CHAPTER 2
Part 1 of 2

Without tectonic forces within the Earth's lithosphere we would not have magnificent mountain ranges such as the Rockies. This is a view of the Kananaskis Country of southwestern Alberta. RON GARNETT / AIRSCAPES.CA.

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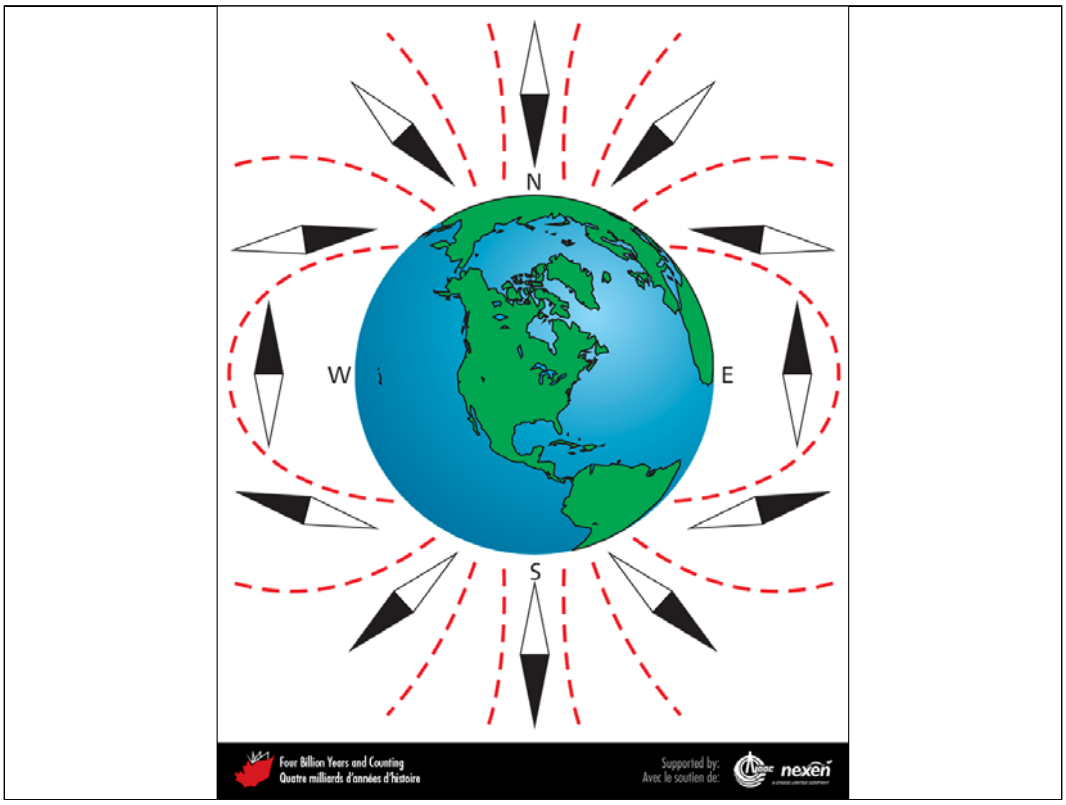

A compass works because in all magnetic fields, including that of the Earth, electrons flow from one magnetic pole to the other, causing the needle to point toward the magnetic north. The Earth's magnetic field also shows varying degrees of inclination to the ground depending on latitude. As shown here, a free-standing compass needle will point vertically at the magnetic poles and parallel to the ground at the Equator, with gradations in between. An analysis of a rock's magnetic signature, frozen-in at the time of formation, thus indicates the approximate latitude at which the rock originated.

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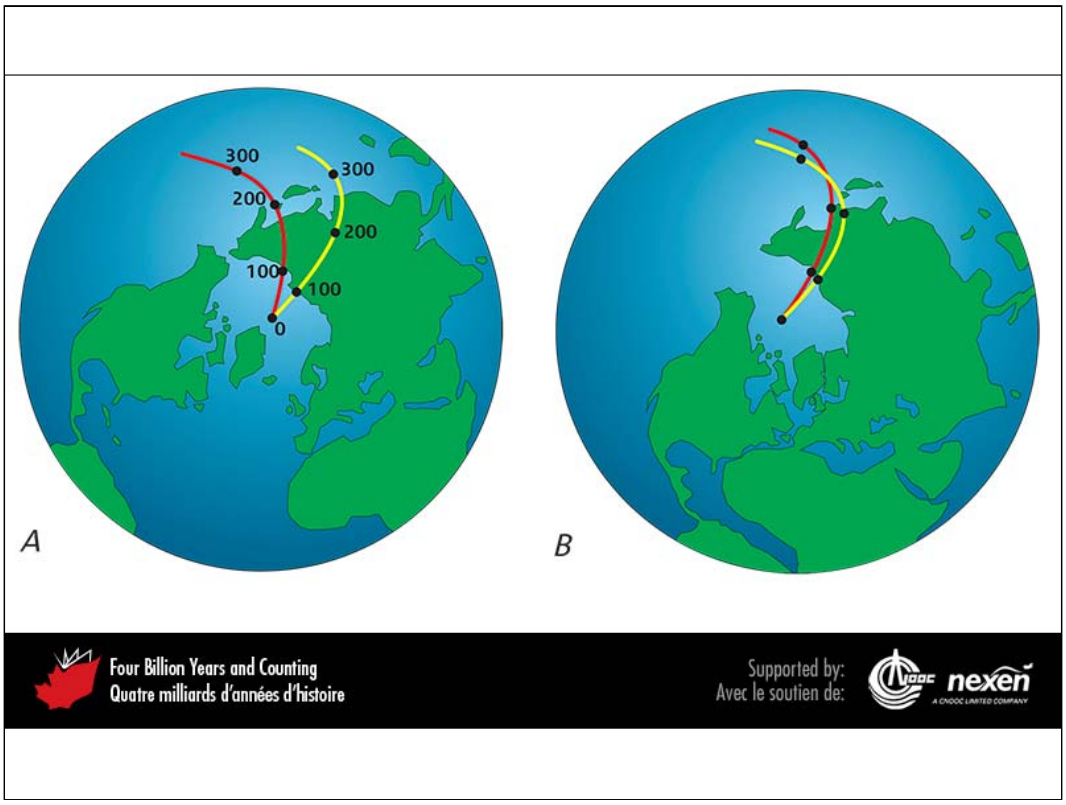

A shows apparent polar-wandering curves for two continents, plotted on a present-day map. The curves were determined by measuring magnetic inclinations from different-aged rocks in each continent. The numbers refer to ages in millions of years. Because only one magnetic north pole can exist at any one time, the fact that two curves result from plotting such data is strong evidence for continental drift. When the curves are drawn together and the continents "pulled" with them, as in B, we can reconstruct what the Earth's geography looked like before the Atlantic Ocean opened. ADAPTED FROM VARIOUS SOURCES.

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The *JOIDES Resolution*, which was built in Halifax, Nova Scotia, departs Honolulu on May 9, 2009. The *JOIDES Resolution* is one of several ships dedicated to exploring the geology of the oceans. WILLIAM CRAWFORD, COURTESY OF THE INTEGRATED OCEAN DRILLING PROGRAM US IMPLEMENTING ORGANIZATION.

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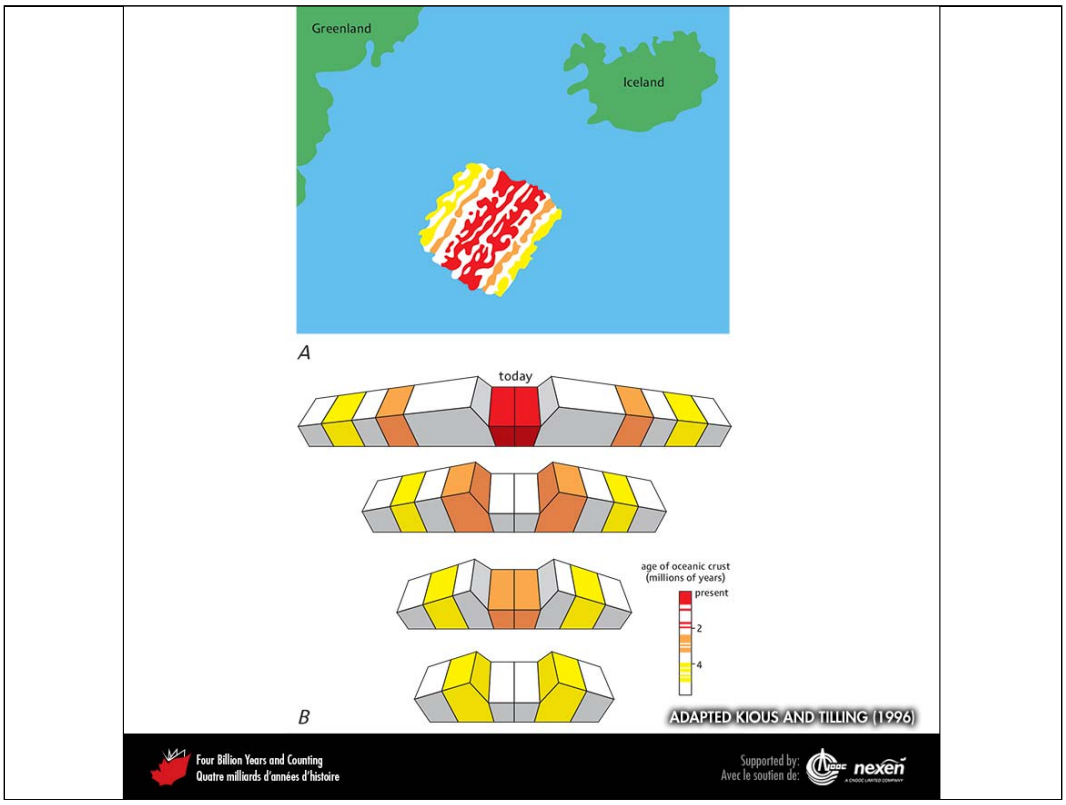

A shows magnetic anomalies on the Mid-Atlantic Ridge southwest of Iceland. B shows an idealized series of cross sections representing stages in the development of the pattern of anomalies shown in A. ADAPTED FROM JANE RUSSELL IN KIOUS AND TILLING (1996), WITH PERMISSION FROM THE US DEPARTMENT OF THE INTERIOR (USGS).

Ring Mountain, British Columbia, a subglacial volcano known as a tuya (see Chapter 11) that was active sometime during the past 2.5 million years. This mountain is one of the volcanoes forming the Cascade Range, a continental magmatic arc above the Cascadia Subduction Zone. STEVE GORDEY.

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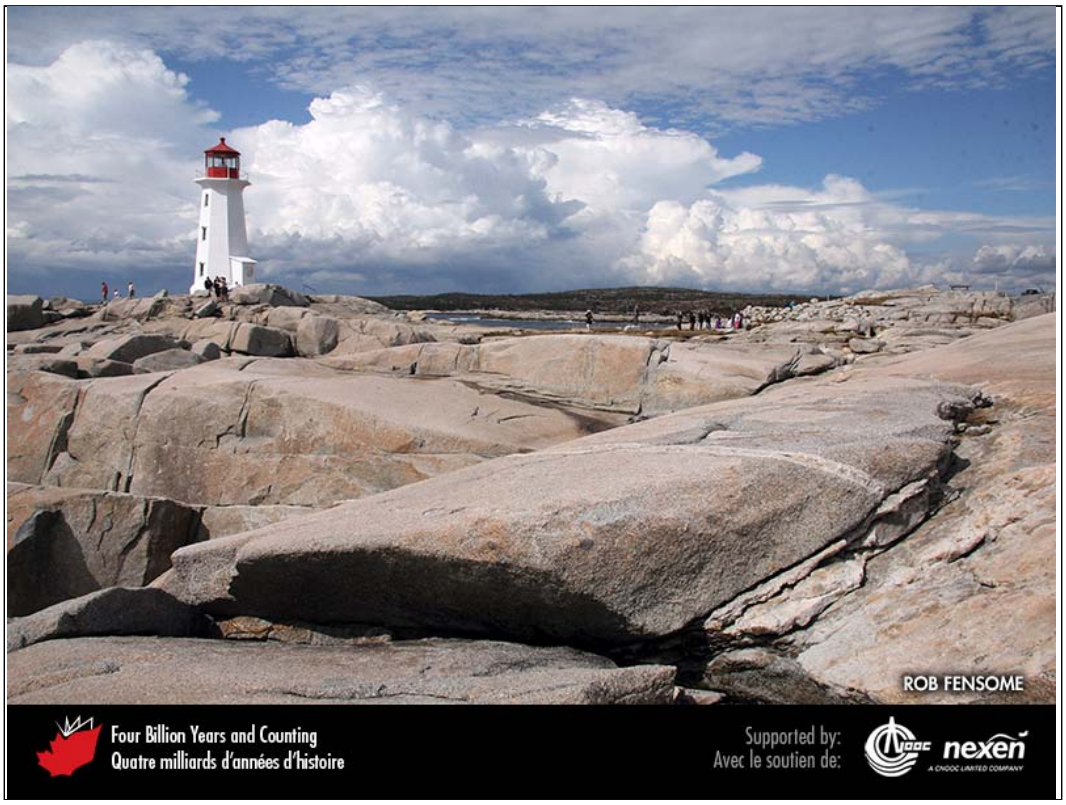

This 375-million-year-old granite at Peggys Cove, Nova Scotia, is associated with the closing of the long-lost Rheic Ocean (Chapter 8). ROB FENSOME.

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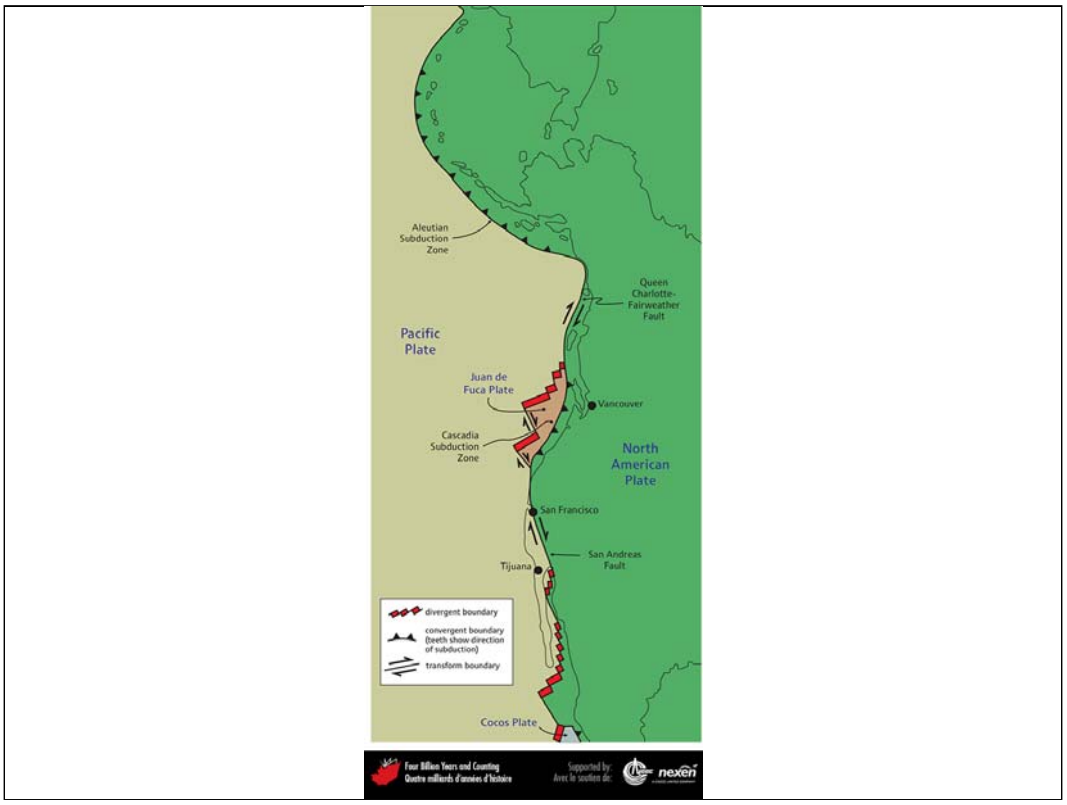

The composite nature of the western boundary of the North American Plate, showing plates and plate boundaries. ADAPTED FROM VARIOUS SOURCES.

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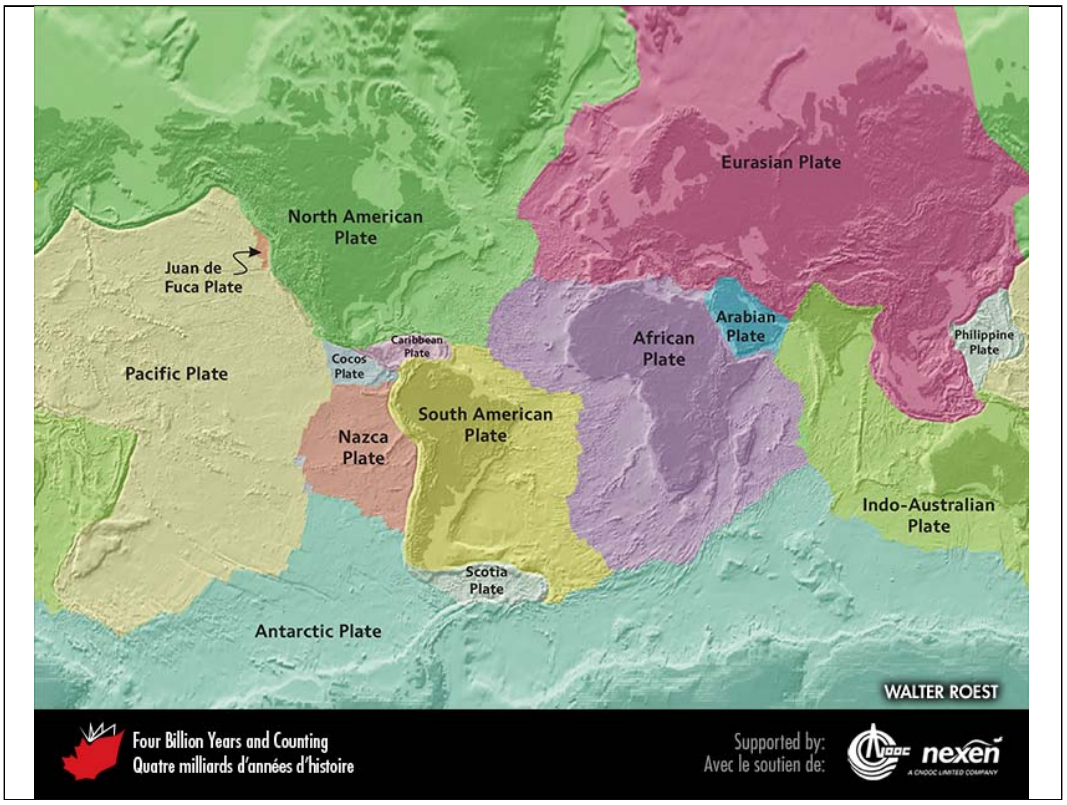

The present global distribution of tectonic plates. WALTER ROEST.

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Plate tectonics explains the distribution of major physical features on the Earth's surface, including Canada's highest mountains in the St. Elias Range of northern British Columbia and Yukon. In the distance is Mount Logan, Canada's highest peak. W. LYNCH , COPYRIGHT PARKS CANADA.

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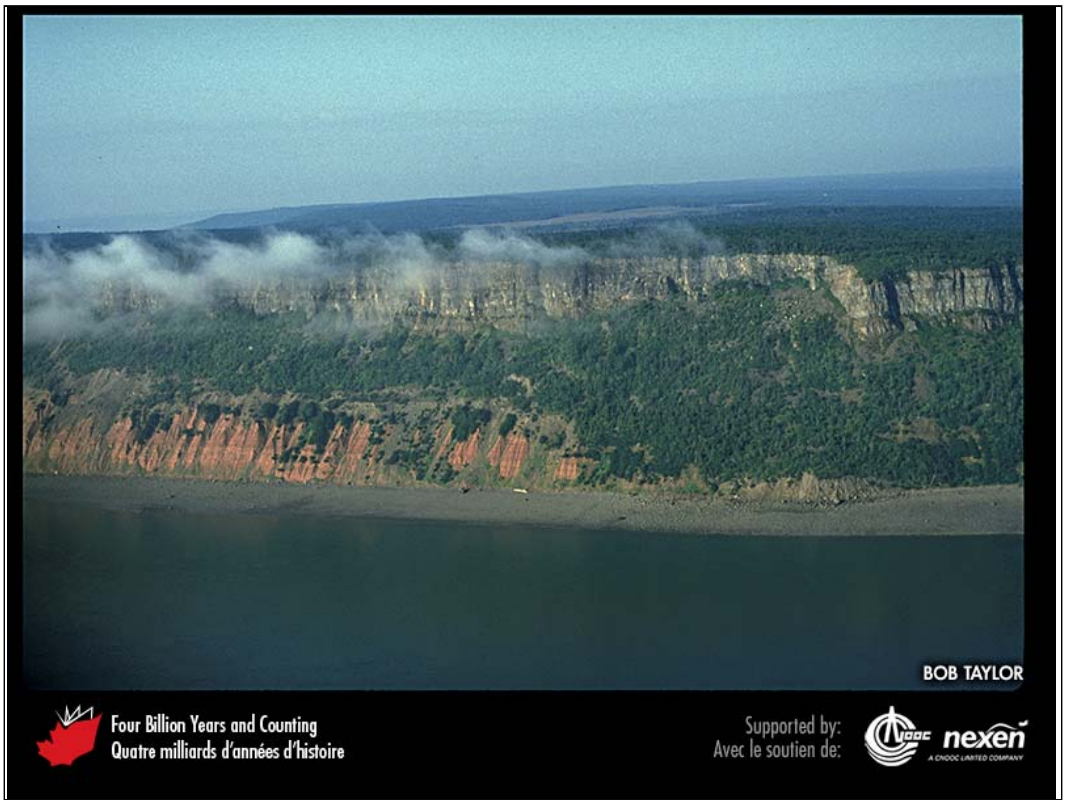

Rift basins form when continents begin to break up. The basins become filled with non-marine sediments such as the redbeds in this cliff at Cape Blomidon in Nova Scotia. The overlying darker layers are of basalt similar to that underlying the ocean floors. BOB TAYLOR.

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Away from plate boundaries, the interiors of continents are dominated by flat to gently rolling landscapes, as here near Foremost, Alberta. ROB FENSOME.

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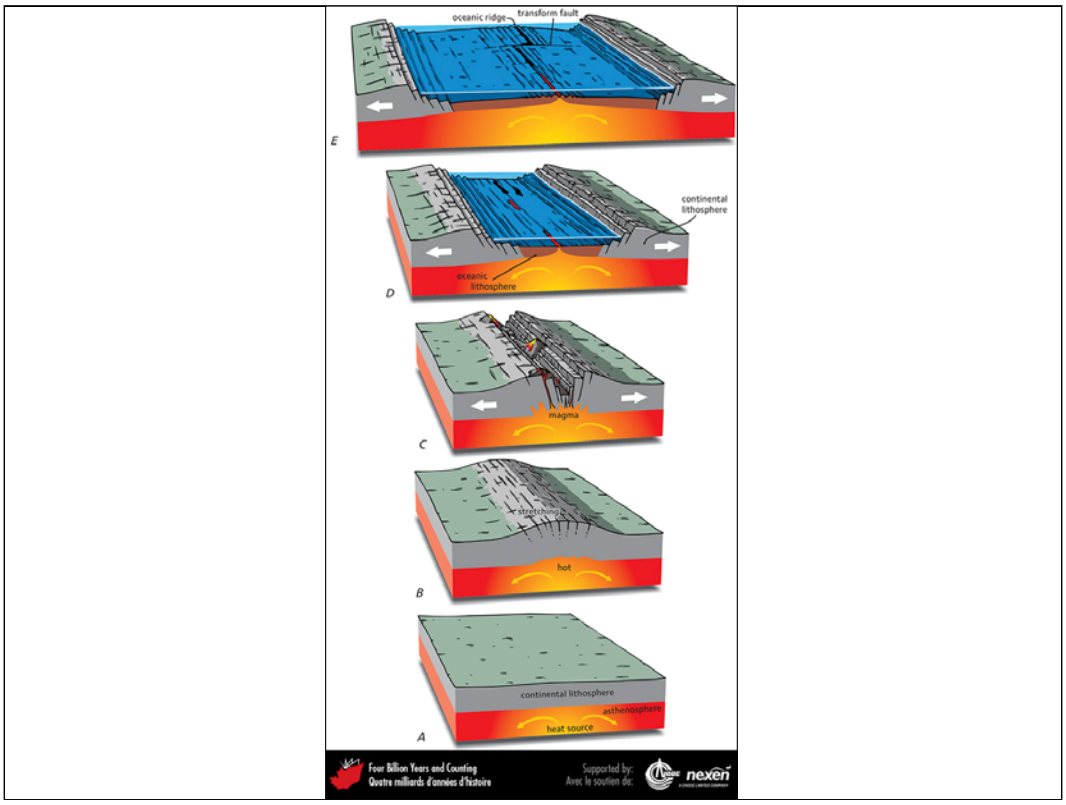
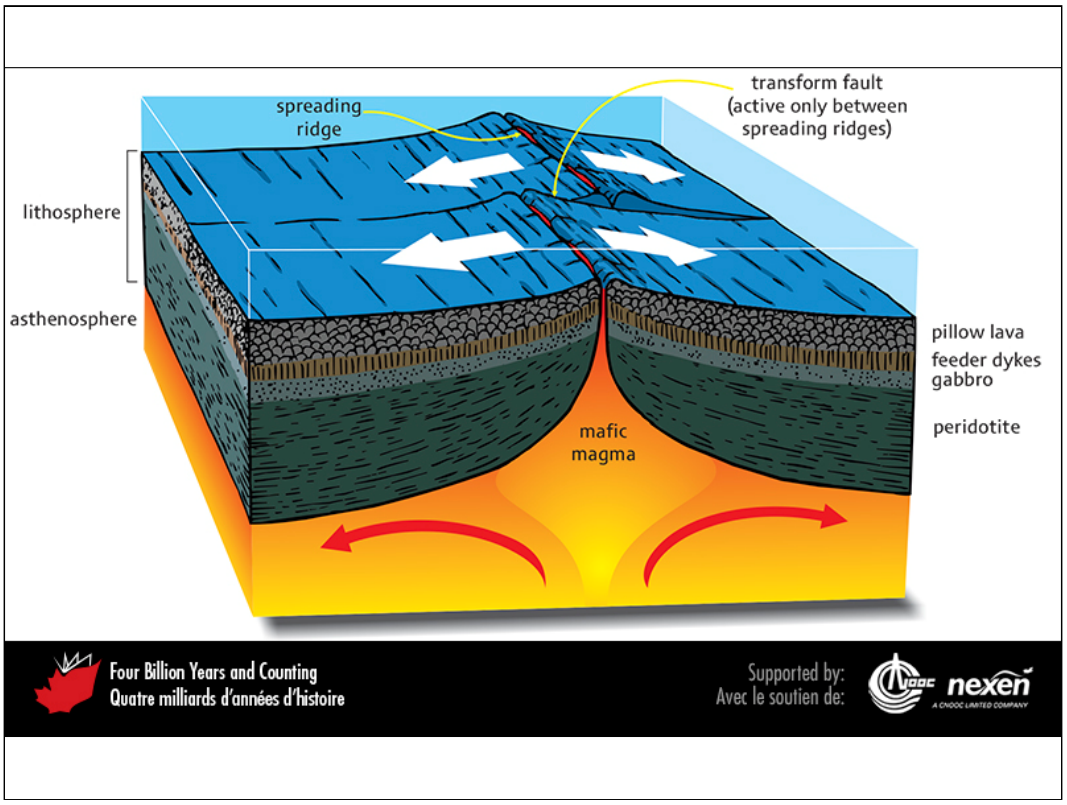
CHAPTER 2
Part 2 of 2



Stages in the breakup of a continent to form a new ocean. A shows undisturbed continental lithosphere overlying asthenosphere. Energy sources in the mantle heat, stretch, and weaken the continental lithosphere, sometimes causing doming (B). Eventually the continental lithosphere rifts and volcanic rocks are extruded (C). The rifted continental lithosphere may split and the two sides drift apart, creating two continents and leaving a small ocean basin in between, as in Baffin Bay and the Red Sea (D). Continuing separation leads to formation of a large ocean basin such as the modern Atlantic Ocean (E).



The structure beneath an oceanic spreading ridge.

Part of the Mid-Atlantic Ridge outcrops in Iceland, as shown here near Thingvellir, where the rift at the centre of the ridge is clearly visible. This marks the boundary between the North American and Eurasian plates. CHRISTOPHER HARRISON.

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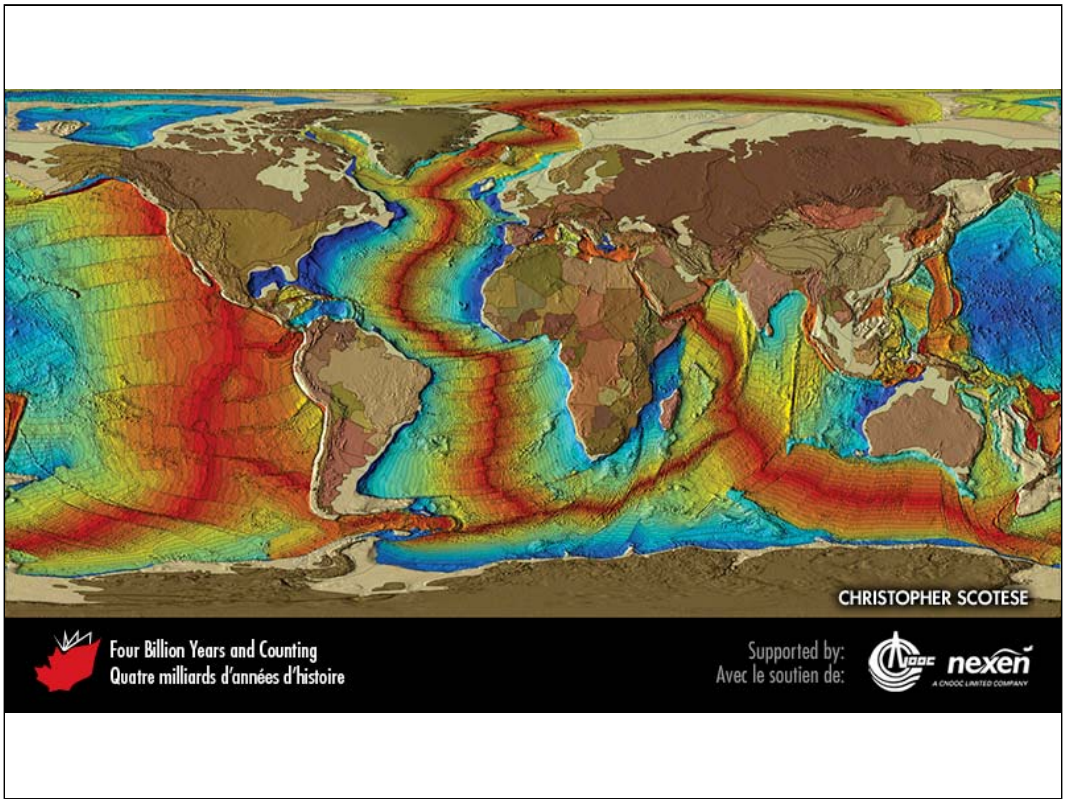

Time of formation of ocean floor has been revealed through paleomagnetism and radiometric dating (Chapter 3) and is shown on the map by the colour pattern. Red through yellow represents ocean floors formed between 70 million years ago and the present, and pale green through dark blue represents ocean floors created between about 180 and 70 million years ago. The growth rate of Pacific Ocean floor is about three times that of the Atlantic, as reflected by the wider colour bands in the former. The symmetrical spreading in the Atlantic and Indian oceans is in marked contrast with the asymmetrical pattern in the Pacific Ocean, a result of the Americas overriding huge areas of the eastern Pacific floor. The light tan colour represents continental shelves and continents are in various brown to pastel shades that indicate countries. CHRISTOPHER SCOTESE.

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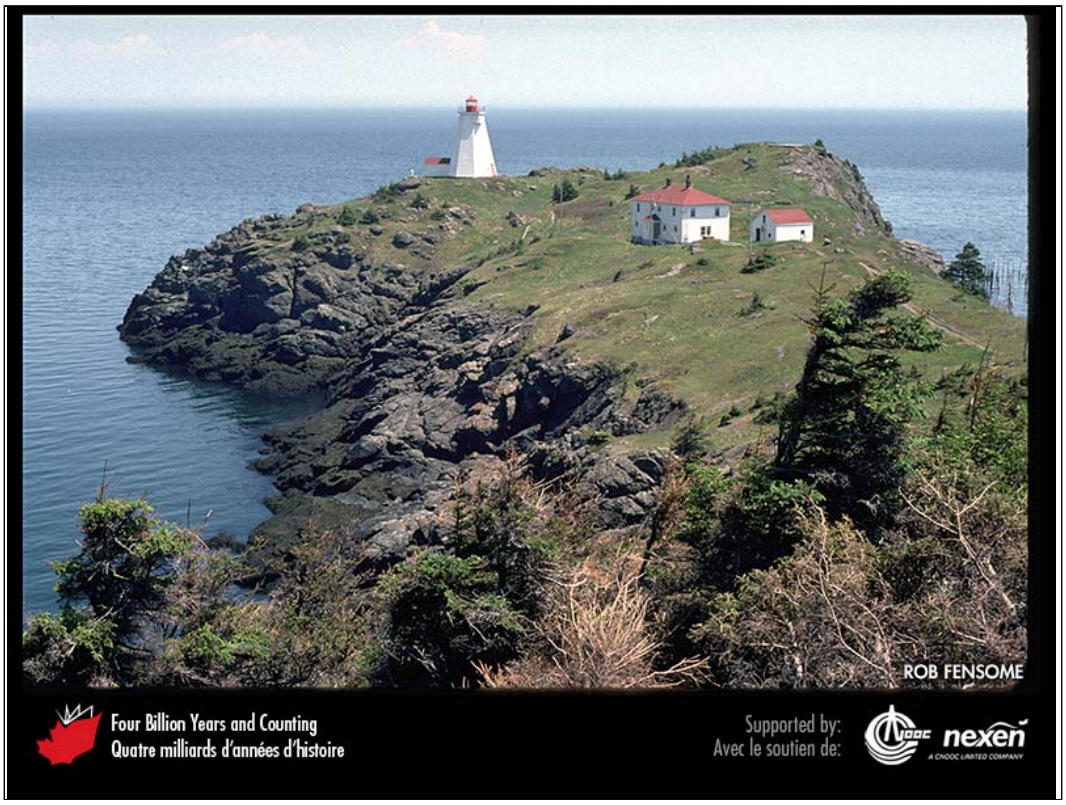

Ancient volcanic rocks underlie the Swallowtail Light on Grand Manan Island, New Brunswick. Although the exact age of these rocks is unknown, they are older (perhaps much older) than about 400 million years and formed on a microcontinent called Ganderia, which originated on the southern margin of the Iapetus Ocean but eventually fused with the ancient continent of Laurentia to the north when the ocean closed (chapters 7 and 8). ROB FENSOME.

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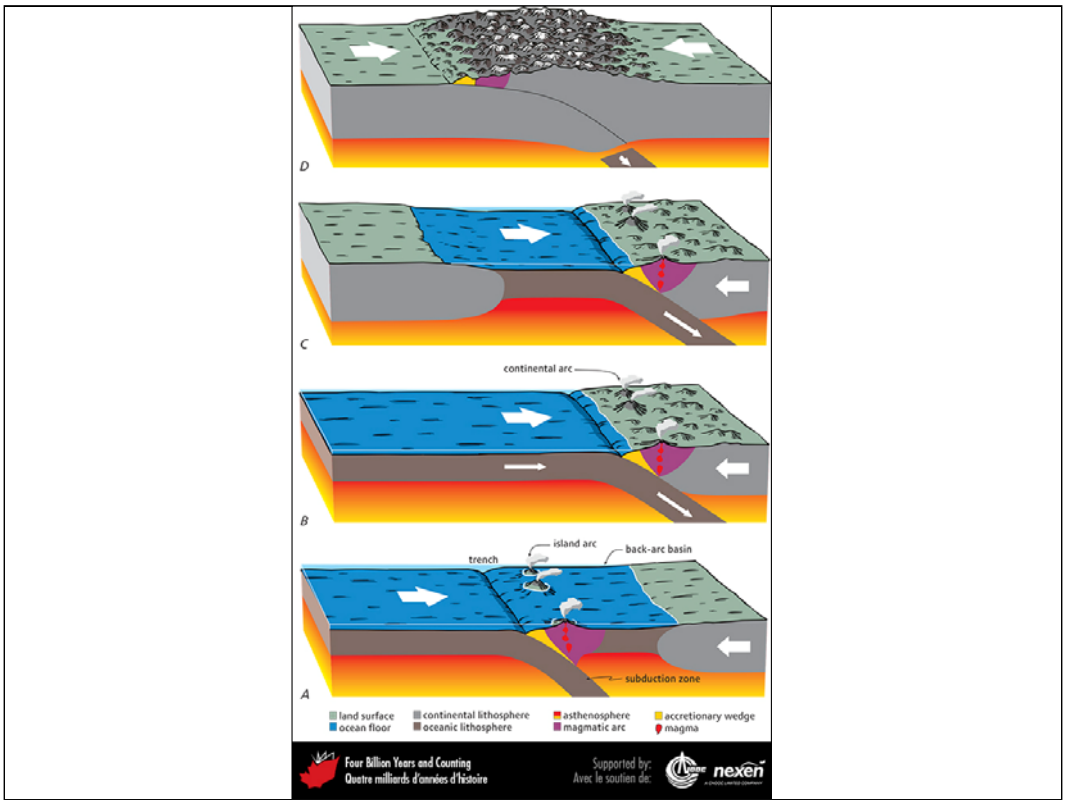
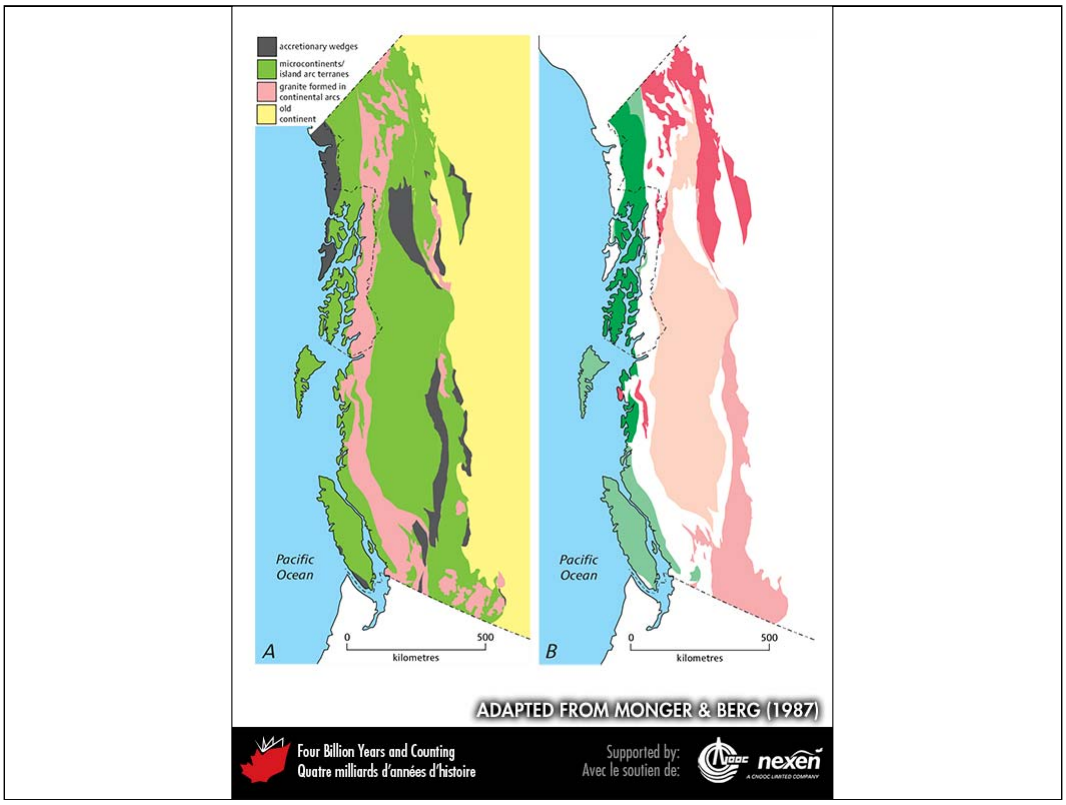
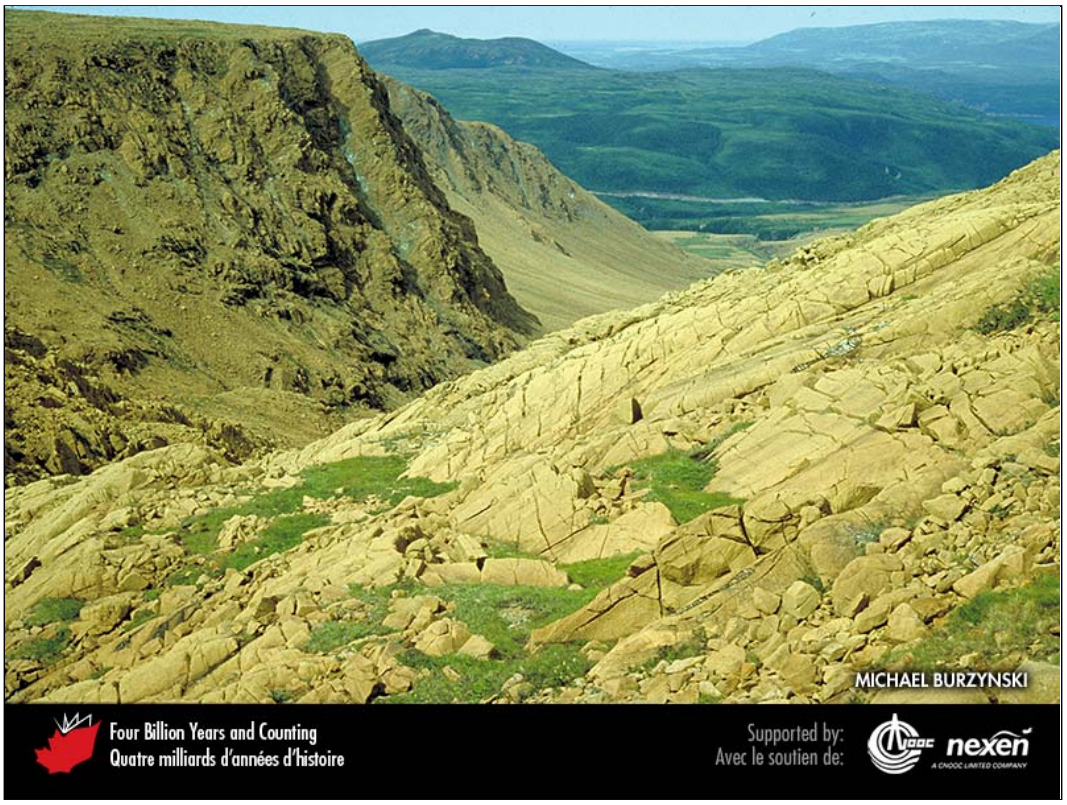


Different kinds of convergent plate margins. When the lithosphere disappears at trenches by subduction into the mantle, chains of volcanoes and bodies of magma are generated in magmatic arcs in the overriding plate. The arrows indicate relative motion of the plates. A shows a setting such as that in the present western Pacific. shows a setting such as today's eastern Pacific margin. C shows a similar situation to B, but with another continent approaching. D shows a continuation of this process—the two continents have collided and one is being thrust beneath the other, a process that will eventually stall, shutting down subduction and causing changes in plate interactions and boundaries.



Anatomy of the still-active Cordilleran Orogen in Canada. A shows the distribution of: accretionary wedges; microcontinents, which commonly incorporate remnants of island magmatic arcs and granites. B shows the distribution of the various major microcontinent/island arc terranes in the Cordillera, names and details of which will be introduced in later chapters. ADAPTED FROM MONGER AND BERG (1987), COURTESY OF THE US GEOLOGICAL SURVEY.



Ultramafic mantle rocks, part of a suite of rocks known as ophiolites, are exposed in Gros Morne National Park of Canada, Newfoundland. These rocks were thrust up about 480 million years ago (Chapter 7). The brown colour and lack of vegetation are characteristic of outcrops of ultramafic rocks. MICHAEL BURZYNSKI.

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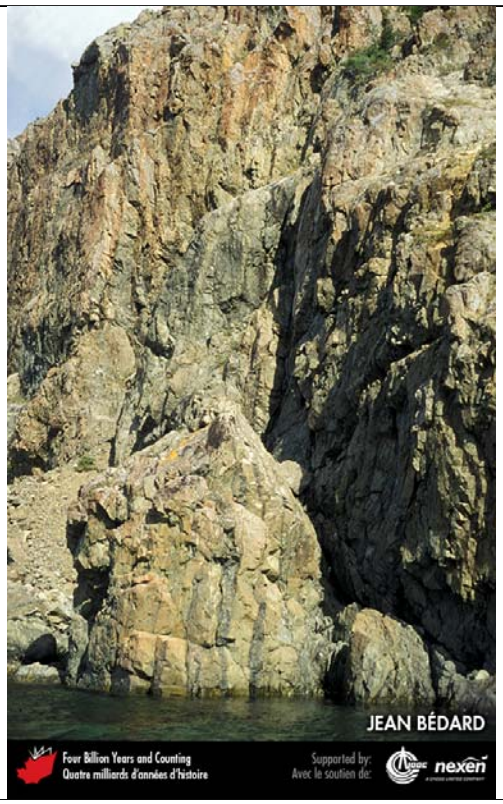

The almost vertical structures in this cliff are the solidified remains of feeder dykes that supplied magma to spreading ridges. Such dykes are preserved in ophiolite suites. This example is from Gros Morne National Park of Canada, Newfoundland. JEAN BÉDARD.

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Basaltic lava flow on Kilauea volcano, Hawaii, perhaps the world's most famous hot spot. This photo was taken about 4 metres from the lava. LASZLO PODOR.

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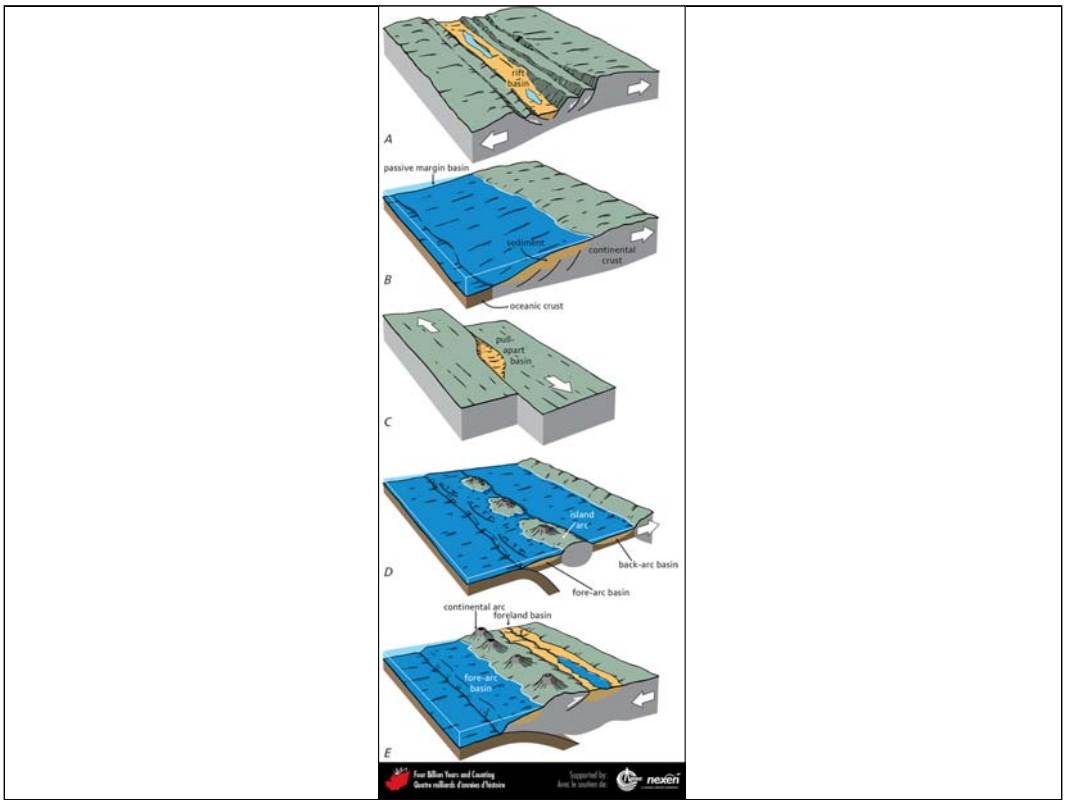

The relationships between sedimentary basins and plate tectonics. Extensional plate tectonic settings with rift basins formed during rifting (A) and passive margin basins formed during drifting (B). Pull-apart basins, which are never large, can occur in transform tectonic settings (C). Convergent-plate settings may include fore-arc basins between the trench and magmatic arc (D, E), back-arc basins between the magmatic arc and continent (D), and foreland basins, depressed by the overloading of the lithosphere as continental crust piles up through thrust-faulting and folding (E).

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These fluvial sedimentary rocks (redbeds) at Burntcoat Head, on the south shore of the Minas Basin, Nova Scotia, were deposited in a rift basin over 200 million years ago (Chapter9). ANDREW MACRAE.

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