

Age of Rocks

Abstract

The geologic time scale divides the 4.6 billion years of earth's history into hierarchy of time periods. Every layer of rock corresponds to a specific time in the history of the formation of the Earth. The Precambrian era began with the formation of the Earth; it was followed by the Paleozoic, Mesozoic, and Cenozoic eras. Each of these eras is divided into periods, the periods into epochs, and epochs into ages. Paleontological studies and isotopic dating methods are used to determine the time divisions.

The geologic time scale divides the 4.6 billion years of Earth history into several units. Each time unit represents a particular stage in the development of the climate, life forms and landscapes of the planet. By studying sequences of superimposed rock strata in different parts of the globe, scientists have been able to divide geologic time into a certain number of periods of very long duration. Every layer of rock corresponds to a specific time in the history of the formation of the Earth.

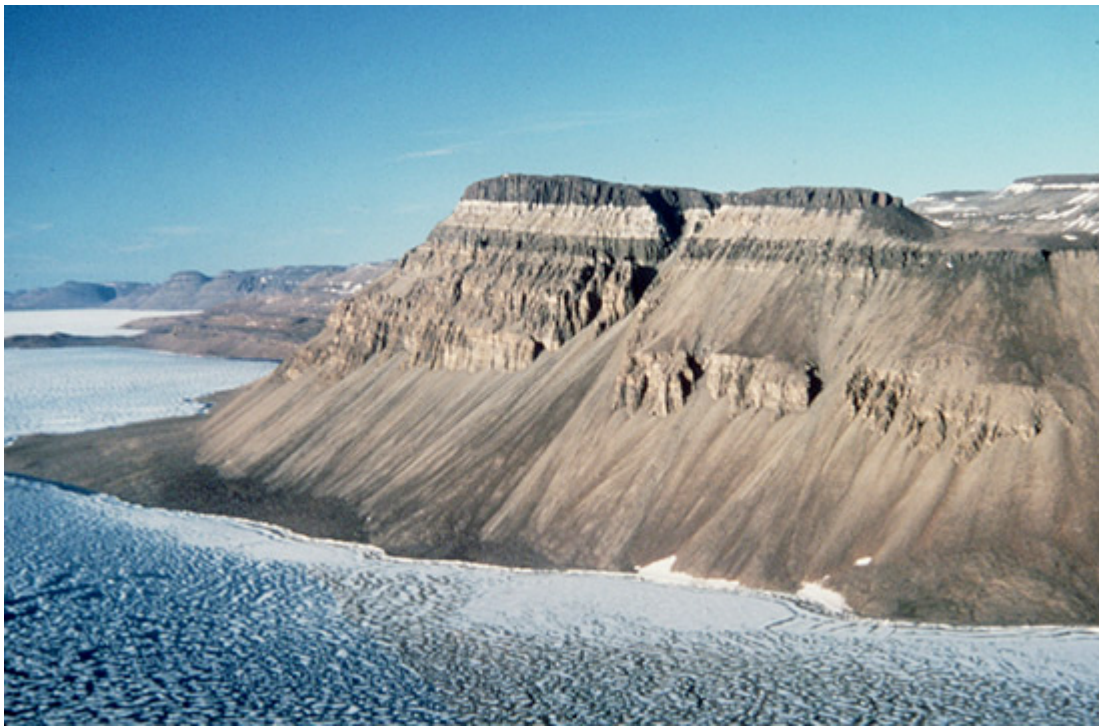


Figure 1: Superposed layers of rock, Victoria Island, Northwest Territories
Source: Geological Survey of Canada (photo number 1995 107)

Geological time is divided into a complex hierarchy of time periods. This note gives some of the most basic and best known. The longest units of time, referred to as eons, are called the Archean, Proterozoic and Phanerozoic.

The first two eons comprise the Precambrian, the most ancient period of time, which accounts for over five-sixths of all geologic ages. The Precambrian, began with the formation of the Earth (at least four billion years ago) and ended approximately 570 000 000 years ago. It corresponds to the time before the appearance of complex life forms. As a result, fossils are rare in Precambrian rocks. As well, these rocks are highly deformed and difficult to trace from one region to another. Consequently, Precambrian time has not been subdivided to the same degree of precision as more recent times. In Canada, Precambrian has two major subdivisions: the lower Precambrian or Archean, and the upper Precambrian or Proterozoic.

Rocks that formed during more recent periods and eras are better preserved than those dating from the Precambrian and it is therefore possible to differentiate their ages more readily. As a result, increasingly recent time units are more numerous and more precise and hence represent increasingly shorter periods of time.

The Precambrian is followed by the Phanerozoic, which is divided into three eras: the Paleozoic, Mesozoic and Cenozoic eras. Each of these eras is divided into periods, the periods into epochs and the epochs into ages.

- The Paleozoic began 570 000 000 years ago. It consists of six periods which, from oldest to most recent are: Cambrian, Ordovician, Silurian, Devonian, Carboniferous and Permian.
- The Mesozoic began 225 000 000 years ago and is divided into three periods which, from oldest to most recent are: Triassic, Jurassic and Cretaceous.
- Finally, the Cenozoic, or most recent era, covers the past 65 000 000 years. It is divided into several relatively short periods. The older, and much longer, is the Tertiary. The Tertiary is subdivided into five periods: Paleocene, Eocene, Oligocene, Miocene and Pliocene. The Quaternary, which follows the Tertiary, is made up of the Pleistocene, which was a time of cooling temperatures in the Northern Hemisphere, and the Holocene, which dates from the end of the most recent glaciation, approximately 10 000 years ago, to the present day.

Scientists have been able to establish the fact that the Pleistocene began approximately 1 500 000 years ago. During that time, alternating periods of cold and warm temperatures generated four successive glacial epochs, during which ice sheets covered vast areas of North America, Europe and Asia. Each of these glaciations is believed to have lasted 100 000 years. Various studies have shown that climate during the interglacials was sometimes warmer than it is today.

How are geologic time divisions determined?

Throughout the world, sediments are continually being deposited and, over time, they become rock. Layers of rock build up on top of each other as they form, with the oldest on the bottom. Each layer contains the remains of animals or plants that lived during the time the sediments were deposited. Once buried, these animals and plants were preserved and became fossils after the sediments were lithified. The appearance and disappearance of certain life forms provide clues that can be used to reconstruct the past. In addition, certain fossils are indicative of a specific time.



Figure 2: Cambrian trilobite from Newfoundland
Source: Geological Survey of Canada (photo number 105633i)

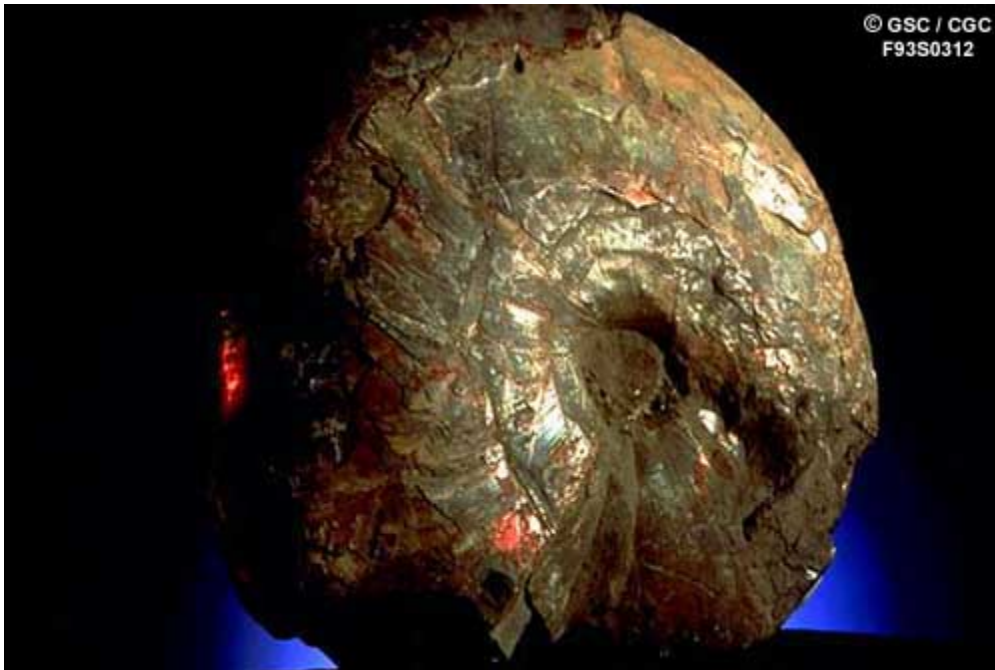


Figure 3: Cretaceous ammonite fossil

Source: Geological Survey of Canada (photo number F93S0312)

The various types of fossils deposited during a given time period have similar counterparts in other areas of the continent. As a result, it is possible to correlate between locations and compensate for problems encountered in areas where specific rock strata are missing or have been shifted out of sequence as a result of sudden, strong folding events.

In addition to the findings of paleontological studies (i.e. of fossils), isotopic dating methods are used to determine the time divisions. The duration of the various periods can be calculated on the basis of the proportions of potassium and argon isotopes. An isotope is an element (like potassium, carbon, argon, etc.) that has lost one or more neutrons. These dating methods are based on the principle that by losing neutrons, elements undergo isotopic decay slowly, at a known rate. Therefore, the greater the quantity of a given element that has undergone such decay, the more time has elapsed, and the older the rock containing the element must be.

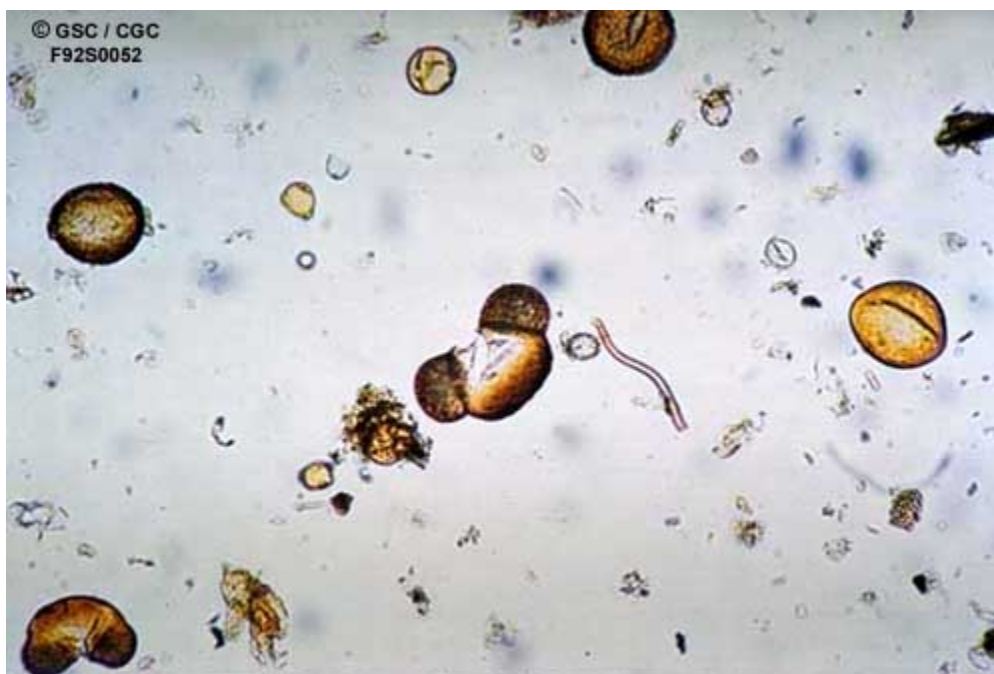


Figure 4: Fossilized pollens are indicators of the past environment. Microscopic samples of ancient pollens

Source: Geological Survey of Canada (photo number F92S0052)

Map Sources

Age of Rocks

This layer was taken from the CD-ROM: Geological Map of Canada - Map D1860A. This edition of the Geological Map of Canada is the latest produced by the Geological Survey of Canada. It shows the age of rock at the era level (Cenozoic, Mesozoic, Precambrian).

References

Canada. Geological Survey of Canada. 1981. Geology and Canada. Adapted from Prospecting in Canada 4th edition by A.H. Lang, published in 1970.
National Geographic Society. 1993. Exploring your World, the Adventure of Geography. Prepared by the Society's Special Publications Division. Washington, D.C.

Related Web sites (1999 – 2009)

Federal Government

Natural Resources Canada. Geological Survey of Canada. Canadian Landscapes
http://gsc.nrcan.gc.ca/landscapes/index_e.php

This collection of photos of Canadian landscapes and landforms is presented as a public service to illustrate the great diversity of Canadian scenery.

Natural Resources Canada. Geological Survey of Canada. Geological Map of Canada
http://gsc.nrcan.gc.ca/map/1860a/index_e.php

These pages comprise the documentation set that appears on the Geological Map of Canada, CD-ROM version (D1860A).

Natural Resources Canada. Geological Survey of Canada. Geoscape Vancouver
http://geoscape.nrcan.gc.ca/vancouver/index_e.php

Geoscape Vancouver - Living with our geological landscape

Natural Resources Canada. Minerals and Metals Sector. Canadian Minerals Yearbook
<http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/cmy-amc-eng.htm>

Each year, the Minerals and Metals Sector (MMS) of Natural Resources Canada undertakes a comprehensive review of developments in the mineral industry and publishes the results as the Canadian Minerals Yearbook.

Natural Resources Canada. Minerals and Metals Sector. Minerals and Metals -A World to Discover

<http://www.nrcan.gc.ca/RedirNotifs-ss/mms-smm.htm>

The following pages have been created as an educational tour of some of Canada's most important natural resources: minerals and metals.

Other

The Royal Tyrrell Museum - Where Palaeontology Comes Alive!

<http://www.tyrrellmuseum.com/home/>

Web site of the Royal Tyrrell Museum. A palaeontology museum and research facility in Alberta.