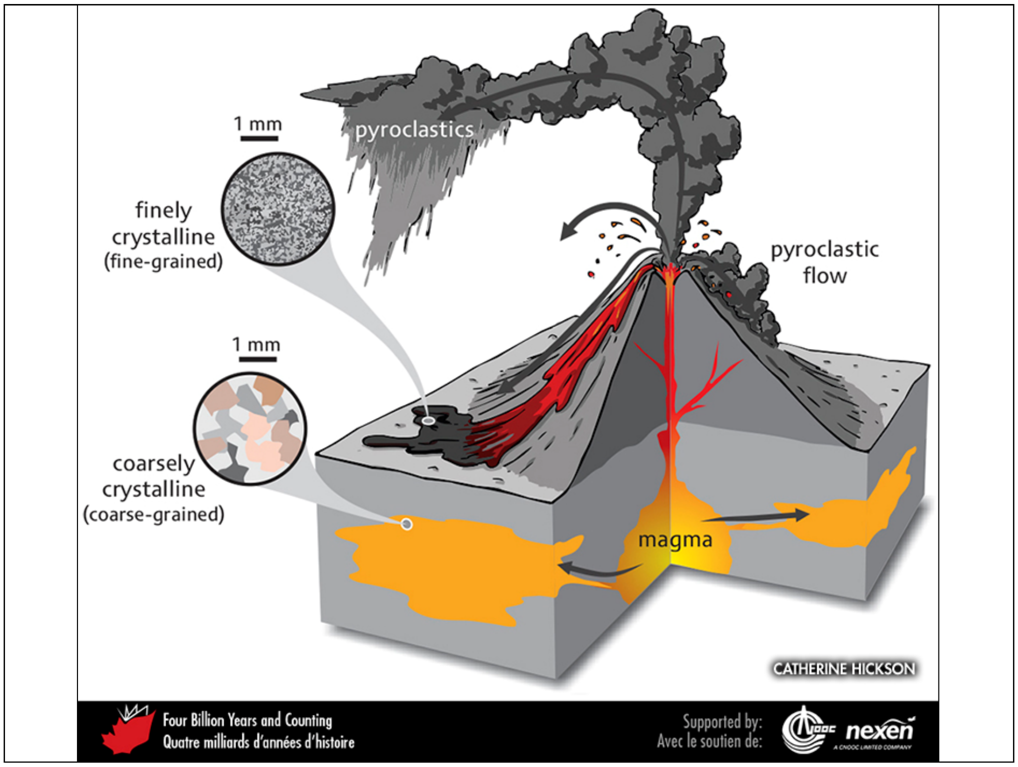
This view, from Skihist Provincial Park, British Columbia, shows the Thompson River flowing through a precipitous canyon before joining the Fraser River at Lytton. The scene shows how the rock cycle can have an impact on everyday life. WALTER LANZ



The rock cycle: an eternal process of recycling rocks through erosion, deposition, subsidence, melting, cooling, uplift, and other processes. Igneous rocks started out as molten material that solidified either at the surface as volcanic (extrusive) rocks or below the surface as intrusive rocks in structures such as plutons and dykes. Erosion of igneous and other rocks produces sediments that may become sedimentary rocks. The effects of heat and pressure on all pre-existing rocks may change (metamorphose) them to metamorphic rocks and might eventually melt them to produce molten magma—and the cycle starts again. FROM COLMAN-SADD AND SCOTT (1994). USED WITH PERMISSION OF THE AUTHORS, THE GEOLOGICAL ASSOCIATION OF CANADA, AND THE GEOLOGICAL SURVEY OF NEWFOUNDLAND AND LABRADOR.

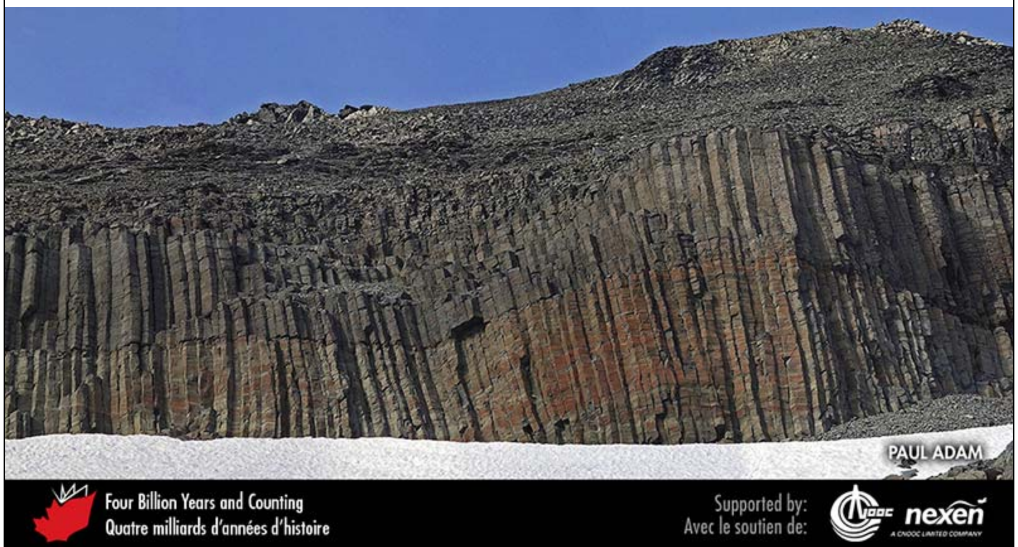
____

A view of the Niagara River's Horseshoe Falls from the Canadian side. The boulders to the left at the base of the falls testify to the erosive power of the River as it plummets over the precipice. KEITH VAUGHAN.



A volcano, partly cut away, to show how magma reaches the surface and how it is then distributed as lava and pyroclastics.

____



Columnar basalt near Mount Garibaldi, British Columbia. Mount Garibaldi is one of the volcanoes of the Cascade Range, which extends from southwestern British Columbia to northern California. PAUL ADAM.

____

A boulder of 200-million-year-old basalt from Newport Landing, Nova Scotia. When molten, the lava gave off bubbles of gas, leaving vesicles once the rock had solidified, and these were later filled by crystals (white) precipitated from mineral-rich water percolating through the rock. ROB FENSOME.

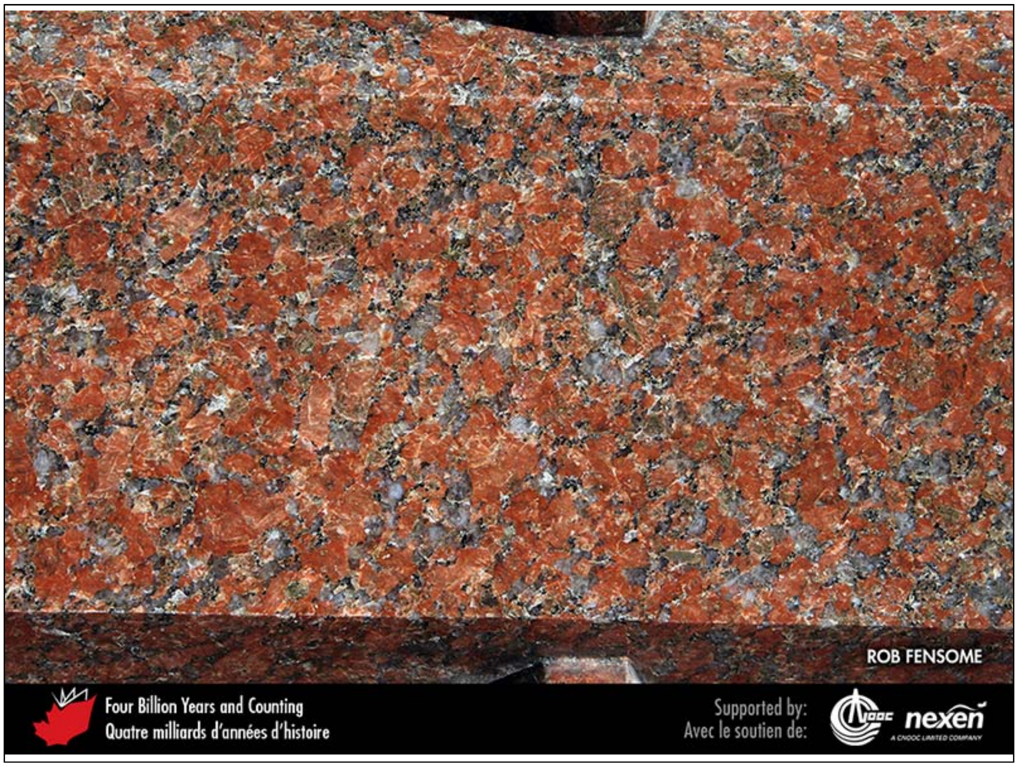
____

A block of rhyolite from Campbellton, New Brunswick. As the original lava cooled and set about 410 million years ago, bands of different composition were stretched out into layers, like multicoloured toffee. HEINZ WIELE, COURTESY OF THE ATLANTIC GEOSCIENCE SOCIETY.

____

Pillow lava from near the Lillooet Glacier, southwestern British Columbia. JOHN CLAGUE.

____



This polished specimen of granite from southern New Brunswick is part of a monument to Quebec historian François-Xavier Garneau near the House of Assembly in Québec City. ROB FENSOME.

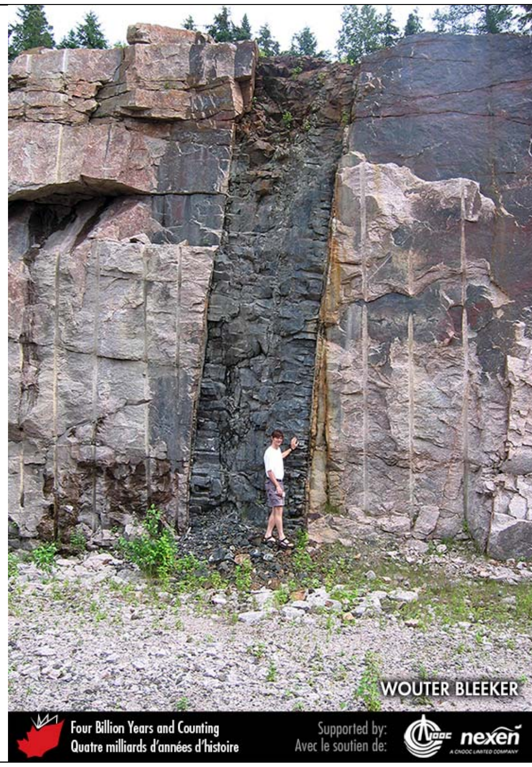
____

Gabbro, about 420 million years old and probably from New Brunswick, was used for gravestones of Titanic victims in Fairview Lawn Cemetery, Halifax, Nova Scotia. ROB FENSOME.

____

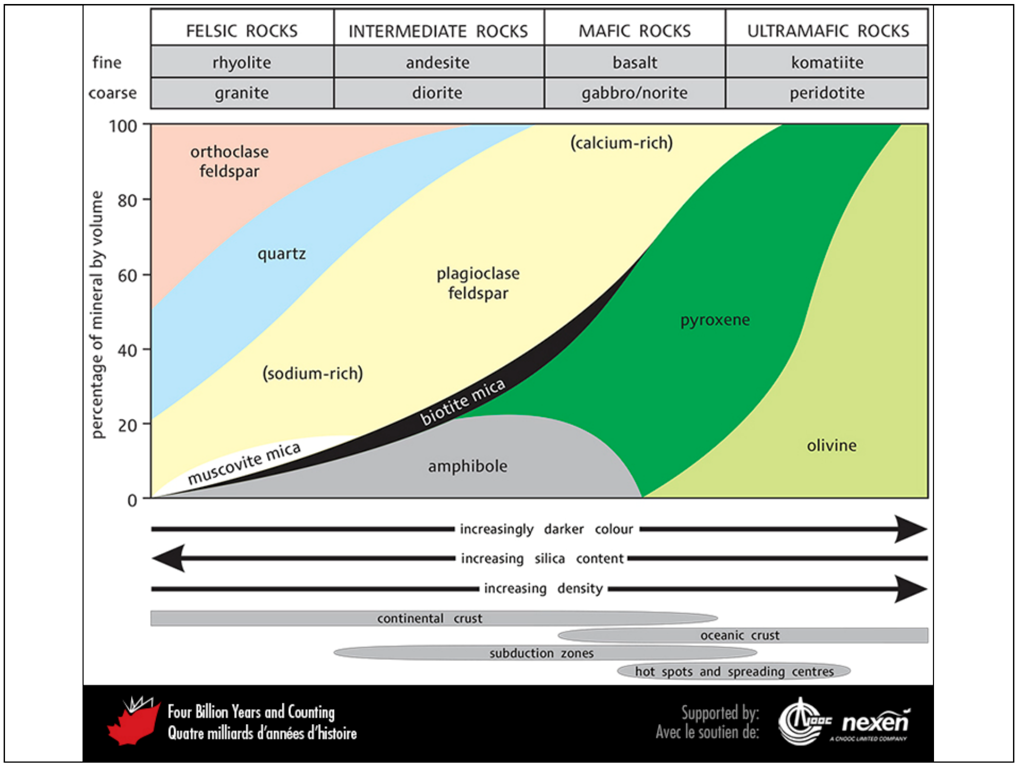
Remnant of what was originally a block of sedimentary rock enclosed by granite of the South Mountain Batholith, a large intrusion dating from 375 million years ago. Such inclusions of surrounding rock within an igneous intrusion are known as xenoliths, and many are visible in the granite around Peggys Cove Lighthouse, Nova Scotia. ROB FENSOME.

____



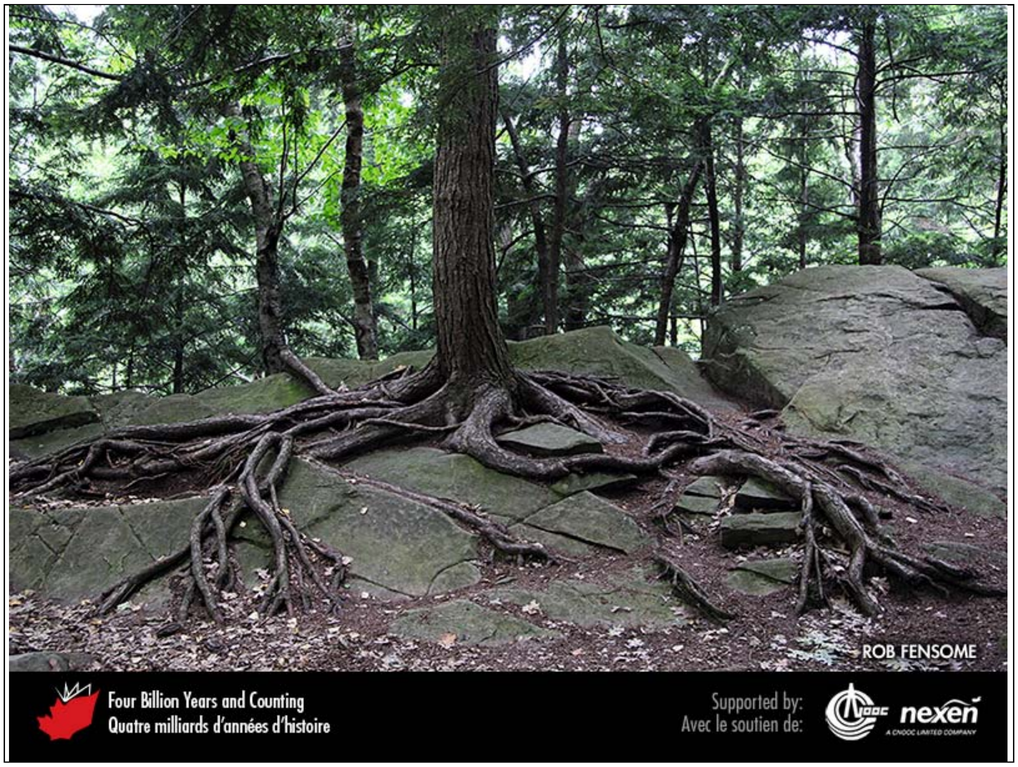
This 590-million-year-old dyke near Powassen, Ontario, cuts through older, lighter-coloured rock. WOUTER BLEEKER.

Aerial view of resistant, mafic sills, about 120 million years old, within more easily eroded, dark-grey marine shales, over 200 million years old, in the Blue Mountains, northwest Ellesmere Island, Nunavut. ASHTON EMBRY.



Different igneous rock types have different mineral compositions, different physical properties such as grain size and colour, and different distributions. Explanations for the features represented by the four bars at the base of the diagram are provided in Box 2 and Chapter 2. ADAPTED FROM VARIOUS SOURCES WITH INPUT FROM BARRIE CLARKE.

____



Tree roots disrupt a resistant sandstone ledge, thus contributing to its weathering and erosion, near Chutes-de-la-Chaudière, Charny, Quebec. ROB FENSOME.

____

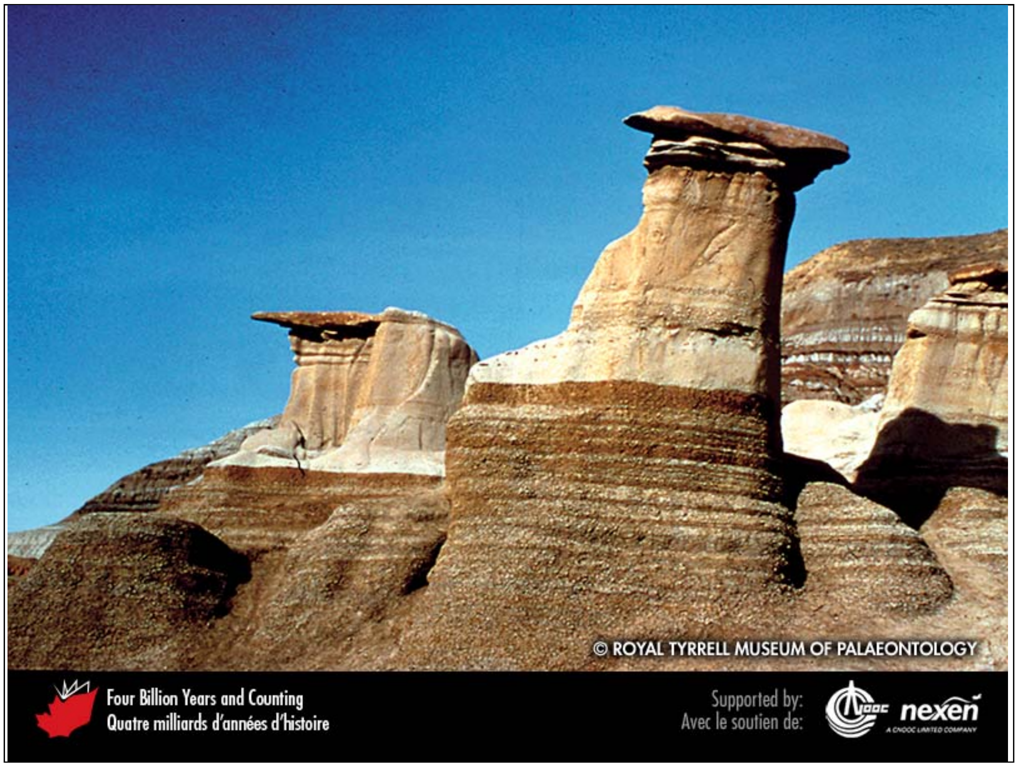
CHAPTER 1
Part 2 of 3

Erosion in the badlands of Dinosaur Provincial Park, near Brooks, Alberta. Weathering breaks down the rocks into sediment, which is moved downhill by gravity and water. The sediment accumulates in small rills as shown here, but may eventually end up in rivers feeding into lakes, seas, or oceans. JOHN WILLIAM WEBB.

____

A plume of sediment entering Hudson Bay from Witchekat Creek, Wapusk National Park of Canada, Manitoba. N. ROSING, COPYRIGHT PARKS CANADA .

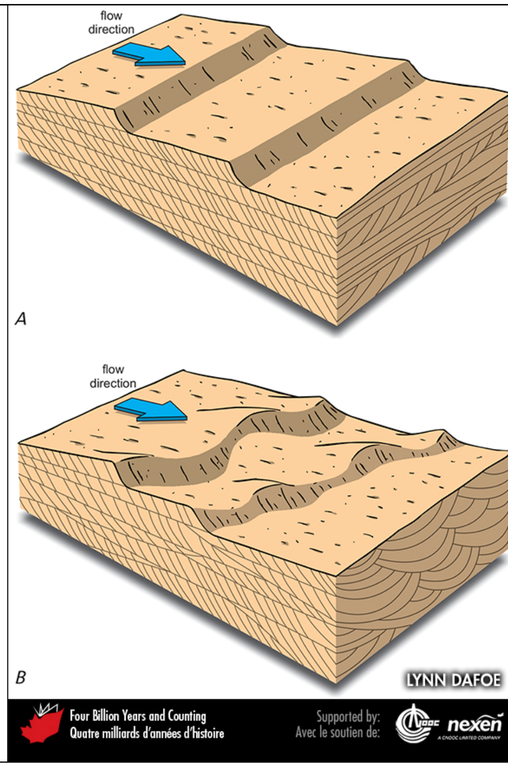
____



Erosion has created these "hoodoos" in sedimentary rocks in the badlands near Drumheller, Alberta. The layering, or bedding, was continuous before erosion sculpted the landscape. The lower brown marine shales are about 75 million years old; the white sandstone above is a slightly younger fluvial deposit. THE ROYAL TYRRELL MUSEUM OF PALAEONTOLOGY.

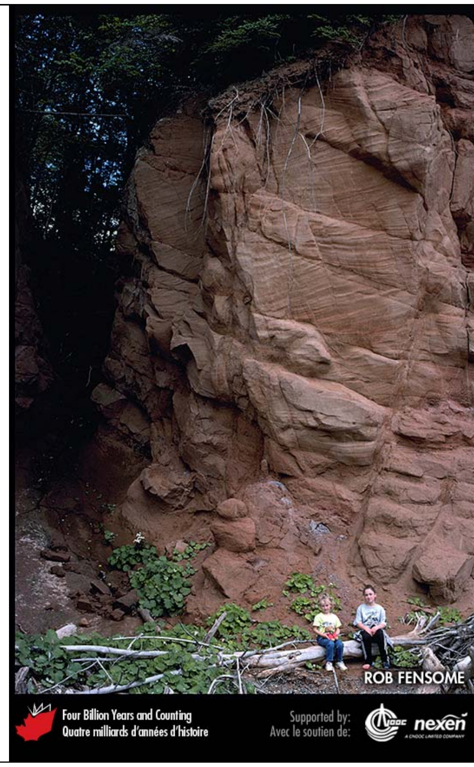
Modern dunes underwater and on the banks of the Saint John River, New Brunswick. RON GARNETT / AIRSCAPES.CA.

____



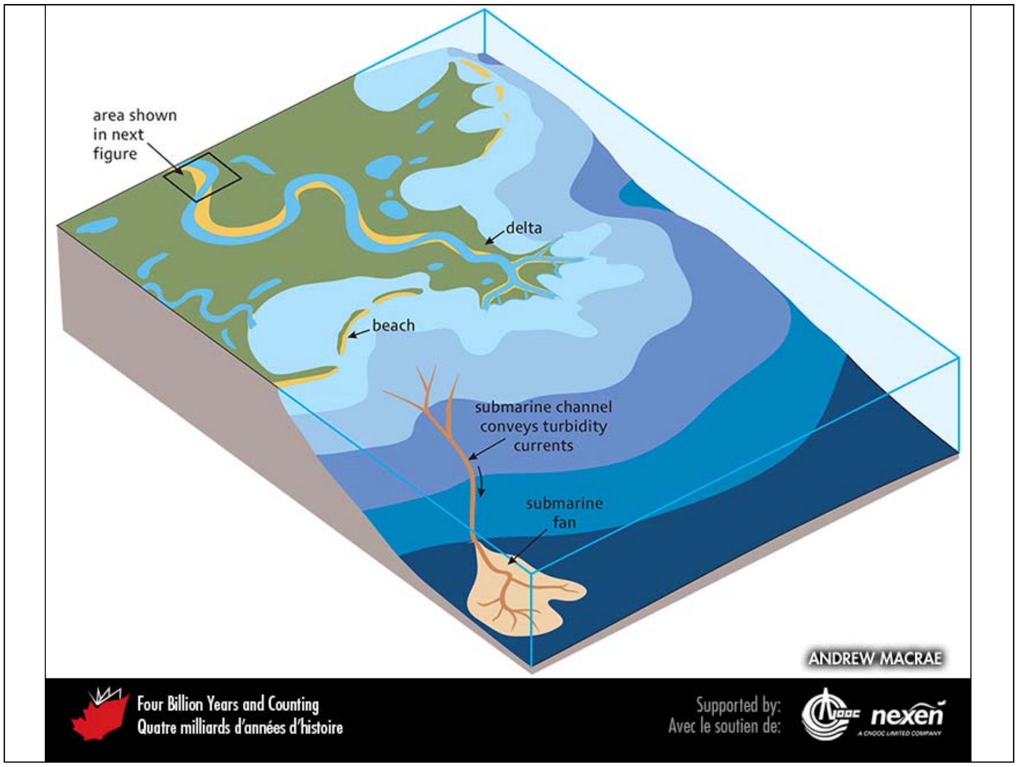
The flow of water and air over loose sediment results in the formation of ripples and dunes on the sediment surface. Factors such as current speed, direction, and variability, as well as the size of sediment particles (grain size) result in the formation of different styles of ripples and dunes. This diagram illustrates two such styles and the respective styles of cross-bedding seen in cross-section. ADAPTE D FROM VARIOUS SOURCES BY LYNN DAFOE.

____



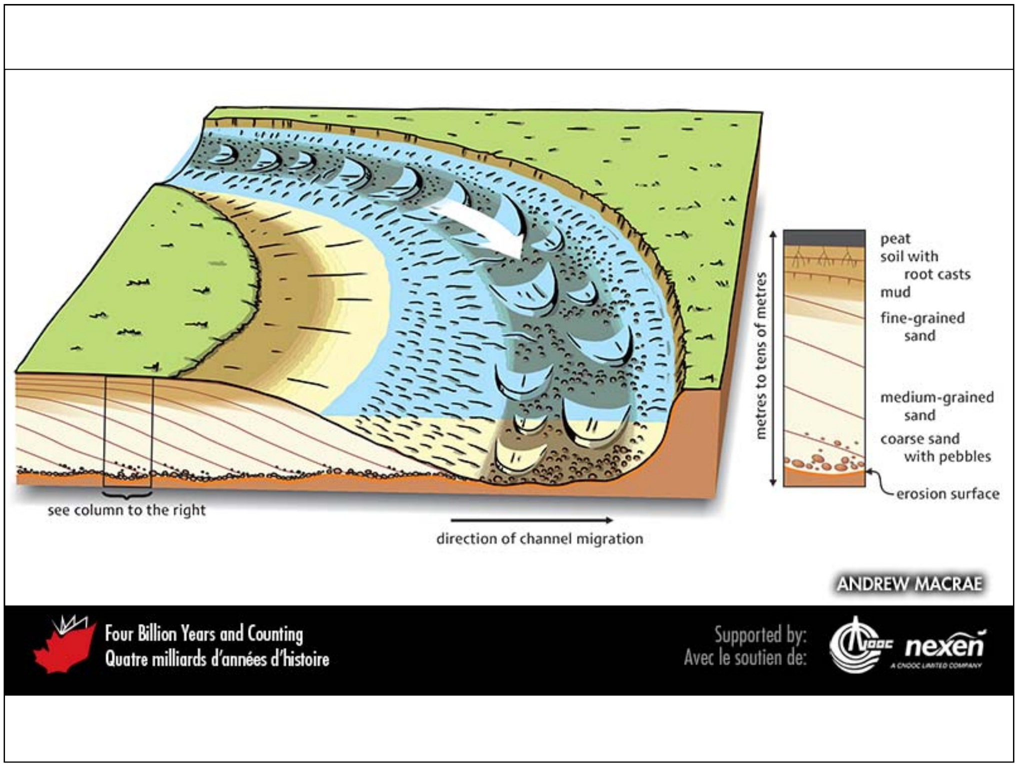
Cross-bedding in 200-million-year-old sandstones (redbeds) of eolian (wind-blown rather than subaqueous) origin, Wasson Bluff near Parrsboro, Nova Scotia. ROB FENSOME.

____



Shown here are a variety of sedimentary environments, including fluvial, lacustrine, deltaic, shoreline, and marine. Upon reaching the sea, a river may build out a delta by dropping its sediment load. Waves and tidal currents then redistribute some of the sediment to form beaches and other coastal features. Generally, the farther out from shore, the finer the sediment deposited, reflecting weaker currents offshore. Turbidity currents will transport sediment down undersea canyons or valleys, where they form deposits known as turbidites. Multiple turbidites form a submarine fan at the mouth of a deep undersea channel. The area outlined by the black box is enlarged in the next figure. ANDREW MACRAE.

____



An example of what happens at a river bend. The main diagram shows the bend with a cutaway view facing the reader. Momentum carries the main river current around the outside of the bend, towards the right side of the drawing. The strength of the current there erodes the river bank, and only coarser material settles to the bottom; the stronger current also leads to the development of large dunes on the channel floor. On the inside bend of the channel, the weaker current deposits finer sand and mud, building out an arc-shaped platform called a point bar. Because of undercutting on the outside bend and deposition on the point bar, the channel migrates, leaving a sediment record of shifting environments and processes. Eventually vegetation and soil may develop on the point bar. The column at right gives an idea of what a vertical section through the sediments would look like at the location shown by the box in the main diagram. ANDREW MACRAE.

Ripples on tidal flats, Five Islands, Nova Scotia. ROB FENSOME.

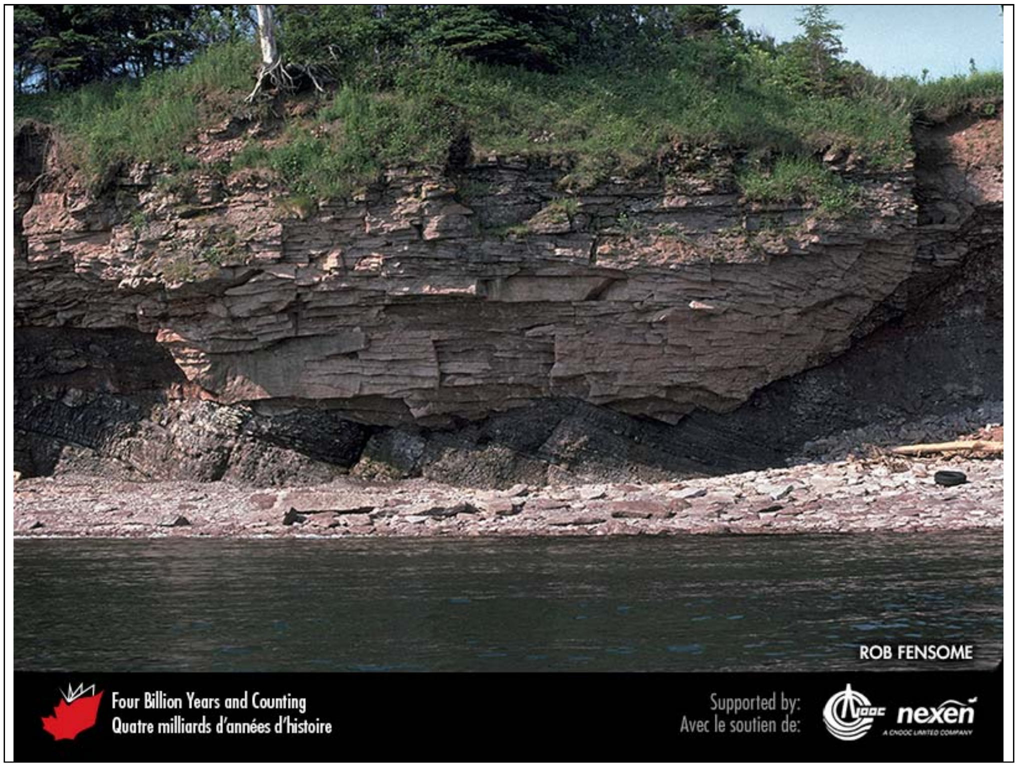
____

Ripples in about 325-million-year-old sedimentary rock from West Bay, near Parrsboro, Nova Scotia. ROB FENSOME.

____

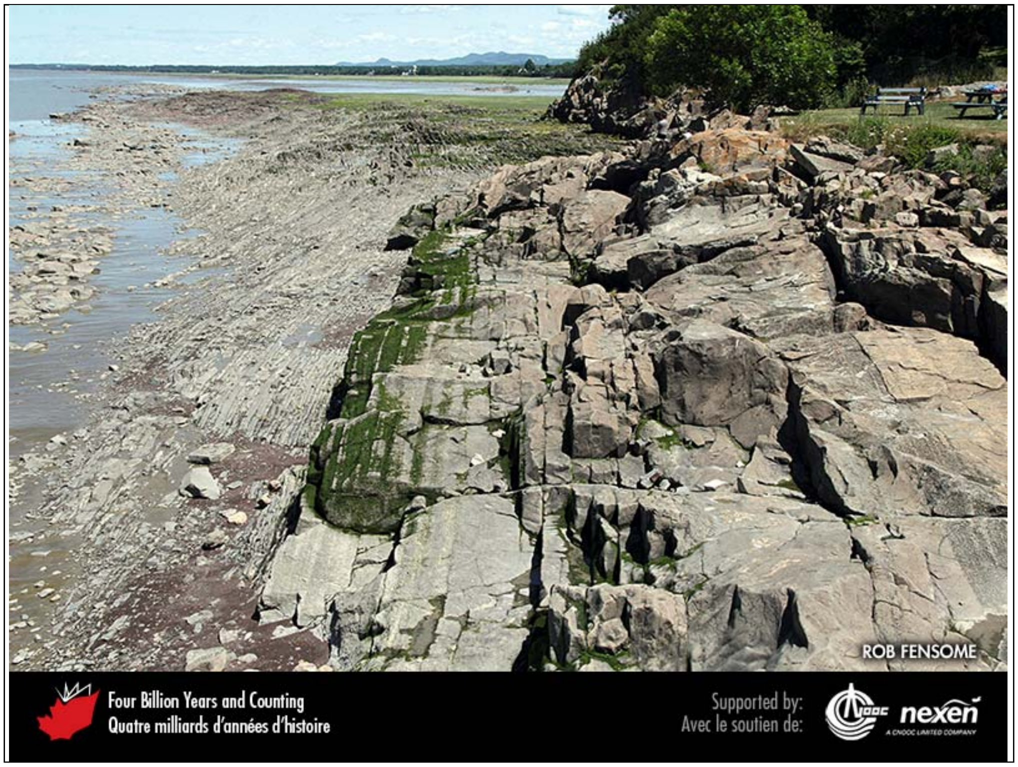
Mudcracks in modern muds, western Cape Breton Island, Nova Scotia. MARTIN GIBLING.

____

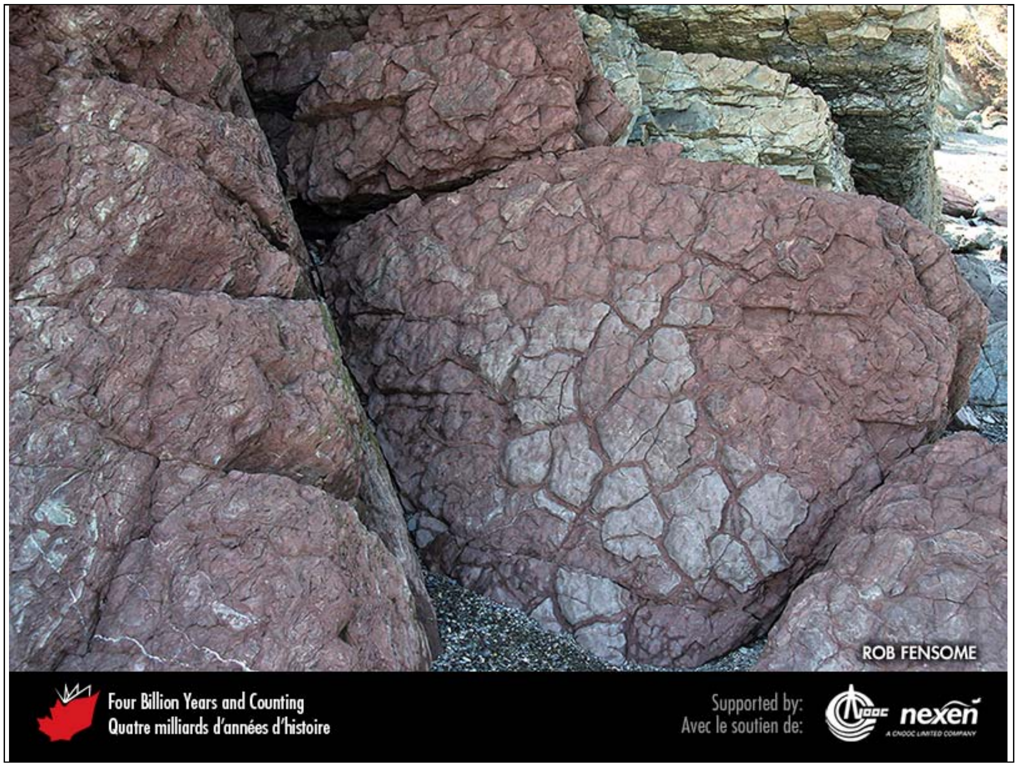


A 300-million-year-old channel filled with layers of sand, now preserved as sandstone, cuts into older sedimentary rock near the village of Jacquet River, New Brunswick. ROB FENSOME.

____



This sequence of sedimentary rocks at L'Islet-sur-Mer, Quebec, deposited about 505 million years ago, have been steeply tilted, so imagine the original sea floor coming vertically out of the ground. The grey, regularly bedded rocks to the left represent turbidites, and the blockier, less well-bedded rocks in the foreground are sandstone and conglomerate that originated as sediment in a deep-sea channel. ROB FENSOME



Mudcracks in 350-million-year-old mudstone, Clarke Head, near Parrsboro, Nova Scotia. ROB FENSOME.

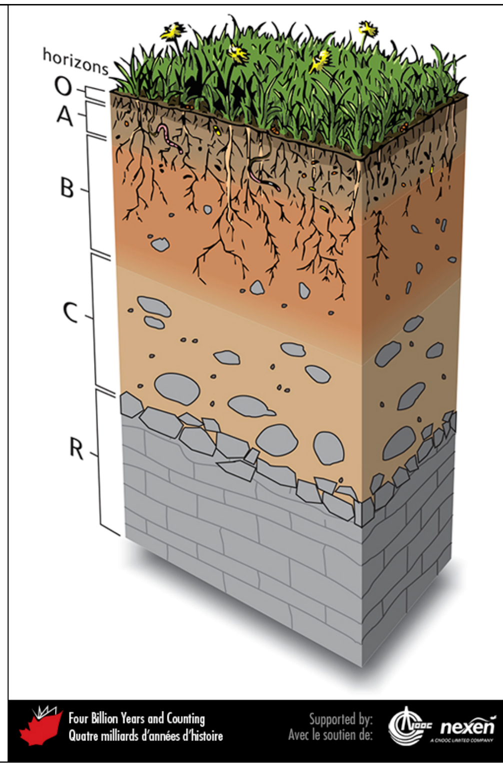
____

Deltas form where rivers enter the sea or a lake and deposit their sediment load, as here at Peyto Lake in Banff National Park of Canada, Alberta. RON GARNETT / AIRSCAPES.CA.

CHAPTER 1
Part 3 of 3

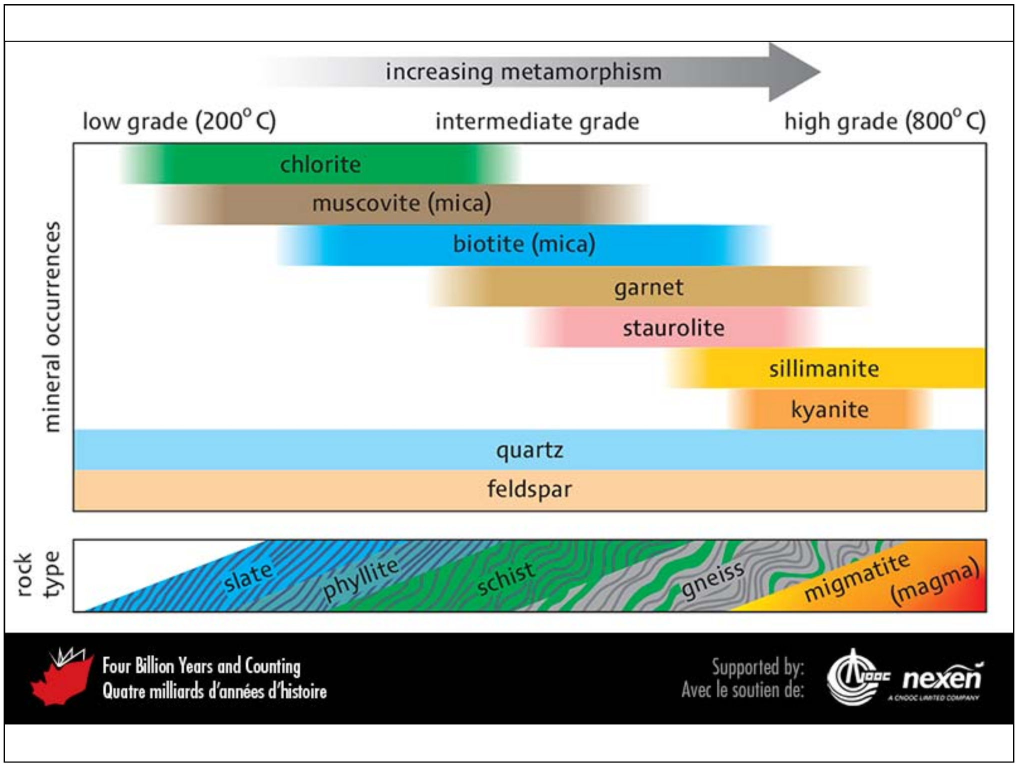
Low cliffs of peat, Escuminac Point, New Brunswick. ROB FENSOME.

____



A soil profile. At the top is the O horizon, consisting of not-yet decomposed organic matter, mainly plant litter. The A horizon is the topsoil, generally darker than horizons lower down because it still contains much organic matter. The B horizon is known as the subsoil and consists mainly of minerals and clay; it also includes many plant roots and organisms that churn the soil. The C horizon is made up mainly of chunks of rock and smaller rock particles. The R horizon is the bedrock on which the soil forms; the nature of the bedrock influences the chemical characteristics of the soil. ADAPTED FROM VARIOUS SOURCES.

An ancient calcareous paleosol, known as calcrete, near St. Martins, New Brunswick. MARTIN GIBLING.



Minerals and rocks that form at increasing grades of metamorphism. Laboratory studies show that different minerals form under different conditions of pressure and temperature. The bottom row shows the succession of rock types formed as metamorphism progresses, assuming that the original rock was a mudstone. ADAPTED FROM VARIOUS SOURCES.

Cleavage in this 480-million-year-old slate from Blue Rocks, Nova Scotia, is vertical and more or less perpendicular to the original sedimentary bedding (the light and dark grey banding). Because sedimentary layers are still discernible, this slate is considered a low-grade metamorphic rock. MARTIN GIBLING.

This roadside block near Pont Rouge, Quebec, illustrates the banded nature of gneiss. ROB FENSOME.

____

Migmatite formed deep in the crust by the partial melting of grey gneiss and later injection of pink granitic melt. The grey gneiss formed about 3,000 million years ago, and the granitic melt was injected about 400 million years later. This beautiful rock is exposed on mainland Nunavut. LEOPOLD NADEAU.

____

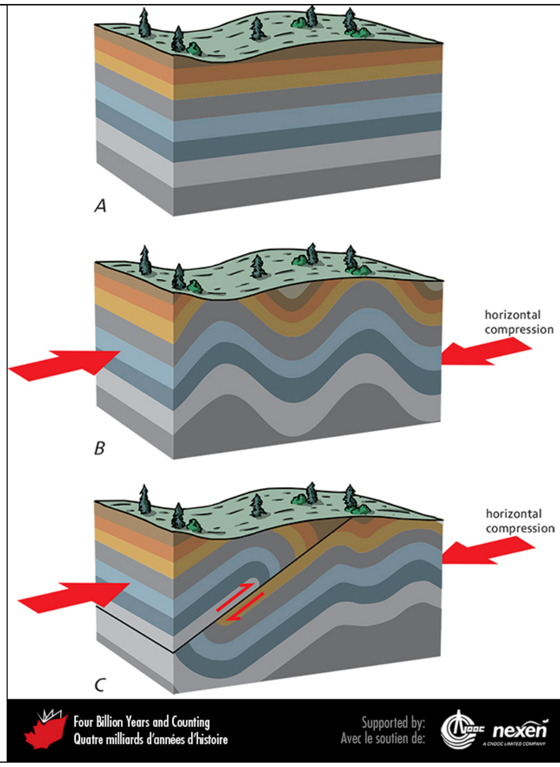
Colourful marble consisting largely of orange calcite and a green pyroxene from a quarry near Bancroft, Ontario. The rock was metamorphosed from limestone about 1,100 million years ago. GRAHAM WILSON.

At Clarke Head, near Parrsboro, Nova Scotia, orange and translucent white gypsum veins have been injected into older (about 350 million-year-old) mudstone. ROB FENSOME.

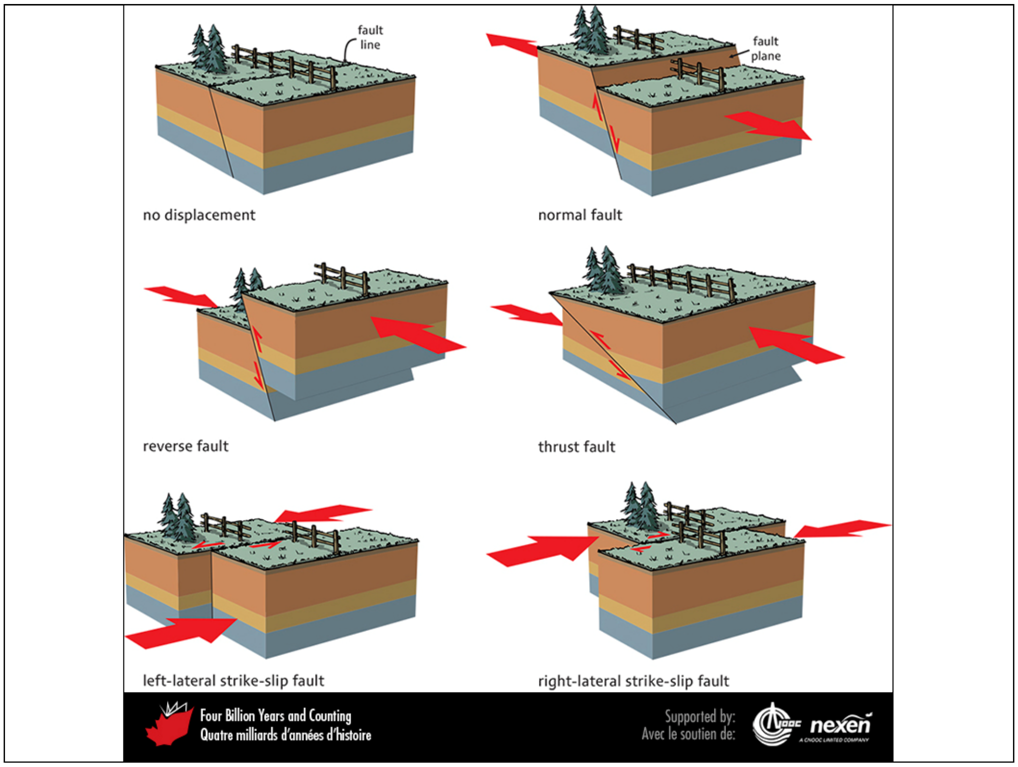
____

Tight folds in 150-million-year-old sedimentary rocks in the Skeena Mountains, British Columbia. MARGO MCMECHAN.

____



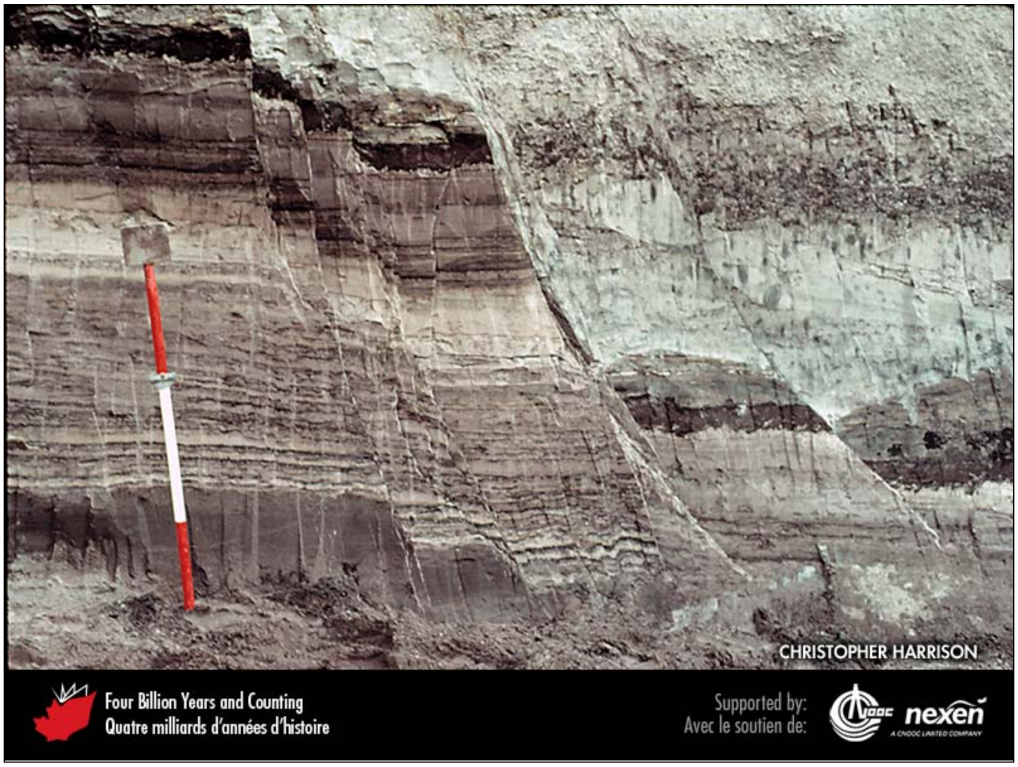
A. Sedimentary strata before deformation. B. The same rocks after horizontal compression rumples them into folds, forming anticlines and synclines. C. Continuing pressure may form thrust faults (low-angle reverse faults—see also the next figure) that push layers of rock on top of other layers.



Different kinds of faults. Check the location of the fence to see which way fault blocks are moving.

____

Rectangular arrangement of joints in sedimentary rocks on Ellef Ringnes Island, Nunavut. CAROL EVENCHICK.



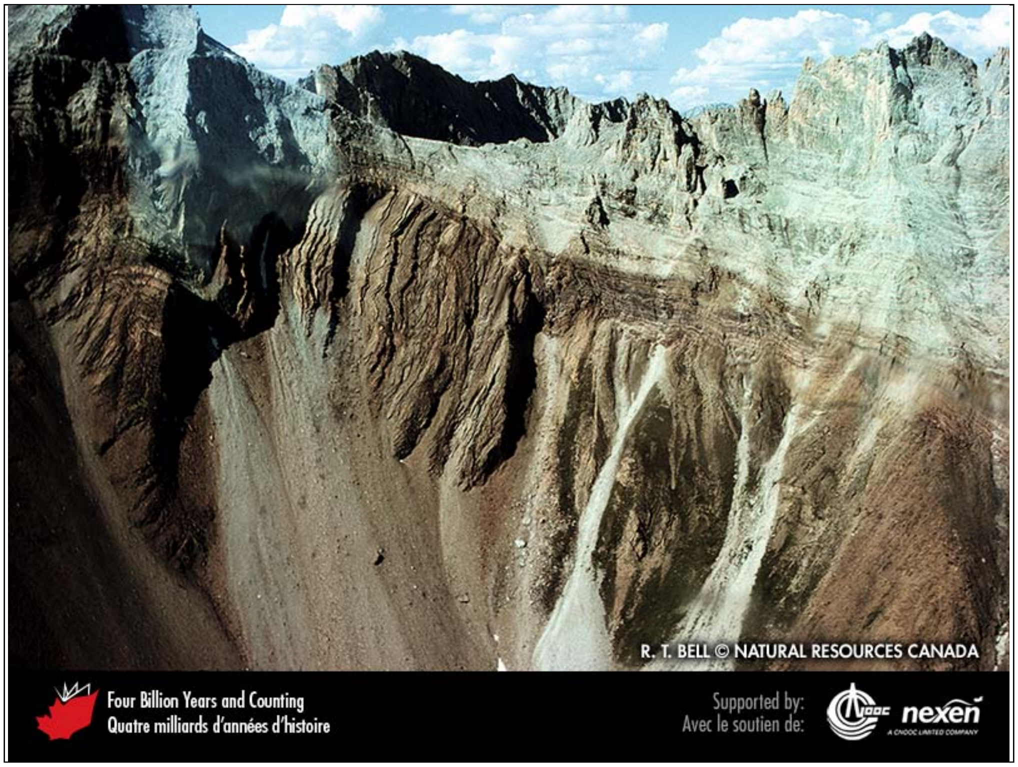
Normal faults in sedimentary rocks, Prince Patrick Island, Northwest Territories.
CHRISTOPHER HARRISON.

____

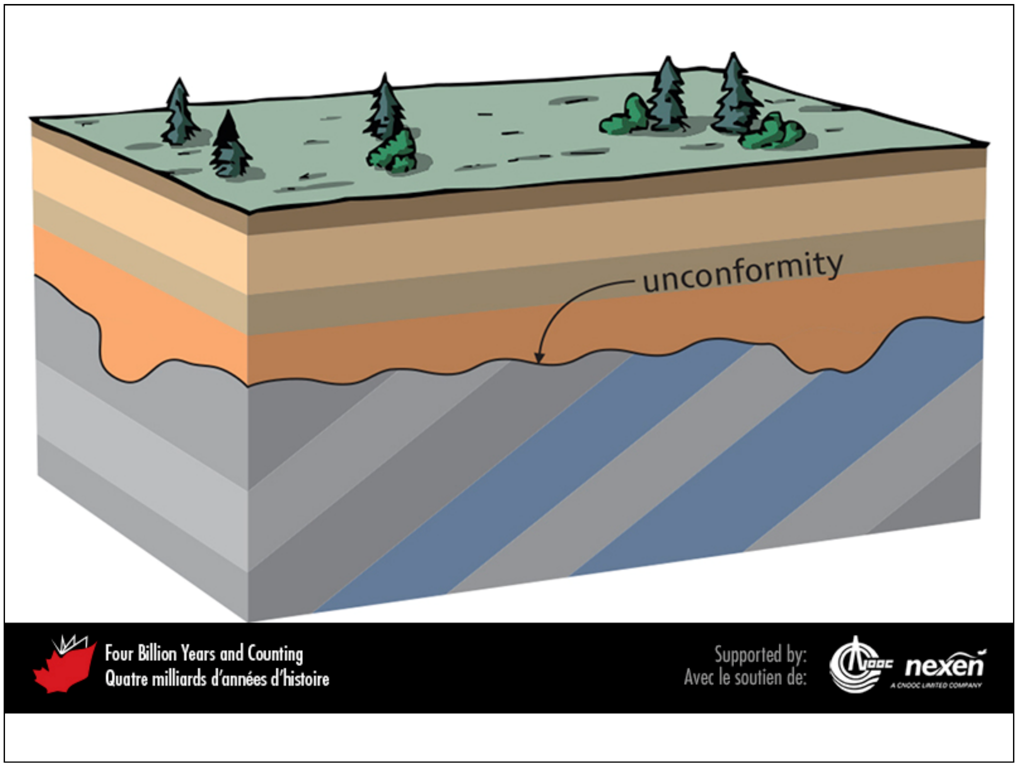
In this cliff near Parrsboro, Nova Scotia, the steeply tilted grey rocks at far right are about 350 million years old and have been thrust up relative to younger (around 200-million-year-old) grey volcanic and reddish sedimentary rocks to the left. The older and younger strata are separated by light-green, finely crushed material produced by grinding as the fault moved the two sets of rocks past each other. ROB FENSOME.

____

Ice-smoothed surface showing folds in dark amphibolite and pink gneiss on the west side of Franklin Island, Georgian Bay, Ontario. Such metamorphic rocks form in the crust beneath mountain ranges, perhaps as deep as 40 kilometres. That these rocks are now exposed at the surface implies that the mountains have eroded away and the crust in the region has been uplifted. CHRISTOPHER HARRISON.



This view of the Wernecke Mountains in Yukon reveals an unconformity between older, steeply tilted, brown sedimentary rocks below and younger, gently tilted, light-coloured carbonates above. The brown rocks were deposited before 1,710 million years ago in the Wernecke Basin (Chapter 6). R. T. BELL, REPRODUCED WITH THE PERMISSION OF NATURAL RESOURCES CANADA 2013, COURTESY OF THE GEOLOGICAL SURVEY OF CANADA.



An unconformity (irregular line) separates a lower suite of tilted strata from an upper suite of horizontal strata. Unconformities represent ancient erosion surfaces, commonly subaerial, and preserve relics of former landscapes such as channels.

____