OHIO GEOLOGY

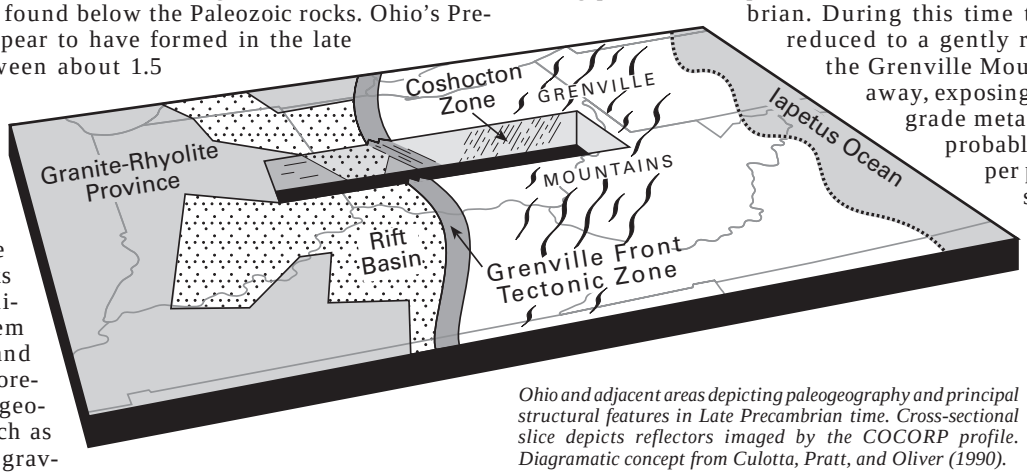
GEOFACTS No. 13

OHIO DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

# THE GEOLOGY OF OHIO—THE PRECAMBRIAN

Precambrian time (all of geologic time before the Cambrian Period) began when the Earth became a solid entity about 4.5 billion years ago and ended when the Cambrian Period began, about 570 million years ago. "Precambrian" is actually an informal term used by geologists. This long period of time is divided formally into two eons—the Archeozoic (greater than 2.5 billion years ago) and the Proterozoic (2.5 billion to 570 million years ago). Despite the immense span of time it represents, the Precambrian is the most poorly known of the geologic subdivisions in Ohio, in part because Precambrian rocks are nowhere exposed in the state. These primarily crystalline igneous and metamorphic rocks are deeply buried beneath younger Paleozoic sedimentary rocks at depths ranging from about 2,500 feet in western Ohio to more than 13,000 feet in southeastern Ohio. These rocks are collectively referred to by geologists as the "basement" because they form the foundation for the overlying Paleozoic rocks. Drillers commonly refer to the Precambrian rocks as the "granite," in reference to a common rock type found below the Paleozoic rocks. Ohio's Precambrian rocks appear to have formed in the late Precambrian, between about 1.5 billion and 800 million years ago. Older Precambrian rocks have not as yet been found in the state.

Our knowledge of Precambrian rocks is derived from direct sampling of them through deep oil and gas wells or other boreholes or indirect geophysical means such as aeromagnetic and gravity maps, reflection seismic lines, or study of earthquake waves. Geophysical techniques are comparatively new, and it has only been since the early 1980's that geophysical data have become widely available.




*Ohio and adjacent areas depicting paleogeography and principal structural features in Late Precambrian time. Cross-sectional slice depicts reflectors imaged by the COCORP profile. Diagramatic concept from Culotta, Pratt, and Oliver (1990).*

## PRECAMBRIAN GEOLOGY OF OHIO

Known Precambrian history of Ohio began with the emplacement of a vast, horizontal, 7-mile-thick layered sheet of granite (coarse-grained igneous rock formed at depth) and rhyolite (fine-grained volcanic equivalent of granite formed near the surface) beneath western Ohio and neighboring states to the west. This emplacement has been attributed to an uprising in the Earth's mantle, known as a superswell. Radioisotopic dating suggests that this event took place between about 1.4 and 1.5 billion years ago, forming what geologists call the Granite-Rhyolite Province.

Continued continental doming of the superswell caused the crust beneath western Ohio, Indiana, and Kentucky to extend and split (rifting), resulting in major faulting and consequent downdropping to form a complex rift basin, now known as the East Continent Rift Basin. Molten basalt flowed upward as erosion began to fill the basin with clastic sediment, perhaps as much as 20,000 feet thick in some places. This extensive deposit is known as the Middle Run Formation. About 1 billion years ago, doming ceased and the rift became a failed or aborted rift. Rifting, volcanic activity, and basin filling also ceased.

At the time of rifting, it appears that eastern Ohio marked the edge of the North American protocontinent. Between about 990 and 880 million years ago a continent to the east collided with North America, resulting in extensive crustal compression and development of a mountain range that geologists call the Grenville Mountains. What is thought to be the zone of continental collision, known as a suture zone, is located in eastern Ohio and is called the Coshocton Zone.

As these continents collided along a 3,000-mile-long line, stretching perhaps from Sweden to Mexico, rocks were folded, twisted, metamorphosed, and thrust westward across part of the rift zone in western Ohio. This north-south-oriented, 30-mile-wide zone of east-dipping, imbricated thrust slices is called the Grenville Front Tectonic Zone and marks the westward limit of the Grenville Mountains. The Grenville Front in western Ohio is a sharp demarcation between relatively undisturbed 1.5 billion-year-old granitic rocks to the west and 800- to 900-million-year-old, greatly disturbed metamorphic rocks to the east.

After the Grenville Mountains were formed, a 300-million-year-long period of deep erosion occurred during the Late Precambrian. During this time the landscape was reduced to a gently rolling surface and the Grenville Mountains were carved away, exposing their roots of high-grade metamorphic rocks. It is probable that even the upper part of the rift-basin sedimentary rocks were removed at this time. At some time during this interval, extensive strike-slip faulting occurred.

The close of the Precambrian was marked by the advance of Cambrian seas across this geologically complex but topographically simple surface, formed by multiple events during more than a billion years of time. This topographic surface and its structural configuration would subtly influence the subsequent geologic history of Ohio forevermore.

## ECONOMIC AND ENVIRONMENTAL INFLUENCE OF PRECAMBRIAN ROCKS

At the present time, no minerals are produced directly from Precambrian rocks in Ohio. There is a potential for petroleum and natural gas to be present in economic quantities in Precambrian sedimentary rocks.

The economic potential for metallic ores, particularly sulfides of lead and zinc, also remains unevaluated. Small amounts of sulfide mineralization occur in carbonate rocks of northwestern Ohio and other areas of the state. It is probable that these occurrences represent deposition by fluids derived from Precambrian rocks.

The small to moderate-sized earthquakes that periodically strike Ohio originate in Precambrian rocks along ancient faults and other zones of weakness that are reactivated by modern crustal stresses. The most seismically active area of the state, in Shelby and Auglaize Counties in western Ohio, is now known to be associated with a segment of the East Continent Rift Basin that has been termed the Fort Wayne or Anna-Champaign rift. Increased knowledge of the Precambrian basement rocks may one day enable us to estimate the location, frequency, and maximum size of earthquakes in certain areas of the state.

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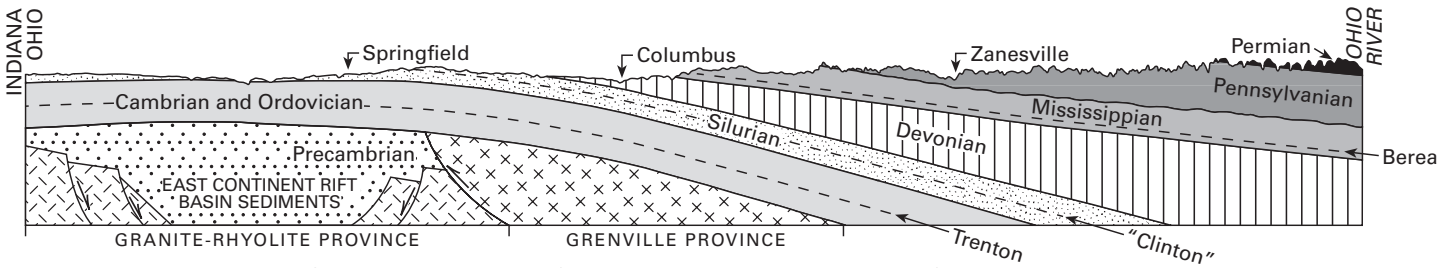
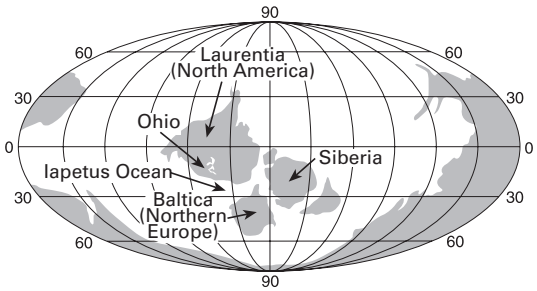



*East-west cross section of Ohio showing relationships of Precambrian rocks and the East Continent Rift Basin to overlying Paleozoic sedimentary rocks.*




*Continental configuration during the latest Precambrian. Modified from Scotese and McKerrow (1990,* in *McKerrow, W. S., and Scotese, C. R., Palaeozoic palaeogeography and biogeography, Geological Society Memoir 12, p. 5).*

## FURTHER READING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