CHAPTER 12

Part 1 of 3

The flow over Kakabeka Falls in northern Ontario reminds us of the vital role water, in large part a geological resource, plays in our daily lives. ROB FENSOME

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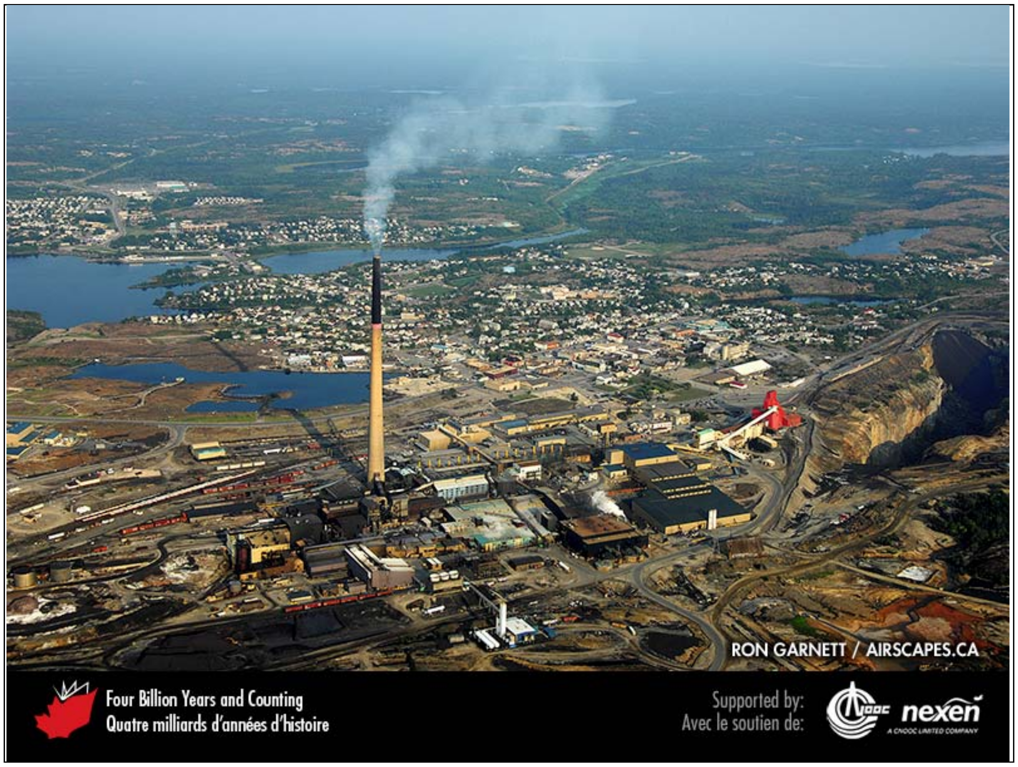

Aerial view of Flin Flon, Manitoba, a major centre for mining VMS deposits hosted by rocks of the Trans-Hudson Orogen. RON GARNETT / AIRSCAPES.CA.

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Potential prospectors climb the trail to the Chilkoot Pass at the Alaska-British Columbia border on their way to the Klondike.

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A dense billowing plume of mineral-laden water (a black smoker) gushes from a hydrothermal vent on the Juan de Fuca Ridge off the coast of British Columbia. As the hydrothermal fluid meets the near-freezing seawater, minerals precipitate to form chimney structures. The vents are home to an unusual fauna, including tube worms shown in the foreground. VERENA TUNNICLIFFE.

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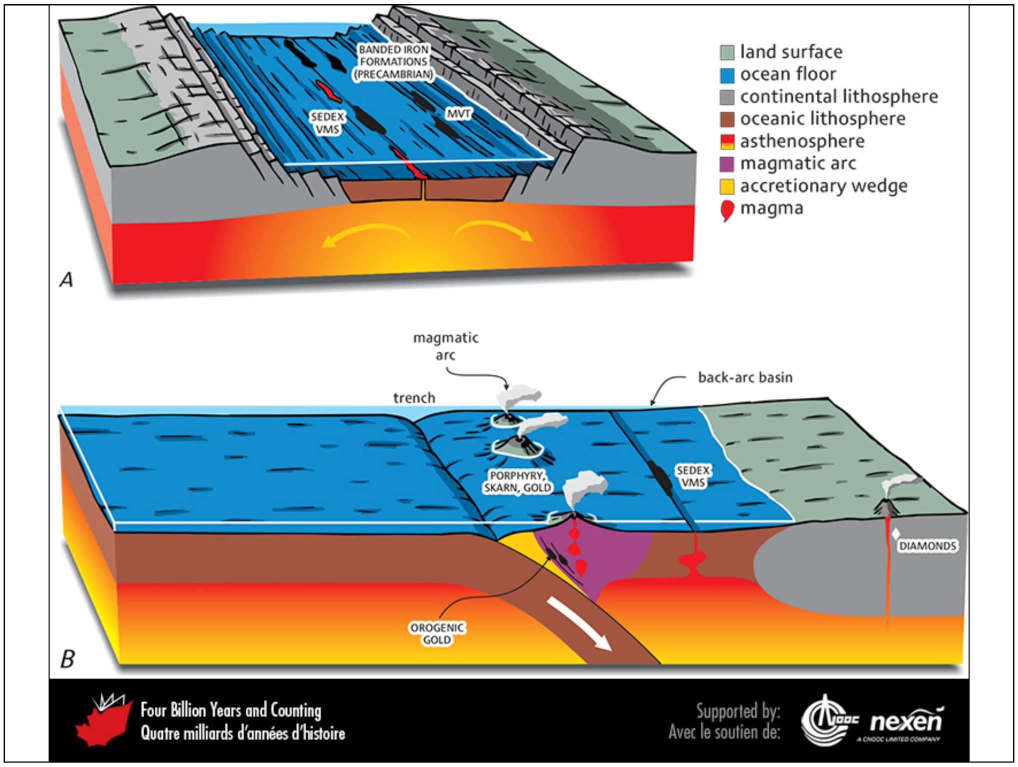

The tectonic settings of some major ore-deposit types broadly associated with divergent (*A*) and convergent (*B*) plate boundaries. VMS (volcanogenic massive sulphide) and SEDEX (sedimentary-exhalative) deposits are commonly associated with spreading ridge and back-arc-basin settings. Porphyry and skarn deposits, including many gold deposits, are associated with convergent plate-tectonic settings. MVT (Mississippi Valley Type) deposits are associated with carbonate rocks and occur on passive margins and other settings conducive to carbonate deposition. Kimberlites and their contained diamonds are associated with stable and ancient continental crust away from plate boundaries.

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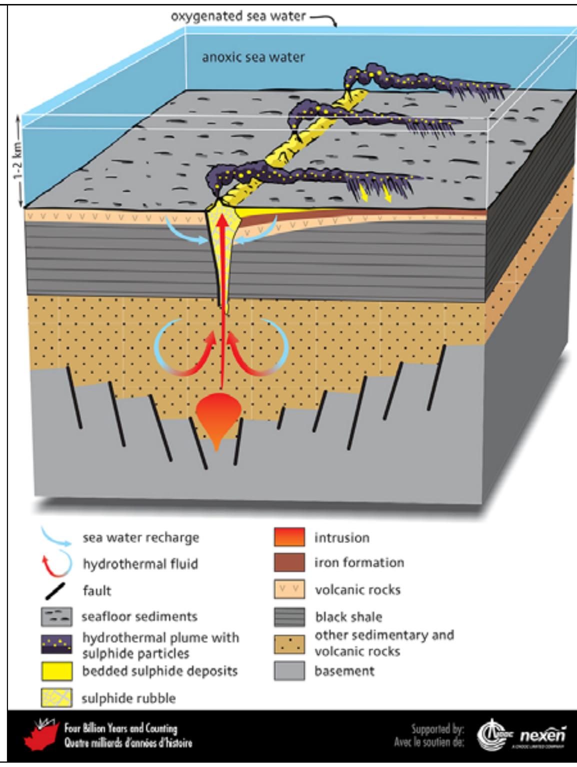

VMS deposits are formed from hydrothermal fluids vented from black smokers commonly associated with oceanic spreading ridges. For the deposits to be preserved, the bottom waters must be anoxic.

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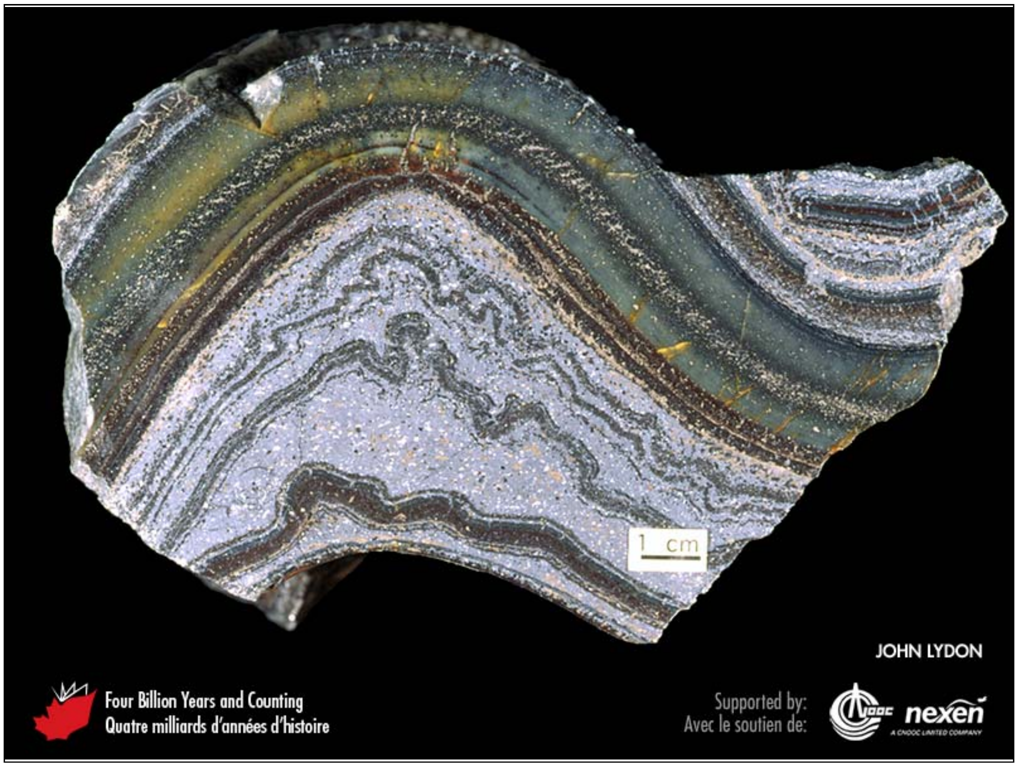
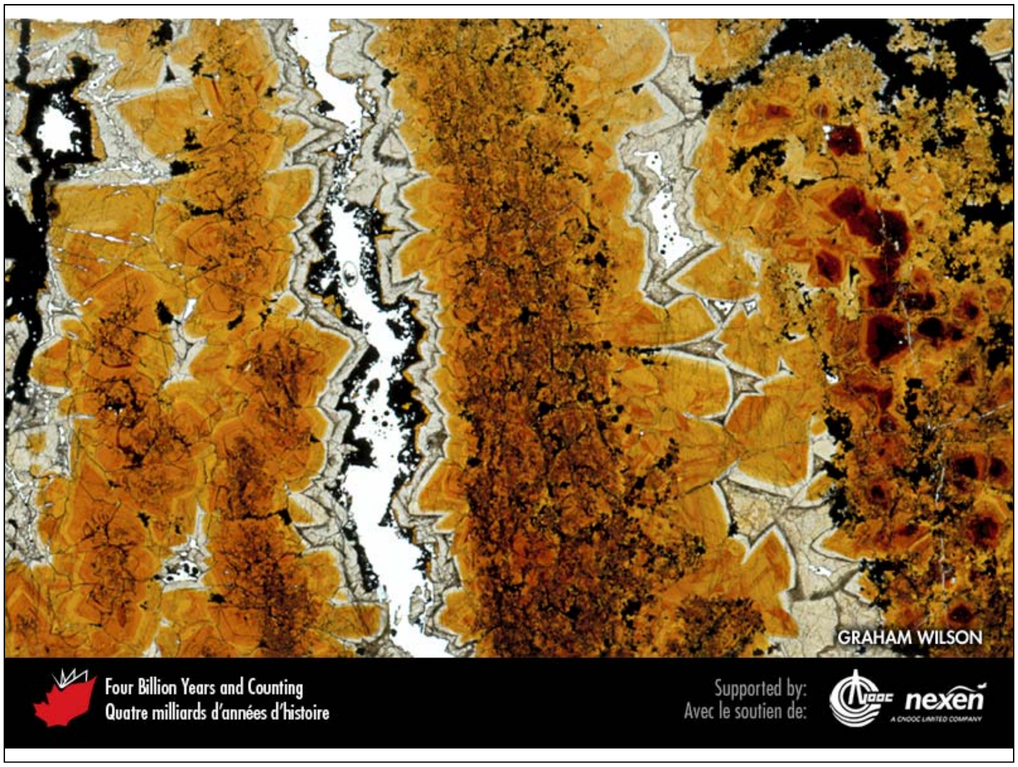
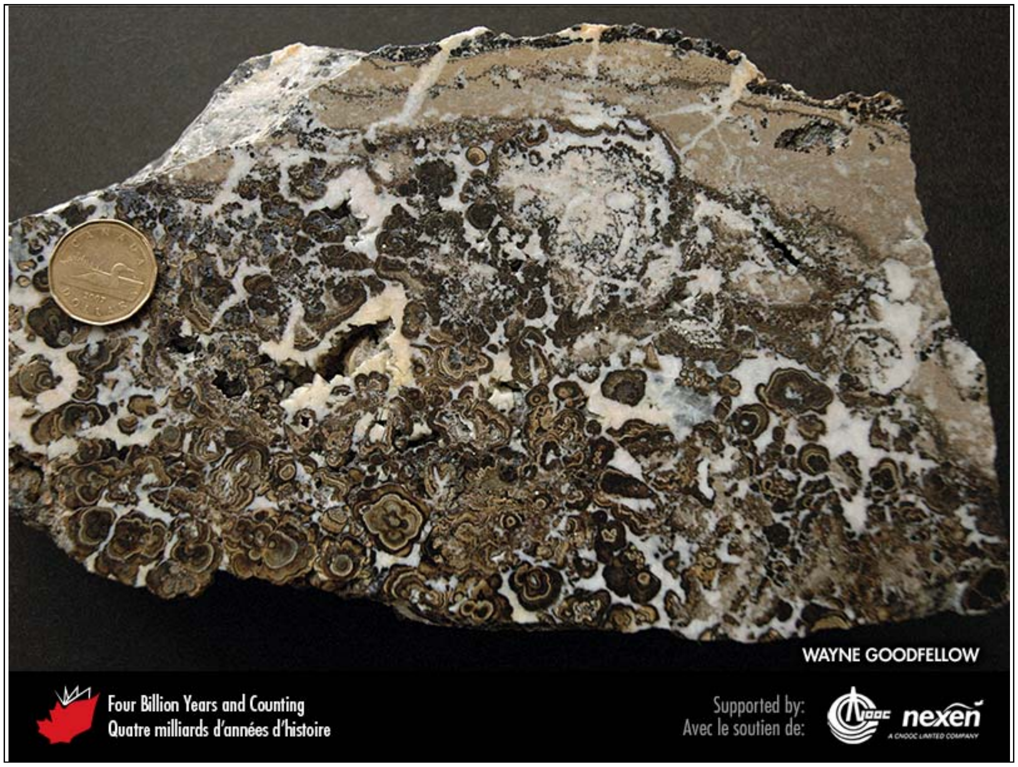
Chalcopyrite-rich VMS deposit at a depth of 2,400 metres in the Kidd Creek Mine, Timmins, Ontario. The ore occurs in Archean rocks about 2,700 million years old. JACOB HANLEY.



Folded SEDEX deposit from the Sullivan Mine, Kimberley, British Columbia, originally deposited in the Mesoproterozoic Belt-Purcell Basin. The brown bands and associated thin cream layers are of sphalerite; the mostly thick light-blue-grey bands are galena interbedded with "wrinkled" argillite layers; and the green- to yellow-grey bands toward the top of the specimen are chert. COURTESY OF JOHN LYDON.



The browny-orange to clear crystals in this thin section are of sphalerite, and form part of a high-grade zinc ore in a middle Ordovician MVT deposit in the former Nanisivik Mine, Baffin Island, Nunavut. GRAHAM WILSON, SPECIMEN COURTESY OF ROSS SHERLOCK.



Zinc-lead ore from the Pine Point MVT deposit in the Devonian Presqu'ile Barrier reef system, Northwest Territories. This deposit consists of cream and brown sphalerite in a matrix of cream-coloured dolomite. WAYNE GOODFELLOW.

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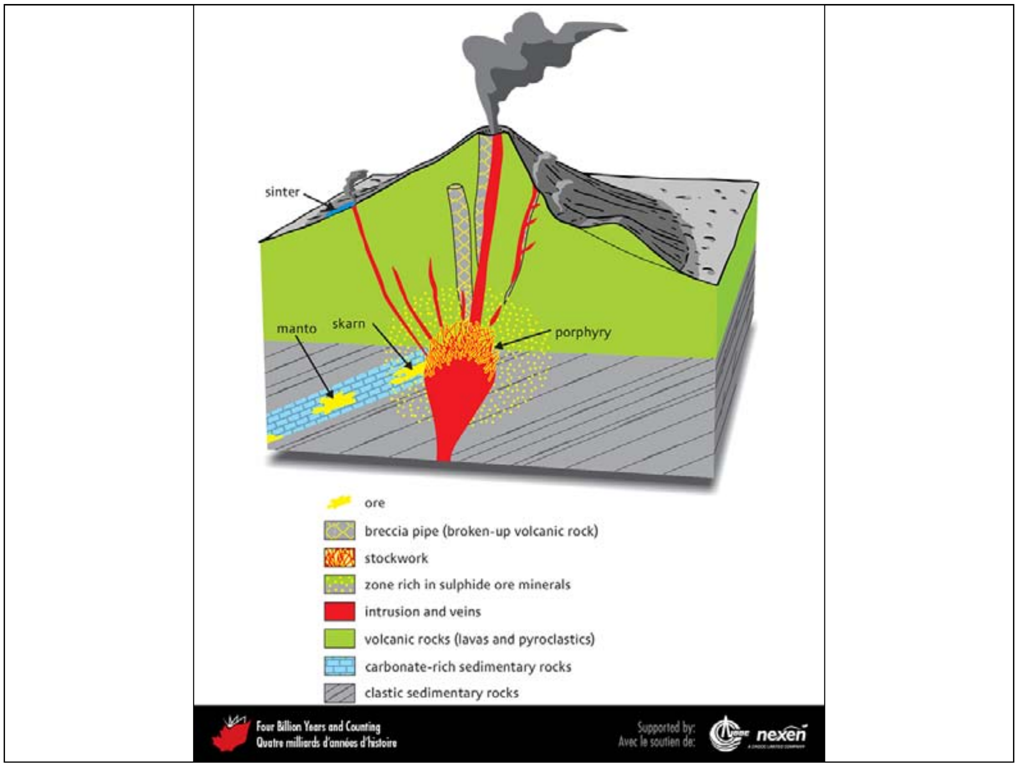
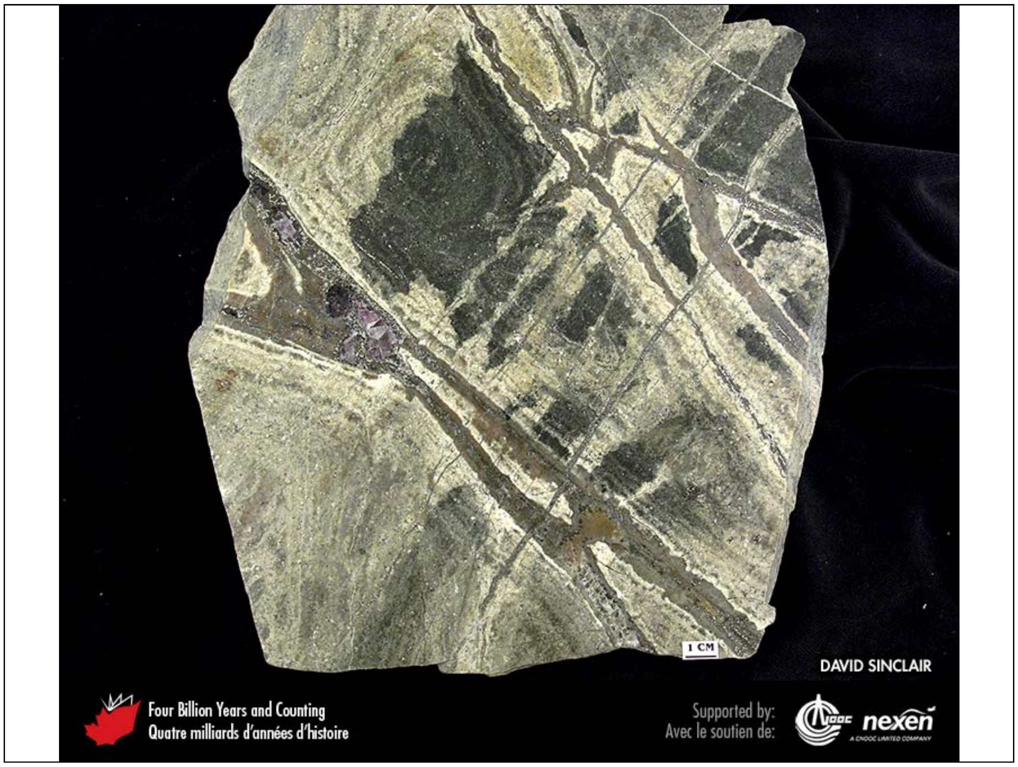


Porphyry and related ore deposits are generally associated with intermediate to felsic igneous activity. This figure shows how different types of ore bodies are related to such volcanic and intrusive settings.



Rocks within a single porphyry deposit can be varied. In this photo, the first of three from the Mount Pleasant deposit in New Brunswick, granitic rock is cut by veins containing quartz, fluorite, arsenopyrite, and cassiterite, a source of tin. The granitic rock is of Devonian age. DAVID SINCLAIR.

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In this sample from the Mount Pleasant deposit in New Brunswick, arsenopyrite- and cassiterite-bearing veins cut fractured and altered granitic host rock. The veins were mined for tin. DAVID SINCLAIR.

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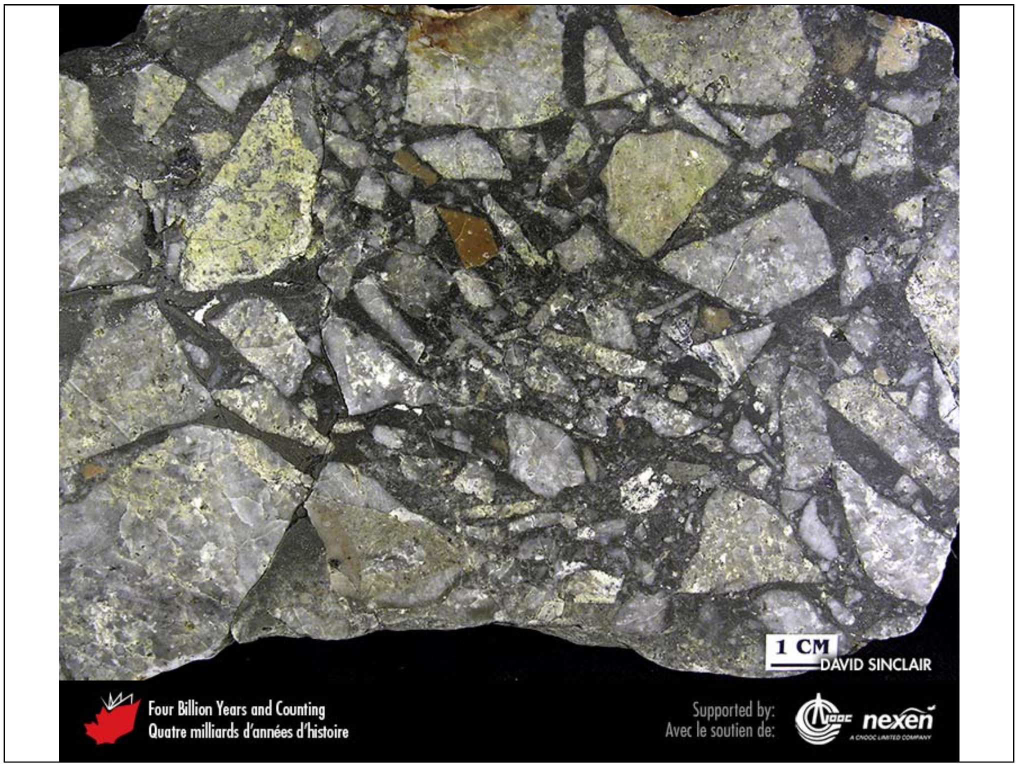

This breccia from the Mount Pleasant deposit, New Brunswick, consists of fragments of granitic rock that have been altered to silica in a dark matrix of sphalerite and cassiterite, a source of zinc and tin. DAVID SINCLAIR.

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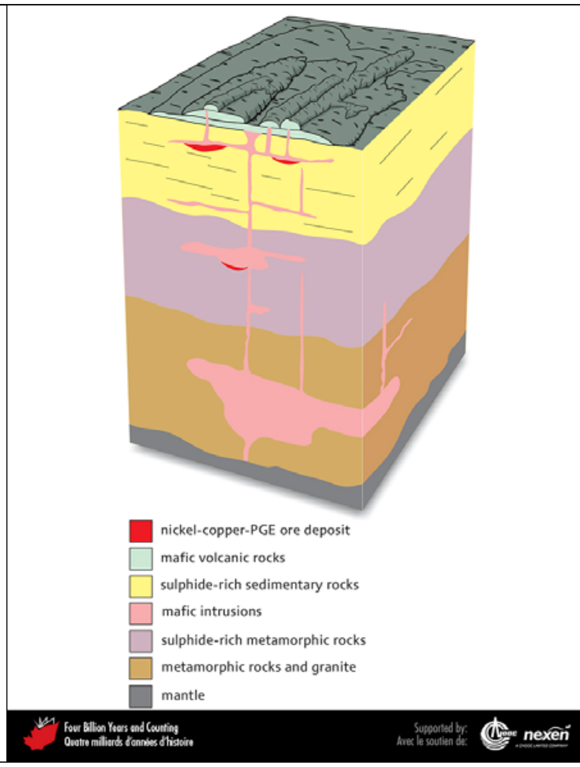

Nickel-copper-PGE deposits are generally associated with mafic igneous activity. This figure shows how different types of ore bodies are related to such volcanic and intrusive settings.

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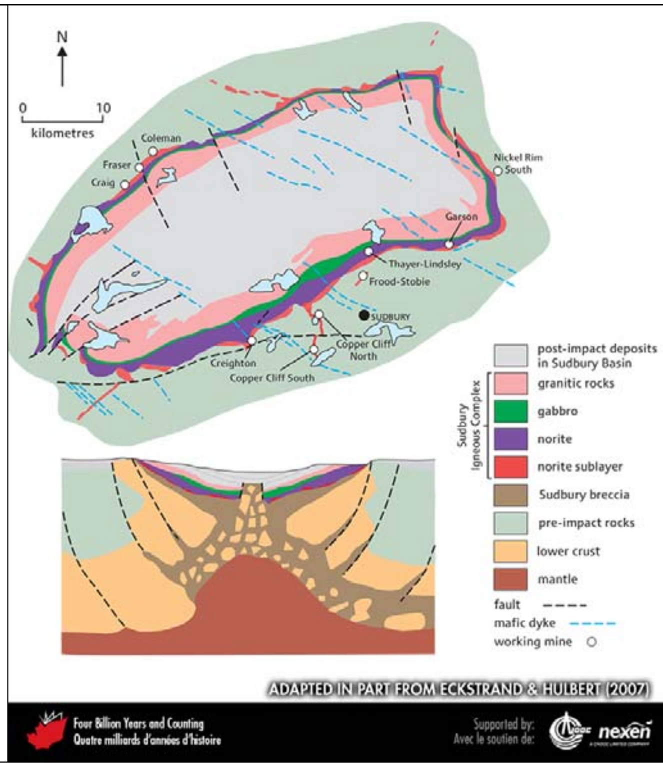
Breccia from below the ore and impact melt layers of the Sudbury impact structure, Ontario. PHOTO COURTESY OF THE ONTARIO GEOLOGICAL SURVEY: COPYRIGHT QUEEN'S PRINTER FOR ONTARIO, 2013.



The Sudbury impact structure. The upper diagram shows the bedrock geology (beneath glacial deposits) and the lower diagram shows a generalized cross-section, with glacial deposits outside the impact structure included as post-impact deposits. UPPER DIAGRAM ADAPTED FROM ECKSTRAND AND HULBERT (2007).

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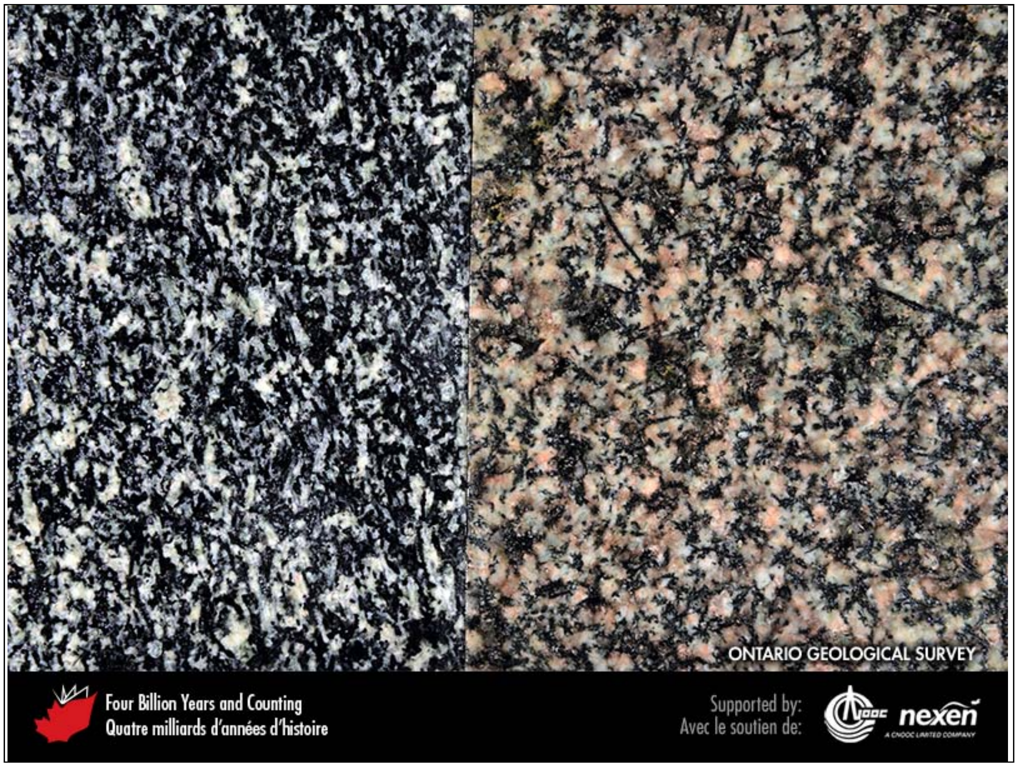

Detail of rocks derived from the upper, granitic melt (top) and from the lower, noritic melt (bottom), of the Sudbury impact structure, Ontario. PHOTO COURTESY OF THE ONTARIO GEOLOGICAL SURVEY: COPYRIGHT QUEEN'S PRINTER FOR ONTARIO, 2013.

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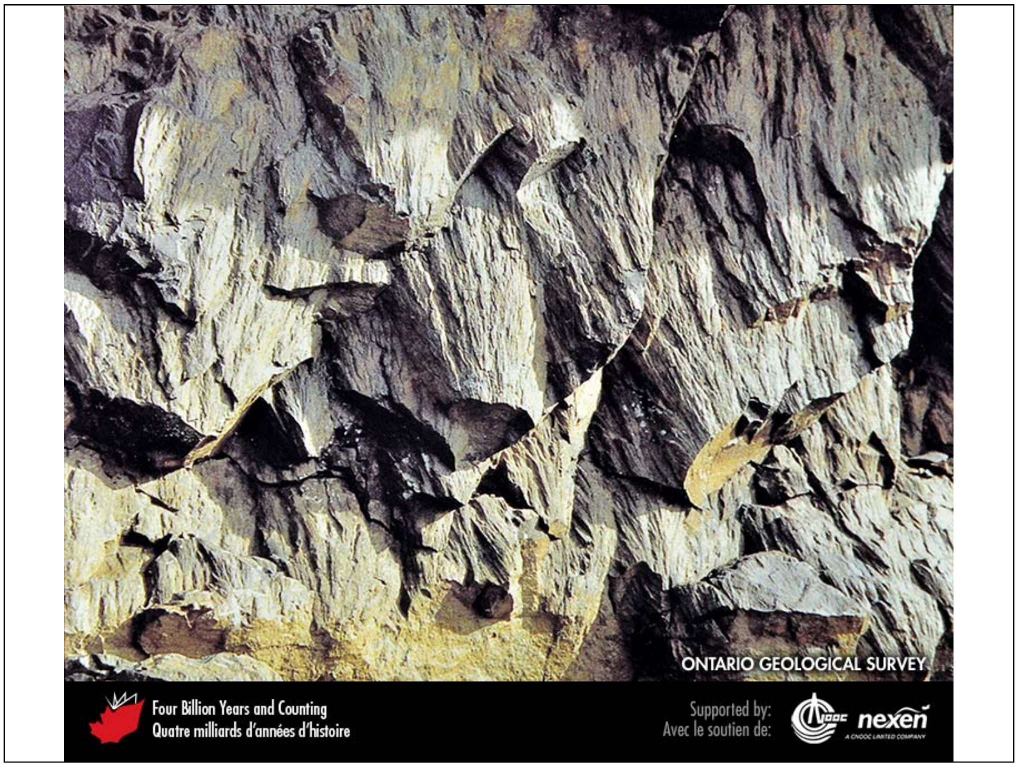

Shatter cones (Box 11) developed in Paleoproterozoic (Huronian) metasandstone, Sudbury impact structure, Ontario. PHOTO COURTESY OF THE ONTARIO GEOLOGICAL SURVEY: COPYRIGHT QUEEN'S PRINTER FOR ONTARIO, 2013.

Ore containing copper and platinum-group elements from the Strathcona Mine in the Sudbury impact structure, Ontario. PHOTO COURTESY OF THE ONTARIO GEOLOGICAL SURVEY: COPYRIGHT QUEEN'S PRINTER FOR ONTARIO, 2013.

Aerial view of a dredge used to mine placer gold, Bonanza Creek, Klondike, Yukon. WAYNE GOODFELLOW.

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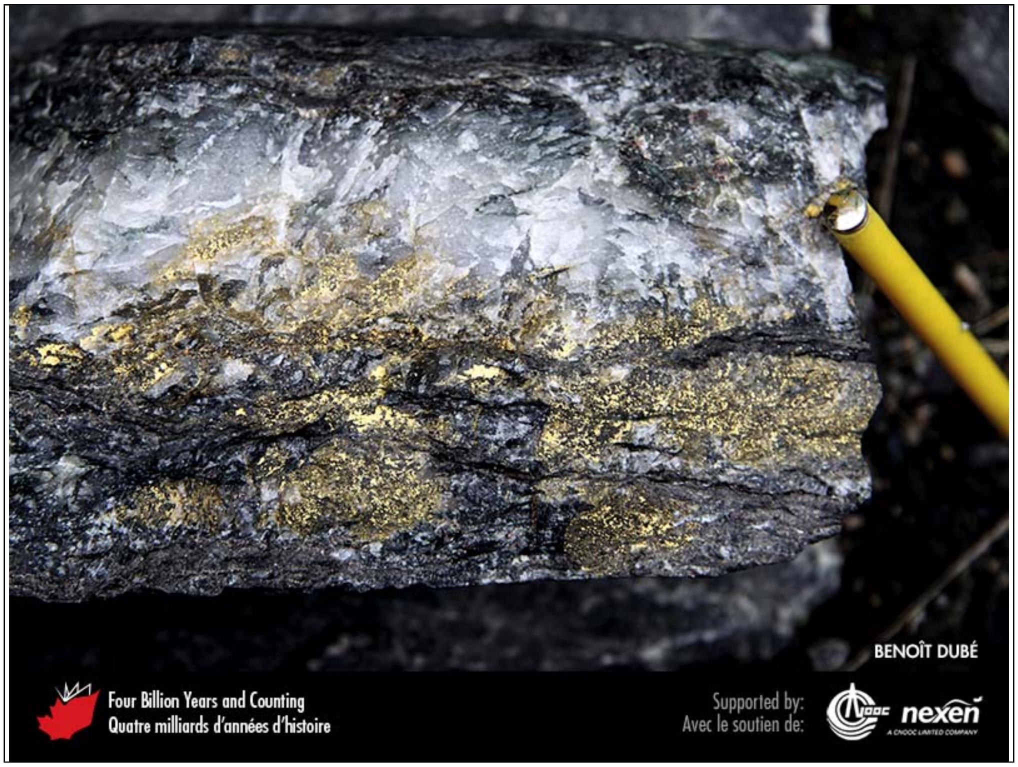
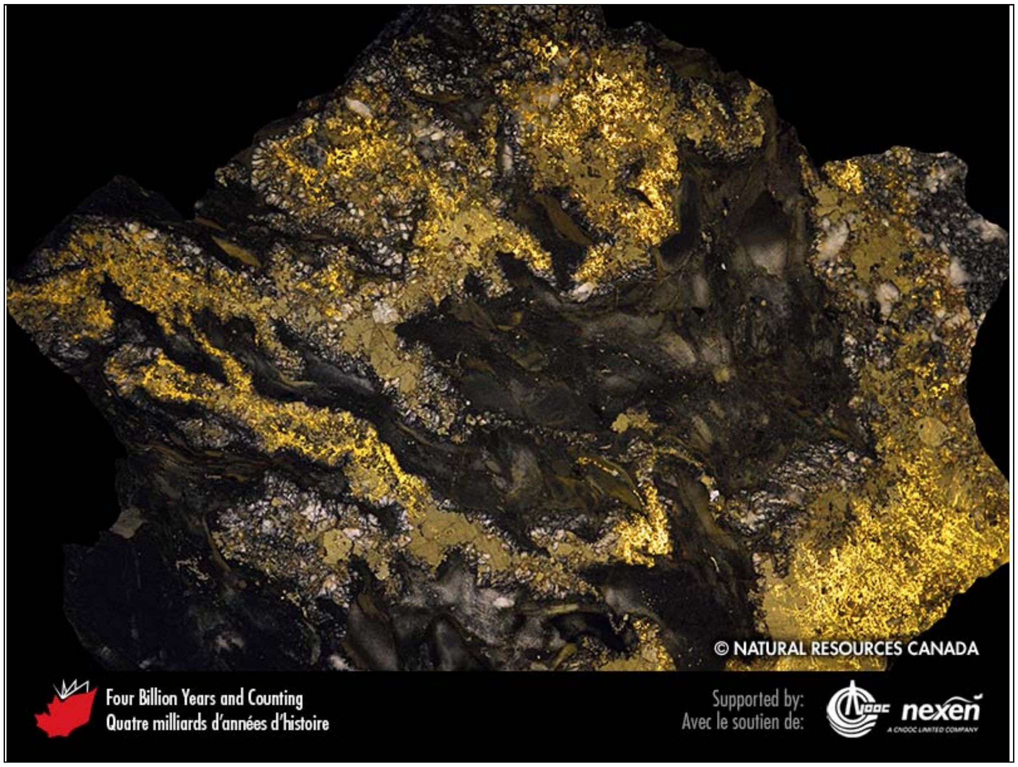


Quartz vein with gold in the Musselwhite Mine of northern Ontario. This mine is within a greenstone belt in the Superior Craton. The ore occurs as veins and as a quartz-pyrrhotite-rich replacement within folded banded-iron formations. BENOÎT DUBÉ.



Gold in conglomerate from the Dome Mine, Ontario. The weight of this specimen is 61.8 kilograms, of which about 20 percent is gold. IGOR BILOT, SPECIMEN COURTESY OF NATURAL RESOURCES CANADA (NATIONAL MINERAL COLLECTION NO. 10003).

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1,880-million-year-old banded iron formation near Schefferville, Quebec. The rock consists of layers of fine-grained hematite and magnetite (bluish grey), jasper (red), and siliceous iron carbonate (brown). ALAIN LECLAIR.

Disused and flooded open-pit iron mine near Schefferville, Quebec. The pit walls show the multicoloured hues associated with the residual iron ore mined here. This ore is termed residual because groundwater leached silica from the original banded iron formation during the Cretaceous, a process that increased the concentration of iron in the rock. ALAIN LECLAIR.

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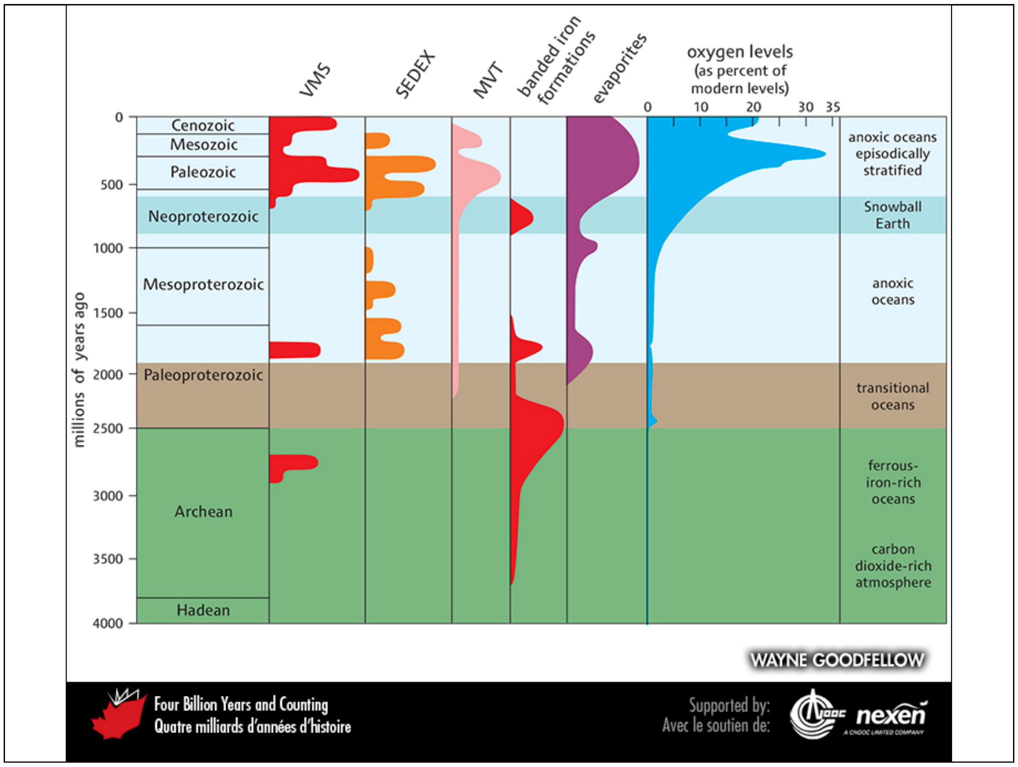

The timing of some major ore-deposit types and evaporites in relation to major events and changes in the Earth's atmosphere and evolution.

The brown area marks the presence of a kimberlite diatreme at Elwyn Bay, northeastern Somerset Island, Nunavut. The kimberlite intruded Silurian dolostones (seen in the distant cliffs) during the middle Cretaceous. The brown colour is due to specialized vegetation associated with phosphorus- and potassium-rich soil derived from the kimberlite. BRUCE KJARSGAARD, REPRODUCED WITH THE PERMISSION OF NATURAL RESOURCES CANADA 2013, COURTESY OF THE GEOLOGICAL SURVEY OF CANADA.

Several open pits mark the locations of kimberlite pipes being mined for diamonds at the Ekati Mine, Northwest Territories. WAYNE GOODFELLOW.

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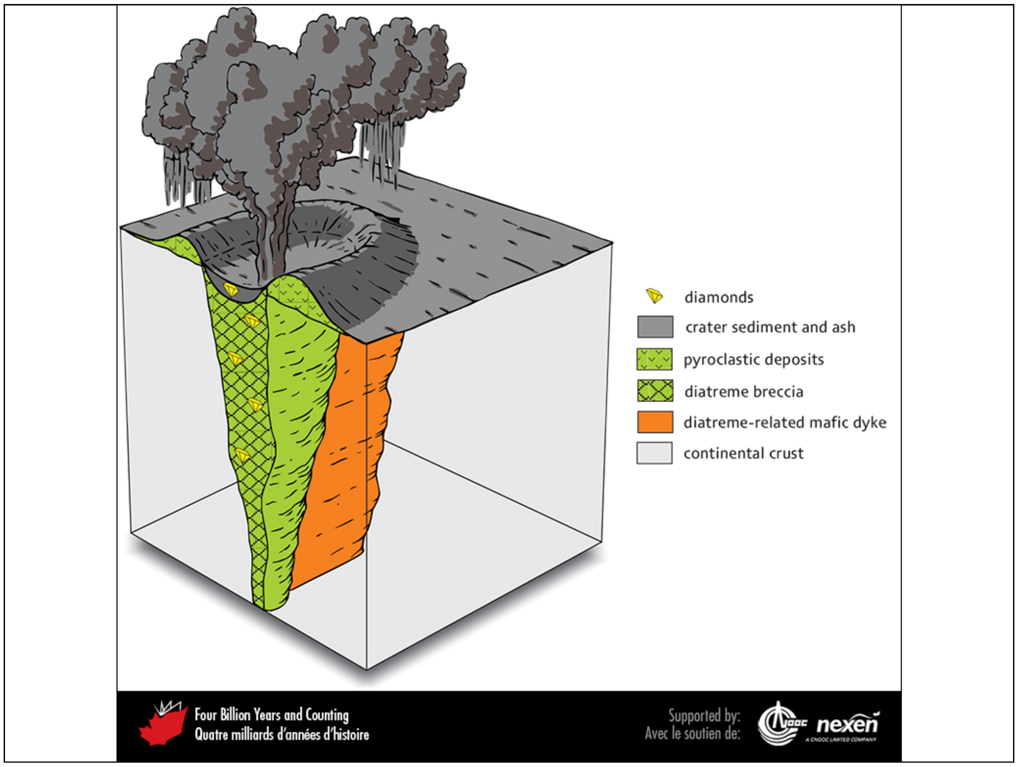

A kimberlite pipe and the related volcanic features at the Earth's surface.

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Head frame at the abandoned Enterprise Mine, southeastern British Columbia. The mine produced primarily silver, lead, and zinc intermittently from 1896 to 1977. MIKE PARSONS.

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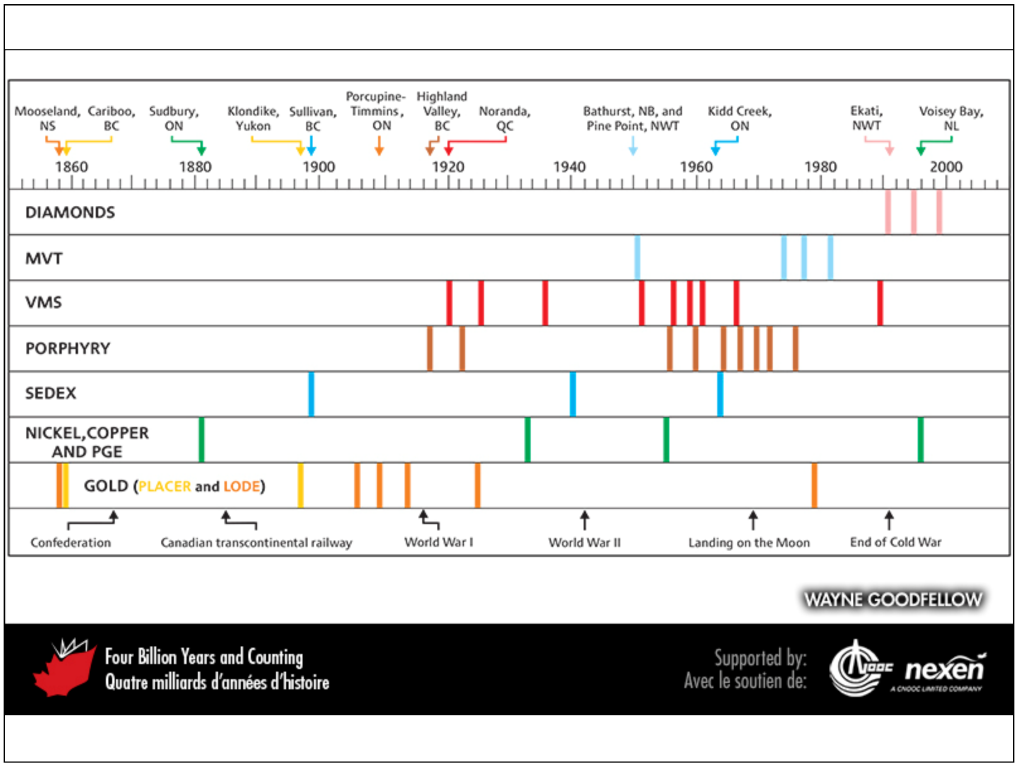

The discovery dates of major Canadian ore deposits and their relationship to some major historical milestones (shown at bottom). BC = British Columbia, NB = New Brunswick, NL = Newfoundland and Labrador, NS = Nova Scotia, NWT = Northwest Territories, ON = Ontario, and QC = Quebec.

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Cores of Ordovician rocks from the Bathurst Mining Camp, southwest of Devils Elbow Brook, New Brunswick. STEVE MCCUTCHEON.

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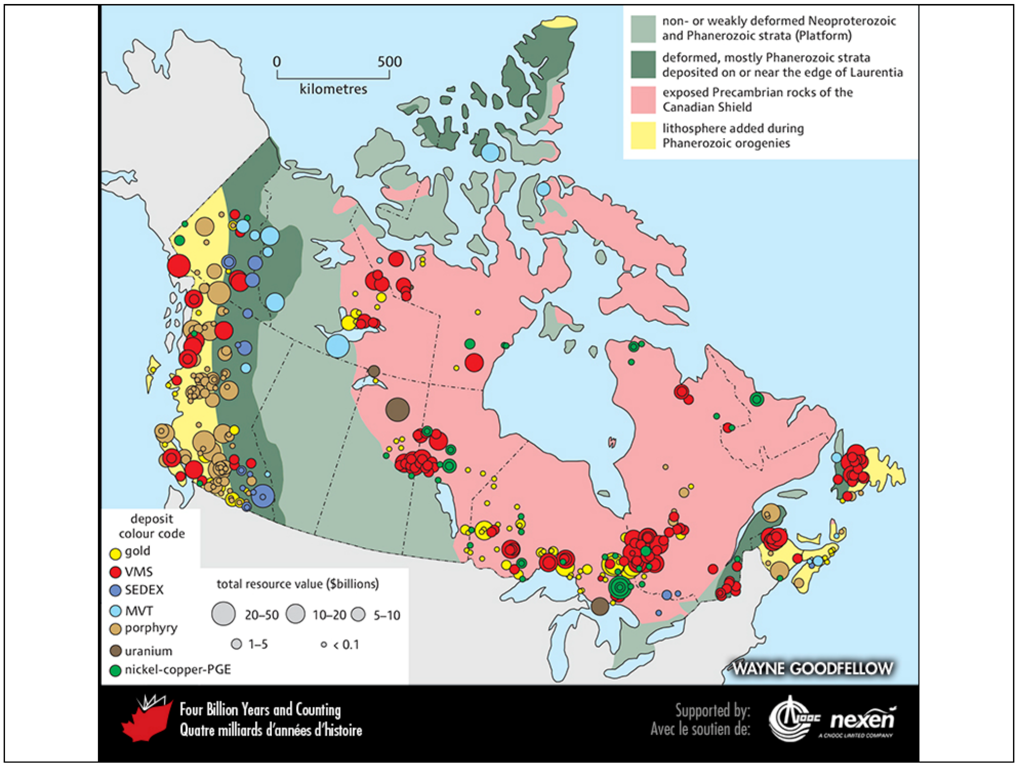

The location and value of Canada's major deposits for 2005 superimposed on a geological map of Canada. Note how almost all mining operations are located on the Canadian Shield (especially its margins, which are closer to potential markets) or in the Appalachian and Cordilleran orogens.

The rusty red feature, a gossan, stands out in this aerial view over Baffin Island, Nunavut, Gossans are produced by oxidation of metal sulphide deposits. Because they can be recognized readily on the ground and from aircraft and satellites, gossans are a useful indicator of mineralization. Y. MAURICE, REPRODUCED WITH THE PERMISSION OF NATURAL RESOURCES CANADA 2013, COURTESY OF THE GEOLOGICAL SURVEY OF CANADA.