units considered, the most promising ones for uranium exploration are the Devonian Hampshire and Catskill Formations from New York to Virginia, the Mississippian Mauch Chunk-Pennington Group from Pennsylvania to Tennessee, the Pennsylvanian Pottsville Group (especially in Alabama, Virginia, and southern West Virginia), the Pennsylvanian-Permian Dunkard Group in West Virginia, and the Triassic basins of the eastern Appalachians. The following units have moderate promise for uranium exploration: Cambrian Rome Formation from Virginia to Alabama; Ordovician Bays Formation from Virginia to Alabama; Ordovician Juniata Formation from Tennessee to Pennsylvania and equivalent Queenston Formation in New York; Silurian Bloomsburg Formation in Pennsylvania; Mississippian Pocono-Price Formation from New York to Virginia; Mississippian Maccrady-Stroubles Formation in Virginia and West Virginia; and Pennsylvanian Allegheny, Conemaugh, and Monongahela Groups from Pennsylvania to Kentucky.

A few uranium shows have been reported from pegmatites and other igneous rocks in the Blue Ridge, but far below commercial concentrations. None of the dikes cutting the Valley and Ridge and Plateau provinces have compositions associated geochemically with uranium, so prospecting them is probably futile.

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Petroleum Potential of Appalachian Basin

The Appalachian basin of the petroleum geologist, the birthplace of the oil industry, covers an area in the eastern United States of about 208,660 sq mi (540,450 sq km), which is divided into the oil-productive Appalachian Plateau segment of 172,000 sq mi (424,300 sq km) and the less favorable, structurally complex Valley and Ridge segment of 45,000 sq mi (116,000 sq km). The Appalachian basin contains at least 350,000 cu mi (1,460,000 cu km) of Paleozoic sedimentary rock, almost equally divided between the plateaus and the Valley and Ridge segments.

More than 2.5×10^9 bbl of oil has been produced almost exclusively from the rocks of the plateau segment; more than half of this volume, about 1.68×10^9 bbl has been extracted from Devonian rocks at depths of less than 1 mi (1.6 km).

Remaining reserves producible by present methods at existing prices for crude oil are estimated to range from 2.6×10^6 to 3.4×10^6 bbl, an amount slightly larger than one tenth the volume produced in the past 113 years. In contrast, the amount of oil originally in place that remains after efforts to extract it, is estimated to range from 10×10^9 to 12×10^9 bbl. Most of this oil, however, is locked in and economically unproducible by existing methods. Recovery of even a modest fraction of this oil will require (1) extensive drilling in the deeper, largely untested parts of the Appalachian Plateau segment of the basin; (2) exploration in the more favorable parts of the Valley and Ridge segment; (3) drilling offshore in Lake Erie; (4) application of established secondary- and tertiary-recovery methods to old and long abandoned producing areas; and (5) the development of new and imaginative techniques to extract more of the remaining oil from the rocks of the Appalachian basin.

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Energy Reserves of Appalachian Area

No abstract available.

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Energy: The Future is Now

No abstract available.

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Cambrian Facies Trends—Tool for Estimating Shortening in Southern Valley and Ridge Province

Regional stratigraphic study of the Nolichucky Shale (Upper Cambrian) northwest of the Saltville thrust fault in the Oak Ridge–Knoxville area, Tennessee, delineated the areal extent of a large lobate algal stromatolite bank. Because the bank has limited geographic distribution, it was possible to identify its edge from northwest to southeast, in the Pine Mountain, Wallen Valley, Clinchport, and Copper Creek fault belts. These thrust faults strike at an oblique angle to the original trend of the algal bank, so that from northwest to southeast different parts of the bank are juxtaposed. Facies changes within the bank sequence permit palinspastic restoration of the original bank that indicates the total movement of the Pine Mountain, Wallen Valley, Clinchport, and Copper Creek thrust faults is about 40 mi (64 km). Although these data are limited to the west half of the Valley and Ridge, continuing study toward the south and east may lead to an estimation of total shortening across the entire Valley and Ridge province.

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Exploration Concepts in Deformed Belt of Appalachians

The deformed belt of the Appalachians consists of the fold-and-thrust structures of the Valley and Ridge and the adjoining Appalachian Plateau provinces. The Blue Ridge and Piedmont provinces are excluded from this belt as being unprospective for petroleum. The deformed belt contains four morphostructural zones, from northwest to southeast, the *folded foreland* (southeastern Appalachian Plateau), the frontal imbricates (Nittany anticlinorium, Wills Mountain–Friends Cove anticlinorium), the *interthrust syncline* (Broadtop synclinorium, Greendale-Kimberling syncline) and the *back imbricates* (North Mountain-Pulaski system). Major types of potential hydrocarbon traps were formed by thrusting in these zones; these include opposed-thrust anticlines, step fold- and anticline-forming thrust sheets, concentric folds, stack-thrust anticlines, and leading- and trailing-edge imbricates. The role of salt, rock competency, sheet thickness and length, tectonic transport, and thrust ramping are the critical factors in the formation of the traps.

Along the strike of the Appalachians, the deformed belt consists of three main arcs which are convex northwestward and display changes in strike and dominant structures. The *southern arc* extends southwest of Roanoke, Virginia; the *central arc* extends from Roanoke to the Hudson River; and the *northern arc* extends from New York to the Gulf of St. Lawrence. A fourth arc begins offshore of western Newfoundland and extends into the Atlantic Ocean where it terminates at the continental margin. Main and secondary arcs are linked at basement nodes. These include the Anticosti platform, the Quebec arch, and the Adirondacks in the north, and the Roanoke(?) and Cartersville recesses in the south.

The component arcs of the Appalachians evolved with different histories subsequent to the quiescent, carbonate-shelf deposition of the Cambrian and Early Ordovician Periods. The *northern arc* was deformed by the Taconian orogeny, has thick Upper Ordovician to Devonian flysch, and was intensely thrusted during the Acadian orogeny. The *central arc* was moderately deformed during the Taconian orogeny, was a source proximal, thick depocenter during the Late Paleozoic and principally was folded and thrusted during the Appalachian orogeny. The *southern arc* was an unstable platform until the Appalachian orogeny, when it was intensely thrust-faulted.

The petroleum potential of the deformed belt is described in relation to its structures and reservoirs. Beginning in the Ordovician, the southeast mobile flank of the Appalachians was deformed and uplifted. Hydrocarbons may have been trapped in the reservoirs of early formed folds which subsequently were relocalized by later thrusting into antiform traps. Thrust structures form large "slab" traps having a high drainage volume for early and late hydrocarbon accumulations. The structures considered the most prospective are those where the Trenton and Knox carbonate rocks are encased by Upper Ordovician shales in the frontal and back imbricate zones where up to four thrust sheets may be superposed. Reservoirs are studied in relation to the depositional trends of Cambrian, Ordovician, Silurian, and Devonian fairways, diagenesis, and the enhancement of porosity and permeability by fracturing. The deformed belt is considered to be a gas province because of the maturing of hydrocarbons through burial and migration. Despite the low calorific gases in some areas, Silurian and Cambro-Ordovician objectives are above the eometamorphic threshold. The deformed belt has been explored sparsely and many large structures and deep objectives remain to be drilled.

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Diagenesis in Sandstone Reservoirs of Appalachian Basin

Diagenetic processes have had an important effect on porosity in the sandstones of the Appalachian basin. The Mt. Simon and Rose Run sandstones (Upper Cambrian and Lower Ordovician respectively) in the deep parts of the basin are generally of low porosity mainly because of quartz and carbonate cementation rather than compaction attending pressure solution or crushing from deformation. Locally, small voids have developed as a result of dolomitization of original calcite. These sandstones, at moderate depths in southeastern Ohio, are porous particularly in the highly feldspathic parts where cementation is incomplete and solution of feldspar is appreciable. Locally, argillaceous coatings inhibited cementation but promoted pressure solution.

The Tuscarora Sandstone (Lower Silurian) is generally well-cemented with quartz except in some of the very coarsest lenses. Small uncemented patches are present where argillaceous coatings or possible gas pockets prevented growth of secondary quartz. The lower part of the Williamsport (Newburg) Sandstone (Upper Silurian) has low porosity mainly because of dolomite filling pores. The upper part of the formation is quartzose with good porosity. Quartz cementation was retarded by argillaceous coatings on grains but locally anhydrite filled pores.

Porosity is developed best in the quartzose phases of the Oriskany Sandstone (Lower Devonian), especially in the western part of the Appalachian basin where cementation is less complete. Primary porosity decreases eastward as the amount of cement increases. Quartz and calcite cements were available both before and after folding. Widespread leaching of carbonate is not indicated. Secondary fracture porosity is important in deformed areas particularly in the well-cemented quartz sandstones which were more brittle. The Benson sand (Upper Devonian) is commonly of silt size and has very low porosity because of argillaceous material and secondary carbonate. Porosity is good in some of the coarser fractions (very fine-grained sand) where quartz cementation is incomplete and carbonate content is low. Locally, porosity was increased by partial solution of feldspar.

In the Berea Sandstone (Lower Mississippian) sericite and illite promoted pressure solution and led to considerable reduction in pore space in many areas. Porosity is relatively high, however, in the Cabin Creek and Gay-Fink trends where chlorite coatings were important in restricting quartz cementation. Solution of feldspar increased porosity in some places.

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Tully (Middle Devonian) to Queenston (Upper Ordovician) Correlations in Subsurface of Western Pennsylvania

Mechanical and sample-log correlations give the following results. The "Tully" of northwest Pennsylvania is a sequence of lenses at differing levels, confirming earlier ideas. The Delaware, Columbus, and Bois Blanc can be correlated eastward into Pennsylvania. The Bois Blanc is absent south and east of Warren County; southward, it grades into the Huntersville Chert. It contains a basal sandy zone locally unconformable on and commonly miscorrelated with the Oriskany. The Oriskany unconformably overlies rocks as old as Late Silurian around the basin margin, but into the basin is conformable on the upper Helderberg. The "no sand" area may be a clastic-starved carbonate facies of the Oriskany, rather than Helderberg. In southern Pennsylvania, a lower sandstone separate from the main Oriskany body may be Helderberg, previously miscorrelated. The Helderberg of northwest Pennsylvania is probably Manlius or older. The Salina Group in Pennsylvania is readily correlated northwestward; good regional markers are the Camillus Shale of New York and the C shale of Michigan. The top of the Salina G corresponds nearly to the top of the Tonoloway, the top of E to the top of the Wills Creek, and the Lockport equals part of the McKenzie. The upper McKenzie probably includes the Salina A. The Rochester Shale thins southeastward, whereas the Rose Hill thickens markedly. The Irondequoit Dolomite of the north is about in the position of the Keefer of the southeast. The Grimsby of the north and west is approximately equal to the Castanea and Tuscarora; the Whirlpool coalesces into the middle and possibly lower Tuscarora. Southeast of a line from northwest Somerset County through central Fayette County into West Virginia, the Tuscarora-Queenston unconformity is gone and the contact is a transition zone. Therefore, some of the basinward lower Tuscarora may be Ordovician.

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Central Broadtop Synclinorium and Its Implications in Appalachian Structure

The Broadtop synclinorium is a large regional synclinorium which extends from central Pennsylvania to western Virginia. Critical study of more than 125 mi of seismic reflection surveys, 22 wells, and surface maps shows that the synclinorium is broken into a series of folded and faulted structures which reflect a precise relation of basement movement to thin-skinned tectonics. This relation indicates that Taconic and older tension-induced features have a pronounced controlling effect on structures caused by later compression. Early tension faults localize features such as decollement ramping. This ramping in turn produces many large prominent first-order structural features in both the Valley and Ridge province and the Plateau province of the Appalachian basin, such as Wills Mountain anticline and the Allegheny front. The decollement ramping in turn induces formation of smaller second-order features such as the Whip Cove anticlines, the Whip Cove syncline, and other faults and folds within the Broadtop synclinorium.

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Lower Silurian "Clinton" Sandstone Geology and Petroleum Production in Eastern Ohio

Recent developments in the energy supply situation have intensified the search for and evaluation of new "Clinton" sandstone prospects throughout eastern Ohio.

Deposition of the "Clinton" sandstones was as distributary channels and barrier bars associated with deltas and as offshore bars along a westward transgressing shoreline. Trapping is controlled stratigraphically and structure serves only to aid in the separation of formation fluids within a reservoir. Minor local structure also helps to improve reservoir conditions through associated fracturing.

Clinton lithology is characterized by interbedded fine- to very fine-grained sandstone, siltstones, and shales. Porosity generally averages 8-9 percent and permeability less than 15 md. Because of these characteristics, the formation requires stimulation by hydraulic fracturing for commercial production to be achieved.