OHIO GEOLOGY

GEOFACTS No. 20

OHIO DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

THE GEOLOGY OF OHIO—THE CAMBRIAN

The beginning of the Cambrian Period about 570 million years ago is marked by the sudden, widespread appearance of multicellular marine animals having hard parts capable of fossilization. Were it not for this dramatic occurrence, the 65-million-year-long Cambrian Period would not be regarded as the beginning of a new, and perhaps the most significant, era in the history of the Earth. Cambrian rocks also mark the first widespread accumulation of hydrocarbons—organic substances such as oil and gas—derived from once-flourishing life.

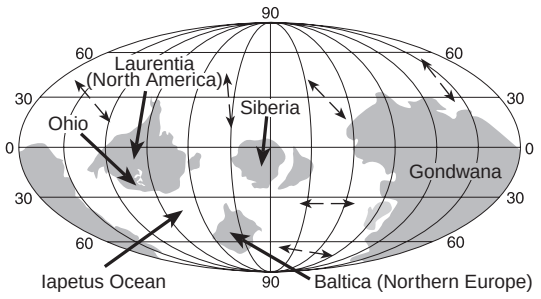
The Cambrian System was named for a succession of rocks in the Harlech Dome area of Wales by Adam Sedgwick in the 1830's. The name "Cambrian" is derived from the Roman name for Wales: Cambria. The apparent sudden appearance of fossils in rocks overlying unfossiliferous Precambrian rocks was a dramatic discovery to early geologists in their attempts to divide geologic time. The base of the Cambrian System marked the beginning of the Paleozoic Era, the era of ancient life.

Cambrian rocks underlie Ohio but are nowhere exposed at the surface. Depth to Cambrian rocks ranges from about a thousand feet in southwestern Ohio to more than 10,000 feet in southeastern Ohio. These rocks therefore must be studied through information obtained from deep oil and gas wells and indirect geophysical techniques such as seismic reflection, gravity, and magnetic intensity.

GEOLOGIC HISTORY

By the beginning of the Cambrian Period the lofty Precambrian mountains, formed a billion years ago by continental collision, had been reduced by erosion to a gentle, rolling landscape. Local relief on the Precambrian surface was not much more than about 300 feet at the time of deposition of Cambrian sediments.

Toward the end of the Precambrian and continuing into the Cambrian, the Laurentian continental plate (North America) began to separate from an eastern continental mass, probably Baltica (northern Europe), and the Iapetus Ocean formed. Ohio was on the stable, passive margin of the Laurentian continent, which had the ancient Canadian Shield as its nucleus.

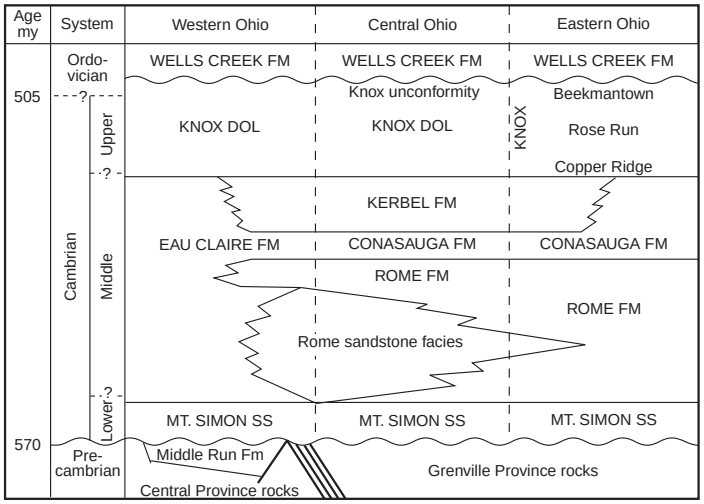


Continental configuration in the Late Cambrian. Ohio was near the continental edge of Laurentia in south equatorial latitudes. Modified from Riley and others (1993).

The basal Cambrian rock unit in most of Ohio is the Mt. Simon Sandstone, a quartzose sandstone that is widespread across a multistate area. The Mt. Simon Sandstone is friable, fine to coarse grained, and in Ohio ranges from 0 to nearly 400 feet in thickness. The Mt. Simon is unfossiliferous and its precise age is uncertain. Trilobites indicate that the units overlying the Mt. Simon are late Middle Cambrian to early Late Cambrian in age; thus, the Mt. Simon may be Early or Middle Cambrian in age.

It is thought that the lower part of the Mt. Simon may represent an accumulation of quartz grains derived from a long period of weathering of underlying Precambrian rocks. Transgression of the Cambrian seas across the shallow shelf on the edge of the craton reworked these sand deposits.

As the Cambrian sea continued to flood the craton during the opening of the Iapetus Ocean, the waters deepened across Ohio, and carbonate deposition began in eastern Ohio as the Rome Formation accumulated. The Rome, which is primarily dolomite, is more than 700 feet thick in far eastern Ohio, becomes sandy in central Ohio, and thins to the west. Overlying the Rome Formation in the eastern half of the state is the Conasauga Formation, which consists of shale, siltstone, fine-grained sandstone, and limestone in the south and dark-gray to brown dolomite and interbedded fine- to coarse-grained sandstone in the north. The Conasauga ranges from 40 to more than 400 feet thick.



Relationships of Cambrian rocks and underlying and overlying systems in Ohio. The positions of the Cambrian-Ordovician boundary and the boundaries between Lower, Middle, and Upper Cambrian rocks are uncertain. Copper Ridge, Rose Run, and Beekmantown are informal subdivisions of the Knox Dolomite. None of these rocks are exposed at the surface in Ohio. my = million years. Modified from Janssens (1973).

The Rome and Conasauga Formations grade westward into the Eau Claire Formation, which is composed of sandstone, siltstone, shale, and dolomite. The Eau Claire ranges in thickness from about 200 feet to more than 500 feet.

The Rome/Conasauga and Eau Claire Formations formed as offshore, shallow shelf and prodelta deposits derived from a northwest source area. Overlying these units in the central part of the state is the Kerbel Formation, an upward coarsening sandstone that is interpreted to be a wedge of deltaic sediments. This north-south-oriented lobate deposit reaches a thickness of about 170 feet. The Kerbel is absent in southernmost, western, and eastern Ohio.

During the Late Cambrian, the Kerbel delta foundered and carbonate sediments (Knox Dolomite) began to accumulate as shelf deposits in the shallow, equatorial sea that covered Ohio. The Knox Dolomite is more than 1,300 feet thick in the southern part of the state and thins to the north beneath a major regional unconformity. Knox deposition continued throughout the remainder of the Cambrian and into the Ordovician Period. The Cambrian-Ordovician

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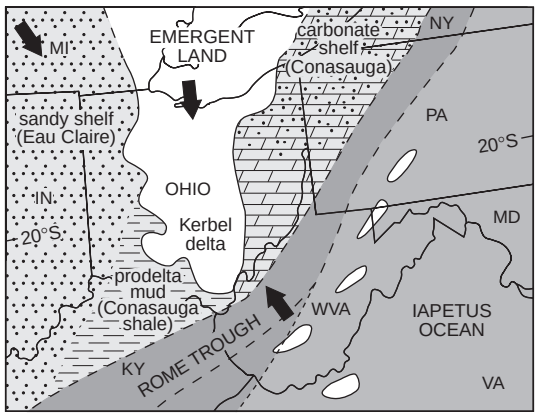

Generalized paleogeography of Ohio and adjacent areas during late Middle Cambrian time. Arrows indicate direction of sediment deposition. The subsiding Rome trough south and east of Ohio accumulated a great thickness of Cambrian sediments. East of the Rome trough was the continental edge and the Iapetus Ocean. From Hansen (1997).

boundary therefore is uncertain, lying within the upper part of the Knox but not marked by a significant unconformity.

ECONOMIC AND ENVIRONMENTAL IMPORTANCE OF CAMBRIAN ROCKS

Cambrian rocks in Ohio have been the last of the Paleozoic systems to be explored for economic benefits because of their great depth below the surface. The first Cambrian hydrocarbon production was in 1919 from the Knox Dolomite in Marion County. This well produced 45 barrels of oil per day.

Beginning in 1959, drilling in Morrow County quickly made Cambrian rocks one of the most important geologic systems in the state for oil and gas production. Thousands of wells were drilled in the first half of the 1960's in a frenzied "oil boom" that saw rigs set up in back yards in Cardington. Approximately 38 million barrels of oil and 35 billion cubic feet of gas have been produced from hundreds of small reservoirs in Morrow County.

Morrow County and surrounding areas are underlain by a concentration of erosional remnants (buried hills) formed during the subaerial erosion of the Knox Dolomite during the early Ordovician (Knox unconformity). When these dolomite hills were exposed to the atmosphere and rain water during the Ordovician, they developed solution cavities, known as vugs, in which hydrocarbons later accumulated. A cap of impervious Ordovician rock trapped the hydrocarbons in the hills.

More recently, the Rose Run sandstone, a sandstone bed within the Knox Dolomite, has become a prime target for hydrocarbon exploration in Ohio. The Rose Run is present beneath most of eastern Ohio, but the primary exploration area is along a linear belt stretching from Ross County on the south northeastward to Ashtabula County. Gas was first produced from the Rose Run in 1965 in Holmes County; however, the majority of Rose Run wells in Ohio (nearly 1,800, or 85 percent) have been drilled since 1987.

The basal Cambrian Mt. Simon Sandstone has been an important unit for disposal of liquid industrial waste through Class I injection wells. Currently, 12 wells at four sites in Ohio inject waste chemicals into the Mt. Simon. This unit is one of the more ideal geologic units in Ohio for disposal and long-term storage of these liquid wastes because it is relatively deep (2,500 to 10,000 feet), it has comparatively high porosity and permeability, and it is underlain and overlain by impervious confining layers (aquitards) that prevent migration of injected fluids.

CAMBRIAN LIFE

Although the beginning of the Cambrian marks the first widespread appearance of abundant, multicellular marine organisms capable of fossilization, discoveries since pioneering geologic investigations of the nineteenth century have revealed that life teemed in the late Precambrian. But these animals are relatively simple organisms in comparison to life that literally burst onto the scene early in the Cambrian.

Traditionally, the Cambrian is known as the Age of Trilobites because these arthropods constitute perhaps 60 percent of the fossils known from this system. Trilobites have proved to be wonderful index fossils for comparative dating and correlation of Cambrian rock units. However, brachiopods, echinoderms, gastropods, graptolites, sponges, and a host of other groups are known from Cambrian rocks. Even fishes swam in the seas by the end of the Cambrian. These animals lived in a marine environment. The terrestrial environment, so far as we know, was devoid of animals and probably plants except, perhaps, for algae and lichens.

FURTHER READING

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