Shale to the south. This change, together with draping of the Utica over the underlying competent Trenton, traps petroleum along the southwestern extension of the Lima-Indiana trend. (4) Fracture systems related to regional fracturing of the early Paleozoic rocks. Apparently these systems have provided fracture-enhanced reservoirs. Similar configurations are well known in the Scipio-Albion trend in southern Michigan. Secondary dolomitization and sulfide mineralization are common in association with these fractured features. (5) Possible porosity-permeability traps, probably on structure, where dolomite is replaced laterally by dense limestone. (6) Small anticlinal terraces off the main arch system, related to minor production. These terraces appear as down-to-the-basin noses on structural maps.

Considered together, the Lima-Indiana fields are a "giant" field extending 120 mi (193 km) in Ohio and another 50 mi (80 km) in Indiana. Before 1900, thousands of wells were drilled, as shallow as 1,100 ft (334 m), producing over 220 million bbl of oil at initial rock pressures between 100 and 450 psi (690 and 3,100 kPa). Exploration continues at a modest pace.

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Berea Sandstone Gas Reservoir in Portage County, Ohio

The Mississippian Berea Sandstone is a reservoir for shallow gas in Randolph and Suffield townships of Portage County, Ohio. The Berea Sandstone is well known in Ohio from its outcrops at the outskirts of Cleveland. It is among the more productive formations in Ohio where it yields gas, oil, or gas and oil at moderate to very shallow depths. The great differences in reservoir quality, sandstone distribution, and producibility in Berea oil and gas fields are partly related to the use of the term "Berea" for several sandstone bodies that produce from different structural and stratigraphic settings.

In Portage County, the Berea Sandstone is up to 60 ft (18 m) thick and has a porosity in the 15-25% range. The sand is white, medium to fine-grained quartz, poorly cemented, and without substantial shale interbeds. The reservoir lies below the "Cap Berea," a gray, cemented thin bed at the base of the Sunbury Shale (driller's Coffee shale). The sequence is similar to the outcrop found on the eastern side of Cleveland, but not like western outcrops of Berea Sandstone. In Portage County, the sand is currently interpreted as fluvial or deltaic. Within the field, thickness of the reservoir and hydrocarbon saturated zone varies little.

Natural gas is produced from the top 30 ft (9 m) of the reservoir. The reservoir energy is water drive. The gas fields lie just updip from a steep structural terrace interpreted as a fault zone. The trap for the fields is anticlinal and the Sunbury Shale is the seal. New wells drilled into the reservoir at 400-500 ft (122-152 m) in depth produce gas without water. Initial open flow tested up to 1.0 MMCFGD at an initial reservoir pressure of about 80 psig (552 kPa). This producing configuration of a nearly uniform sandstone reservoir on structure differs markedly from that found in Medina and Ashland Counties, Ohio, where the Berea Sandstone is also a producing reservoir.

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Cave Levels of Trenton–Black River in South-Central Michigan

Four generalized cave levels of the Trenton–Black River in south-central Michigan are most notable because of lost circulation zones in productive field areas. The levels are herein referred to as uppermost, upper middle, lower middle, and lowermost.

The uppermost cave level extends about 250 ft (76 m) into the Trenton. It is best developed in the widest, most productive areas of Albion-Scipio, where the drill bit dropped as much as 62 ft (19 m). About 59 productive wells in Albion-Scipio lost circulation at this level.

The upper middle level includes the lower, slightly argillaceous Trenton, and the uppermost Black River formation. This level is developed to some extent in all fields, and is a common zone of solution-collapse brecciation. Because this level is collapsed, lost circulation is less common.

The lower middle level below the "Black River shale" is not penetrated by many wells in Albion-Scipio. Where penetrated, it is developed in all fields, and is the main producer in most smaller fields. About 26 wells in Albion-Scipio lost circulation at this level, with the drill bit dropping as much as 80 ft (24 m).

The lowermost cave level extends into the Glenwood Shale. It is the most widely developed level, but is intersected by few productive holes. Only seven wells lost circulation at this level in Albion-Scipio, but the drill bit has dropped as much as 8 ft (2.4 m) in the Glenwood. This cave level effectively drained some oil from reservoirs where the oil-water contact intersects the Glenwood.

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Silurian and Lower Devonian of Southwestern Virginia

Thermal maturity of the Silurian and Lower Devonian rocks in Virginia west of New River decreases southwestward. Oil and gas shows are reported.

The total thickness of Lower Devonian plus Silurian strata ranges from 52 to 1,000 ft (16 to 305 m), with a maximum in Buchanan County. Sandstones were derived from sources southeast of the central Appalachian basin, some from lands southeast of the outcrop belt, and some formed by reworking of sandstones within the outcrop area. Sandstones change northwestward to shales in the Clinch and Rose Hill Formations. In the Middle Silurian and Helderberg Group, sandstones grade northwestward to limestones. Limestones in the Hancock Formation change westward to dolomite. The Onesquethaw Stage is represented by sandstone, chert, and limestone assigned to the Wildcat Valley and Huntersville Formations.

In the Middle Silurian (Keefer or "Big Six" sandstone) and Early Devonian (Wildcat Valley Sandstone), longshore currents carried sand across the southwest end of the basin toward Kentucky.

Several regional unconformities are present. These unconformities are mostly related to sea level changes, but some are probably tectonic in origin. Five unconformities are significant: (1) at base of Silurian, (2) at base of upper Helderberg over much of the area, (3) at base of Oriskany Sandstone, (4) at base of Huntersville Formation, and (5) at base of Upper Devonian black shales in extreme western Virginia, where Chattanooga Shale overlies Middle Devonian to Middle Silurian strata.

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Basement and Structural Control of Ordovician Trenton Dolomite in Extreme Southeastern Michigan, with Emphasis on Hydrocarbon Accumulations in Relationship to Dolomitization

Recent exploration activities along the northerly extension of the Bowling Green fault have sparked renewed interest on the flanks of one of North America's first giant oil fields (Lima-Findlay field). Extreme southeastern Michigan lies on the northwest flank of the Cincinnati arch and the southeastern flank of the Michigan basin. Within the study area, basement and structural control dictate the occurrence of dolomite within the predominantly limestone Trenton Formation. Commercially productive hydrocarbon accumulation within this study area has been associated with dolomitization within the top 150 ft (46 m) of the Trenton Formation.

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Upper Devonian Catskill Delta of West Virginia

Oil and gas reservoir rocks of the Upper Devonian of West Virginia were deposited as shoreline sands along a coastal plain characterized by marine-dominant deltas (Catskill delta complex). These sandstones exhibit facies relationships between red beds and interbedded sandstones and shales that shift westward and eastward with offlap and onlap. Outcrop equivalents at Elkins, West Virginia, are correlated with the interval of Balltown to Fourth sands. Subsurface correlation indicates that maximum westward progradation occurred during deposition of the Gordon and Gordon Stray sands, and that transgression mainly characterized the younger Devonian sands of the Thirty-foot, Fifty-foot and Gantz.