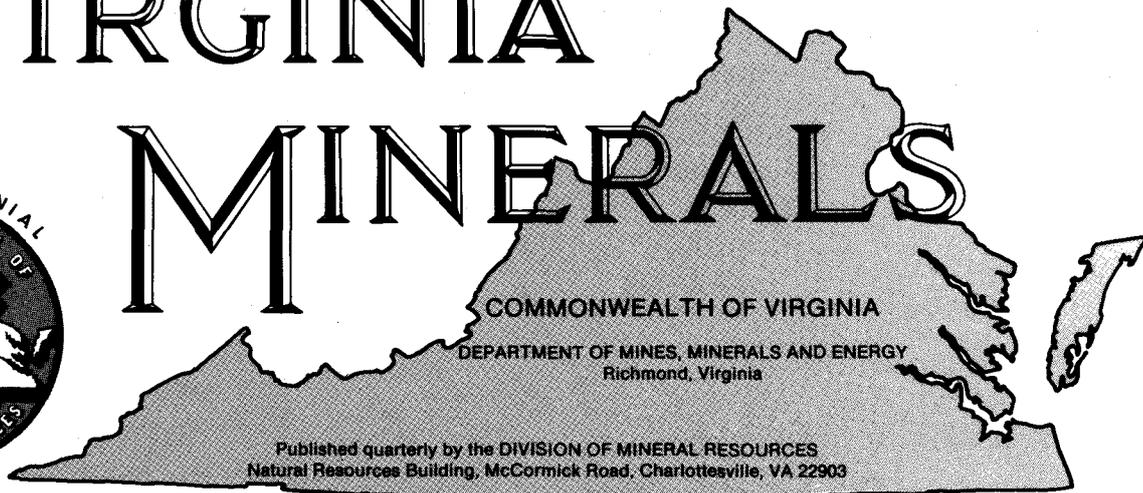
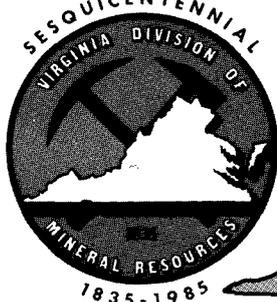


VIRGINIA

MINERALS



Vol. 36

February 1990

No. 1

OIL AND GAS EXPLORATION AND DEVELOPMENT IN VIRGINIA, 1979-1988

Robert C. Milici

ABSTRACT

There is production or the potential for production of oil and/or gas in all of the major physiographic regions of Virginia. Natural gas currently is being produced in the Appalachian Plateaus and Valley and Ridge regions of southwestern Virginia. Small amounts of oil are produced from a relatively small number of wells in a part of the same area. There is a potential for the development of the coalbed methane resources in the southwest Virginia coalfields, in the Valley coalfields, and in the Richmond basin (Triassic/Jurassic age). In addition, the buried Taylorsville basin (Triassic/Jurassic age) is currently (1989) a major exploration target of industry.

The number of producing gas wells and the production of natural gas has more than doubled during the past decade, so that Virginia currently is producing some 18 bcf annually from about 700 wells. During the past decade, oil production from as many as 60 wells generally has ranged upwards to several tens of thousands of barrels annually.

INTRODUCTION

Virginia is divided into several major physiographic regions; the Atlantic Coastal Plain on the east, and the Piedmont, Blue Ridge, Valley and Ridge, and the Appalachian Plateaus provinces to the west (Figure 1). There is production or some potential for oil and gas production in all

of the provinces of Virginia, as well as in the adjacent Atlantic Outer Continental Shelf (AOCS). By far, the most productive region in Virginia for natural gas has been the Appalachian Plateaus, which occupies all or parts of seven counties in the southwestern part of the state. Nearby areas of the Valley and Ridge produce some oil and gas, and gas has been produced in relatively small amounts from the Valley and Ridge of central Virginia (Le Van, 1981). Vibroseis data indicate that Paleozoic strata, which may have some potential for hydrocarbon production, extend eastward beneath the crystalline thrust sheets of the Blue Ridge and Piedmont (Harris and others, 1986) (Figure 2). Mesozoic basins in Virginia's Piedmont Physiographic Province have yielded shows of oil and gas. Currently, the Taylorsville basin is being explored by industry where it extends beneath younger coastal plain strata in the northern neck peninsula of Virginia. Although the region offshore of Virginia has been tested unsuccessfully by one well at the edge of the continental shelf, a large area remains to be explored. Mesozoic basins, similar to the Richmond and Taylorsville basins, occur in the subsurface of the nearby Atlantic Outer Continental Shelf, where some are buried at depths accessible by drilling (Bayer, 1987; Bayer and Milici, 1987). Much of the statistical and historical data utilized herein were obtained from the annual reports of the State Oil and Gas Inspector and the annual summaries published by the American Association of Petroleum Geologists. These references generally are not cited in the text.

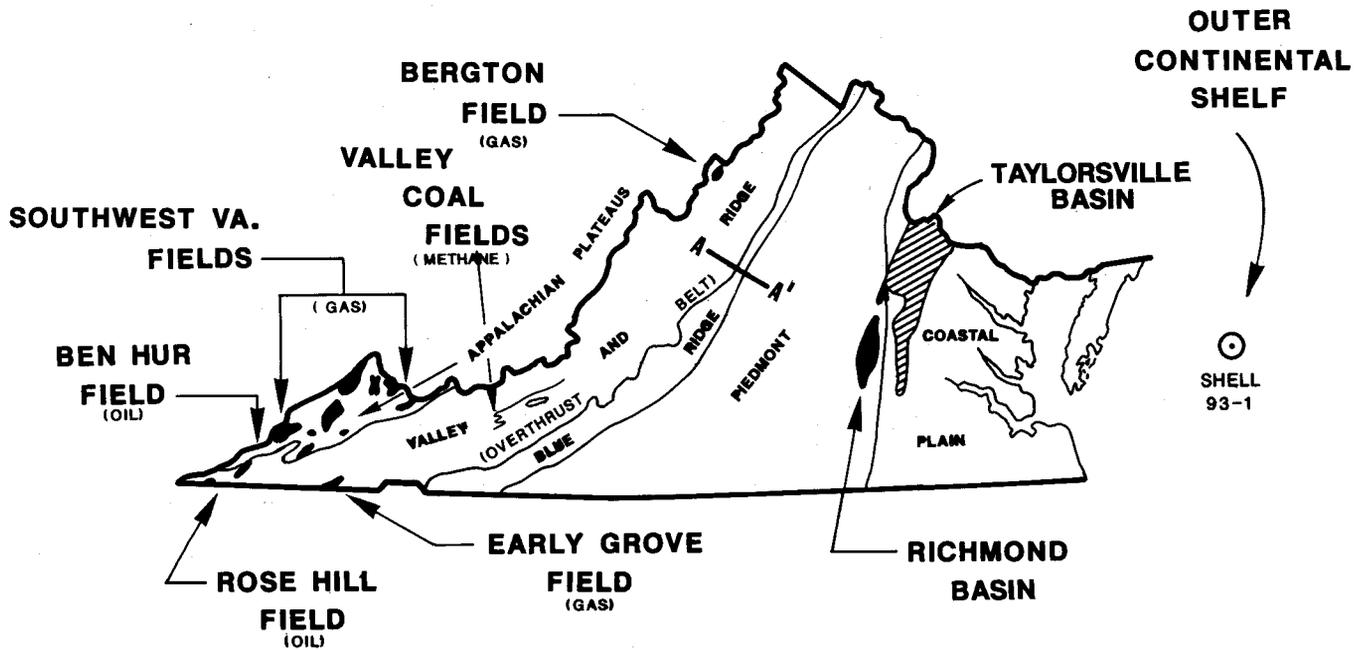


Figure 1. Oil and gas in Virginia.

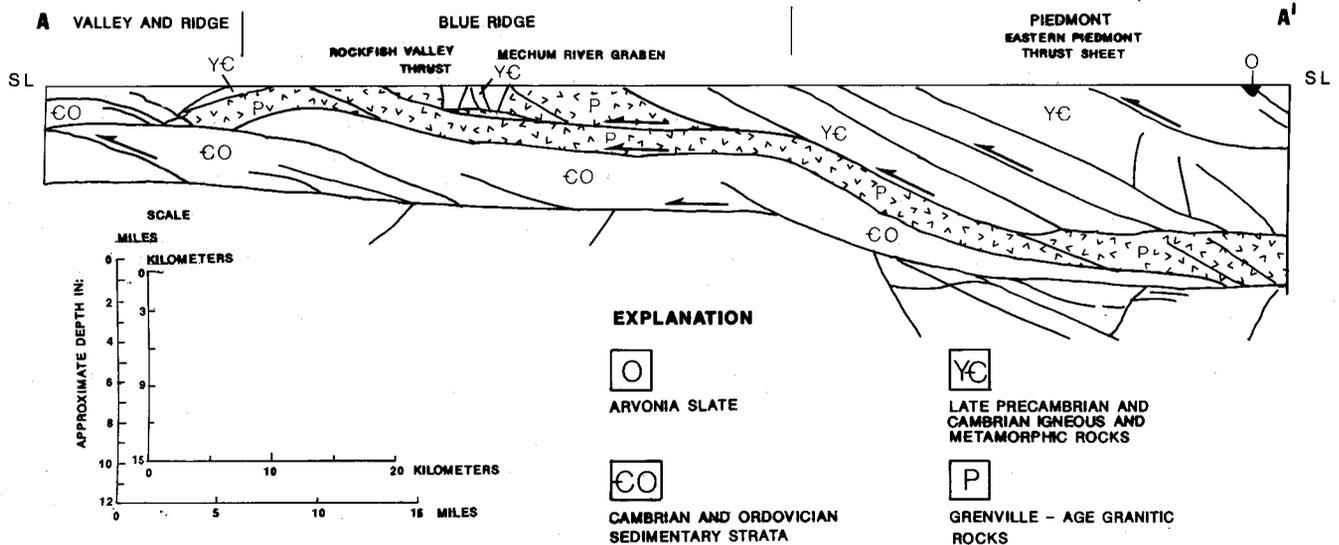


Figure 2. Cross section A-A', illustrating Paleozoic strata extending eastward under Blue Ridge (Adapted from Harris and others, 1986).

NATURAL GAS

APPALACHIAN PLATEAUS

During the past decade, the number of wells producing gas in Virginia has increased from 258 in 1979 to 728 in 1988 (Figure 3). Natural gas production has ranged from a low of 4.3 billion cubic feet (bcf) in 1983 to a high of 19.5 bcf in 1987 (Figure 4). The most significant increase in production was in 1985, when 68 percent more gas was produced than the

year before (15.0 bcf vs. 8.9 bcf) from 70 additional producing wells. More gas wells were added (139) and more footage drilled (782,380) in 1986 than in any other year (Figures 5 and 6).

Columbia Gas Transmission, Philadelphia Oil Company, and Ashland Exploration, Inc. were the major gas producers in Virginia from 1979 to 1984, with all of their production coming from the coalfield region of southwestern Virginia. Columbia produces gas from wells in Buchanan, Dickenson, and Tazewell counties chiefly from the Big Lime,

Berea sand, and Devonian shale, with some production from the Maxon, Injun, and Weir sands. Philadelphia Oil Company produces from the Nora field in Dickenson County and from a few wells in Wise County (Figure 7). Their production is chiefly from the Big Lime, Berea sand, and Devonian shale. Ashland Exploration produces gas from wells in Buchanan County, generally from the Big Lime, Berea sand, and Devonian shale, with additional production from the Maxon sands.

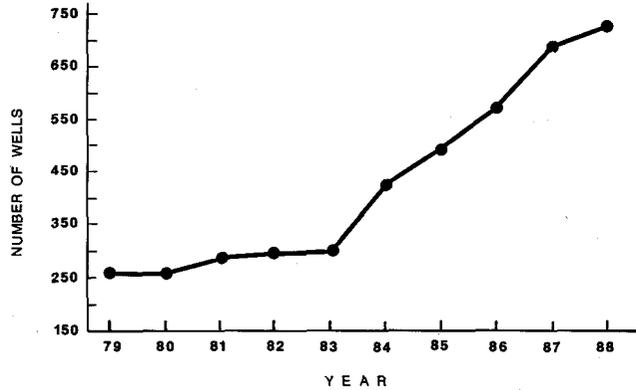


Figure 3. Number of producing gas wells in Virginia, 1979-1988.

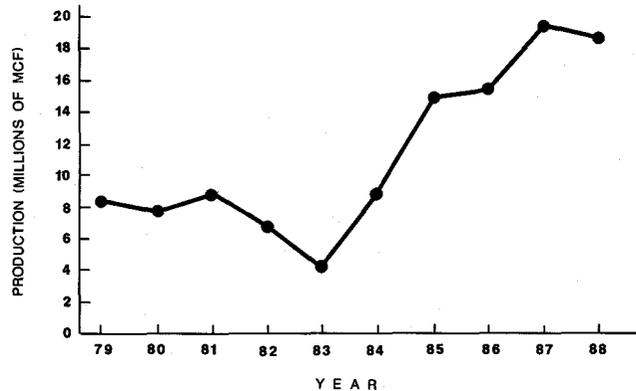


Figure 4. Production of gas in Virginia, 1979-1988.

A major drilling effort in Wise County commenced in 1984, when ANR Production Company began to develop its Roaring Fork prospect (Figure 7). Most of the wells were multiple completions, with production coming primarily from the Big Lime, Weir sands, Berea sand, and Devonian shale. In 1985, with 103 new wells on line, ANR became the principal producer of natural gas in Virginia, with a production of about 6.2 bcf. That year, Philadelphia Oil Company (3.7 bcf, 153 wells) and Columbia Gas Transmission (2.9 bcf, 134 wells) were second and third, respectively.

Ashland Exploration (0.5 bcf, 41 wells) dropped out of the top three producers in 1985 to fifth, behind Early Grove Gas, which had produced about 0.8 bcf from only 15 wells in the Early Grove field in Scott and Washington counties.

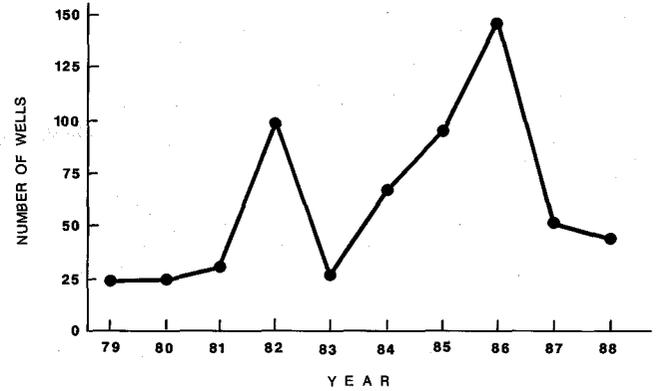


Figure 5. Number of wells drilled in Virginia, 1979-1988.

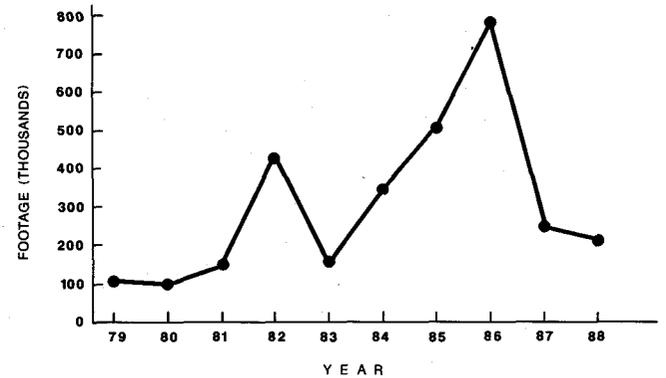


Figure 6. Total footage drilled in Virginia, 1979-1988.

In 1986, Philadelphia Oil Company began a major development effort in its Nora field by drilling 94 wells in Wise and Dickenson counties. These wells also, were completed primarily in the Big Lime, Berea sand, and Devonian shale, with some production coming from the Ravencriff and Maxon sands. Philadelphia Oil drilled six deeper pool tests in the Nora field to test the Clinch Sandstone. Although all of the wells were productive from the shallower zones, only one was productive from the Clinch.

ANR remained the dominant gas producer in Virginia until 1987, when Equitable Resources Exploration, Inc. (EREX, Philadelphia Oil) increased its gas production to 7.5 bcf. The additional production was gained from the 102 wells which had been added recently to the Nora field. At the same time, a new 8-inch pipeline was completed from the Nora field to East Tennessee Natural Gas Transmission's main line near Abingdon, Virginia. In 1988, gas production

in Virginia declined slightly from its record high the year before, chiefly because of a depressed market. EREX, however, increased its production from the Nora field to 9.1 million Mcf from a total of 313 wells.

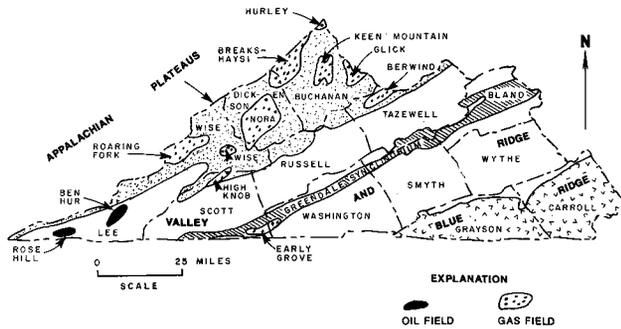


Figure 7. Oil and gas fields in southwestern Virginia.

EARLY GROVE GAS FIELD

The Early Grove gas field (Averitt, 1941) (Figure 7) was revitalized in 1980 after being dormant for over 30 years, when the Early Grove Gas Company, a subsidiary of United Coal Company, drilled four wells in the field into potential reservoirs in the Little Valley Limestone and Price Formation (Mississippian). In 1983, the company drilled several new wells and constructed a pipeline to Tenneco's main transmission line near Bristol. Penn-Virginia Resources, Inc., purchased the field from Early Grove Gas Company in May, 1987 and drilled six additional tests in 1988, of which four were completed as producing wells in the Little Valley and Price (Weir sands) Formations. The Early Grove field attained its greatest production in 1985 (0.76 bcf) and currently yields a little more than half that amount from 18 wells.

BERGTON GAS FIELD

The Bergton gas field in Rockingham County was discovered in 1935 when the Eastern Oil and Gas Corporation and the Eastern States Oil and Gas Corporation drilled three wells into Devonian "Oriskany" sands (Young and Harnsberger, 1955). By 1965, fifteen gas tests had been completed. Of these, five were classified as shut-in gas producers, chiefly from Oriskany sandstone, and 10 were plugged and abandoned. Interest in the area continued into 1980, when Merrill Natural Resources, Inc., drilled three development wells and one new field wildcat in Rockingham County. The wildcat, located nine miles south of the Bergton field on the eastern limb of the Bergton-Crab Run anticline, was drilled to test the Oriskany and was abandoned as a dry hole.

The development wells drilled by Merrill in the Bergton gas field were completed in the Oriskany as producers. Scott Enterprises reworked two old Oriskany wells and completed about 18,000 feet of pipeline in 1980 to tie them into Columbia Gas Transmission's pipeline system, thus opening the Bergton field to commercial production for the first time.

Merrill drilled three new wells in the Bergton field in 1982; two were classified as development wells and one as a new field wildcat. Drilling depths ranged from 4042 to 4913 feet; two wells bottomed in the Oriskany and one bottomed in the Brallier Shale (Devonian). All were dry, plugged, and abandoned. There is no reported production for Merrill Natural Resources in Virginia after 1982, when Merrill produced 196,160 Mcf.

New Frontier Exploration drilled two development wells in 1983. One well bottomed in Devonian shale at a total depth of 4556 feet; the other bottomed in the Oriskany at a total depth of 3452 feet; both were dry. The producing Rockingham County wells were operated by Yankee Exploration from 1984 until 1986, when 4503 Mcf of gas were produced. There has been no reported production from Rockingham County since 1986.

COALBED METHANE

SOUTHWESTERN COALFIELDS

The southwestern coalfields, the Valley coalfields, and the Mesozoic basins of Virginia contain potentially producible resources of coalbed methane. Of these, the southwestern fields have the greatest potential, by far, for economic production of methane.

In 1978, Island Creek Coal Company began a project in Buchanan County designed to recover the methane gas produced from the vertical ventilation holes that were drilled into the Pocahontas No. 3 coalbed in order to degas the bed prior to mining. They planned to use portable liquification units in the field that could be tied into gathering lines from the holes. Liquified methane would be stored on site until it could be trucked to a potential user. Although the project was suspended in 1979, 10 vertical-ventilation holes were drilled in 1980.

Clinchfield Coal Company, in cooperation with the U.S. Bureau of Mines, began a similar program in 1978 to drill vertical-ventilation holes into the Jawbone coalbed in Dickenson County. Four holes were drilled in 1979 to degas the seam in advance of mining.

In 1988, EREX drilled two exploratory wells to Lower Pennsylvanian coal beds in the Nora field, Dickenson County, to test these unmineable seams for their potential to produce methane. The coal beds were fractured with fresh water and sand was added as a "proppant." After the treatment water was removed by the completion rig, a gas-operated pump jack was installed to remove additional water.

Gas is being produced, compressed, and stored on site prior to shipping.

VALLEY FIELDS

The Virginia Division of Mineral Resources completed a study in 1983 (Stanley and Schultz, 1983) designed to evaluate the coalbed methane potential of the unmineable coal beds of Mississippian age in Montgomery County, Virginia. The Division had three core holes drilled. Two penetrated coal and samples of the beds were tested for their gas content. Stanley and Schultz (1983) concluded that under certain conditions there could be a potential for economic development of the methane resource. Subsequently, several tests have been drilled in the area, but thus far none have been successful.

OIL AND GAS

MESOZOIC BASINS

Merrill Natural Resources conducted an extensive exploration program in the Richmond basin during the early 1980s, by drilling 13 stratigraphic and gas tests to a maximum depth of 3080 feet (Wilkes, 1988, Appendix II). In addition, Cornell Oil Company drilled two deep wildcat tests, to 6386 and 7438 feet, in the basin in 1982. The Cornell Oil No. 1 Bailey, the deepest well drilled, penetrated the entire Triassic section and bottomed in granite (Wilkes, 1988). In 1985, Shore Exploration drilled a 4650-foot-deep wildcat test in the Richmond basin. This test, also, bottomed in crystalline rocks and was plugged and abandoned. Most of these recent Richmond basin wildcats bottomed in the Triassic and were all dry.

The Taylorsville basin, which is almost entirely buried by younger Mesozoic and Cenozoic strata of the Atlantic Coastal Plain, is currently an exploration target of industry. In 1986, Texaco and Exxon, in a joint venture, drilled six stratigraphic core tests; two each in Caroline, Essex, and Westmoreland counties (Files, Department of Mines, Minerals and Energy). The cores apparently yielded shows of oil and natural gas. In 1989, Texaco and Exxon drilled a new field wildcat on the northern peninsula near Dahlgren. The exploration target was a near-basement Triassic sandstone. The hole was dry, abandoned, and plugged after reaching a total depth near 10,000 feet.

SOUTHWESTERN VALLEY AND RIDGE

Oil is produced currently (1989) in Lee County from the Ben Hur and Rose Hill fields in the Fenster area of the Powell Valley anticline. In Wise County, oil is produced as condensate from some of the gas wells in the Roaring Fork field. Oil production increased gradually in Virginia during

the late 1970s and early 1980s from 2390 barrels from five wells in 1978 to 13,244 barrels from 12 wells in 1981. In 1982, crude oil production from the Ben Hur and Rose Hill fields increased significantly as companies shifted their exploration from natural gas development to oil development (Figure 8). Oil prices dropped markedly during the remainder of the decade, however, and drilling activity has failed to replace consumption.

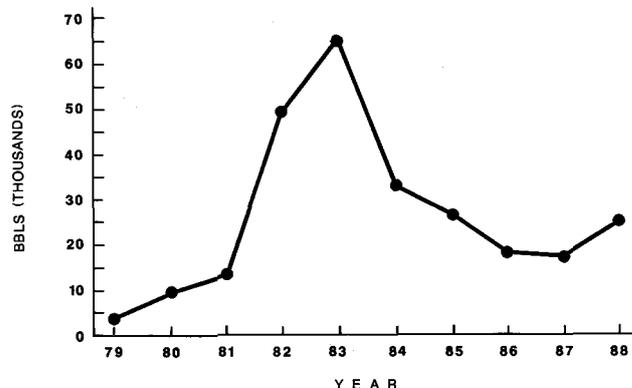


Figure 8. Oil production in Virginia, 1979-1988.

Lower crude oil prices caused Virginia's oil production to continue to decline as drilling was further curtailed in 1986. Two wells were drilled in 1986 for oil in Lee County with only one completed as a producer. Six wells were drilled in Lee County in 1987. Of these, a well drilled by Sovereign Petroleum in the Rose Hill field was completed in the Knox, Trenton, and Clinch formations with initial production rates of 5 bop/d and 5800 Mcfg/d. Penn-Virginia began a four-well drilling program to test the Knox and Stones River Groups in Lee County during 1987. Two of these wells drilled in central and eastern Lee County were completed as low-yield gas wells. A gas test in the Rose Hill field encountered a large oil flow in the Trenton and, instead of being drilled to its initial target, was completed as a new pool discovery. Another test was completed as a gas well in the basal Stones River and Upper Knox Groups, confirming a discovery made in 1984 by the Arco No. 1 Hensley well. A shallow test drilled by Robert F. Spear was abandoned after encountering large flows of fresh water. Penn-Virginia drilled five additional wells in Lee County during 1988, completing one as an oil well in the Knox, one as a gas well in the Trenton, and abandoning two as dry holes. The remaining well is under evaluation.

THE FUTURE

The future of the oil and gas industry in Virginia lies in the orderly development of the gas resources of the southwestern Virginia Plateaus region; a region of proven hydrocarbon production. In addition, coalbed methane re-

sources of the southwestern coalfields appear to be substantial. Industry currently is venting a great deal of methane into the atmosphere in advance of mining. Large areas of the Valley and Ridge, the buried Taylorsville basin of Virginia, and the Atlantic Outer Continental Shelf offshore of Virginia remain untested.

Oil production in Virginia apparently will be limited to a small area in the southwestern part of the state. Perhaps the Taylorsville basin and the region offshore of Virginia, should these areas contain suitably mature source beds and traps, will also provide future oil production. At present, gas rather than oil appears to be the future for hydrocarbon production in Virginia.

REFERENCES CITED

Averitt, Paul, 1941, The Early Grove gas field in Scott and Washington counties, Virginia: Virginia Division of Mineral Resources Bulletin 56, 50 p.

Bayer, K. C., 1987, Geologic interpretations of offshore seismic lines, Virginia: Virginia Division of Mineral Resources Publication 73 Part A.

Bayer, K. C., and Milici, R. C., 1987, Geology and petroleum potential of Mesozoic and Cenozoic rocks, offshore Virginia: Virginia Division of Mineral Resources Publication 73 Part D, 111 p.

Harris, L. D., de Witt, Wallace, Jr., and Bayer, K. C., 1986, Interpretive seismic profile along Interstate I-64 in central Virginia from the Valley and Ridge to the coastal plain: Virginia Division of Mineral Resources Publication 66.

Le Van, D.C., 1981, Natural gas in Virginia: Virginia Division of Mineral Resources, Virginia Minerals, v. 27, n. 1, p. 1-8.

Stanley, C. B., and Schultz, A. P., 1983, Coal-bed methane resource evaluation Montgomery County, Virginia: Virginia Division of Mineral Resources Publication 46, 59 p.

Wilkes, G.P., 1988, Mining history of the Richmond coal-field of Virginia: Virginia Division of Mineral Resources Publication 85, 51 p.

Young, R. C., and Harnsberger, W. T., 1955, Geology of the Bergton gas field: American Association of Petroleum Geologists Bulletin 39, n. 3, p. 317-328.

FIELD TRIPS AND CONFERENCES

February 1990

February 15-20. AAAS, ann. mtg., New Orleans. Joan Wrather, AAAS, 1333 H Street N.W., Washington, D.C. 20005. Phone: 202/326-6440.

February 20-22. Society of Exploration Geophysicists, mtg., New Orleans. SEG, Box 702740, Tulsa, Oklahoma 74170-2740. Phone: 918/493-3516.

March 1990

March 5-7. Northeastern Section, Geological Society of America, mtg., Syracuse, New York. Meeting Department, Box 9140, Boulder, Colorado 80301. Phone: 303/447-2020.

March 19-21. 21st Annual Appalachian Petroleum Geology Symposium, Morgantown, West Virginia. Lee Avery, West Virginia Geological and Economic Survey, P.O. Box 879, Morgantown, West Virginia 26507. Phone: 304/594-2331.

April 1990

April 5-6. Southeastern Section, Geological Society of America, mtg., Tuscaloosa, Alabama. Meeting Department, Box 9140, Boulder, Colorado 80301. Phone: 303/447-2020.

April 22-24. Virginia Water Resources Conference, Richmond, Virginia. Elizabeth B. Grumbley, Virginia Water Resources Research Center, 617 North Main Street, Blacksburg, Virginia 24060-3397. Phone: 703/231-5624.

May 1990

May 13-18. 26th Annual Forum on the Geology of Industrial Minerals, Charlottesville, Virginia. General Chairman Palmer C. Sweet, Virginia Division of Mineral Resources, P.O. Box 3667, Charlottesville, Virginia 22903. Phone: 804/293-5121.

May 18-20. Eastern Section, National Association of Geology Teachers, ann. mtg., University Park, Pennsylvania. B.B. Tormey, Department of Environmental Sciences, Penn State University, Altoona, Pennsylvania 16601. Phone: 814/949-5272.

June 1990

June 3-6. AAPG Annual Meeting (with SEPM, EMD, and DPA), San Francisco, California. General Chairman James R. Baroffio, Chevron USA Inc., 575 Market Street, San Francisco, California 94105. Phone: 415/894-1170.

September 1990

September 10-12. AAPG Eastern Section, London, Ontario, Canada. General Chairman Robert A. Trevail, c/o Telesis Oil & Gas, 733 Exeter Road, London, Ontario, Canada N6E 1L3. Phone: 519/685-4350.

September 30 - October 6. Association of Engineering Geologists, ann. mtg., Pittsburgh, Pennsylvania. Pat Oshel, 1110 South Jefferson Drive, Huntington, West Virginia 25701.

October 1990

October 29 - November 1. Geological Society of America and affiliated societies, ann. mtg., Dallas, Texas. Vanessa George, GSA, Box 9140, Boulder, Colorado 80301. Phone: 303/447-2020.

NEW PUBLICATIONS

Publication 95, Coal, oil and gas, and industrial and metallic minerals industries in Virginia, 1986-1987, by Palmer C. Sweet, 33 pages with 1 map. Price: \$4.50.

Sinkholes, by David A. Hubbard, Jr., folded brochure. Free.

List of Publications and Maps, January 1990. Free.

Index to topographic and other map coverage, Virginia, folded map. Free.

POTENTIAL GEOLOGIC HAZARDS

This is the **International Decade for Natural Disaster Reduction**. A new brochure, "Sinkholes," is now available free, upon request from the Division of Mineral Resources. The brochure contains information about the cause of these subsidence features and what types of problems are associated with their existence or formation. A number of similar brochures are planned to inform the public and policy makers about the potential geologic hazards that exist in Virginia.

A bill "designed to expand the federal government's preparedness for earthquakes and promote more research into their causes" has passed the U.S. Senate (S. 1062) and will be considered by the U.S. House of Representatives, according to the American Society of Civil Engineer's January 1990 issue of ASCE News. The bill would increase funding for the Natural Earthquake Hazards Reduction Act and "calls for state-by-state study of earthquake hazards and for adoption by June 1993 of seismic design and construction standards for all buildings funded or insured in whole or in part by the

federal government." The ASCE News also mentions a pending "ASCE policy statement" which will advocate that "state and local governments and industry adopt the same more stringent codes as those that would be mandated for the federal government...the proposed policy seeks to redress the decreased level of appropriated funds for earthquake research...there is inadequate transfer of findings to those who help communities prepare for earthquakes. Little money has been available to help localities improve building codes and zoning provisions and thus improve building safety."

Prepared by David A. Hubbard, Jr.

Field Trips, Public Lands, and Secondary School Earth Science Education— Volunteer Geologists Needed

During recent months, several geologists have expressed their concerns to me that something more needs to be done by the geological profession to support secondary schools in their efforts to teach earth sciences. Indeed, the U.S. Geological Survey is in the process of facilitating a national program to this end and has started outreach programs to secondary school earth science teachers in the northern Virginia, Maryland, and Washington, D.C. metropolitan area.

The need for a better, more comprehensive understanding of earth sciences by the non-professional public is clear. A basic awareness and knowledge of one's natural environment and the processes that form the surface of the earth—the scenic landscapes, the woods, waters, mountains, and coast lines that we enjoy—enhances our quality of life. Of greater significance, however, are the environmental problems associated with ever-greater populations and ever-changing technologies that have increased man's pressures on the natural environment for resources and waste disposal. Increasingly, officials who are not highly trained in earth sciences are being asked to render decisions that affect our daily use of the earth, its waters, materials, and its atmosphere. They are confounded and befuddled by scientists, engineers, and technicians who support opposing points of view and courses of action. At all levels of government, officials are pressured by an undereducated public that is responding to concerns that may or may not be well based in fact. Do we mine or not mine? Do we dump or not dump? What about agricultural chemicals and fertilizers, the fumes from automobiles and power plants, noxious chemicals from other industrial plants? How much can we tolerate in our environment? Is our groundwater clean and safe to drink? Where will we build our reservoirs, roads, toxic waste sites? Do we support nuclear power or the burning of fossil fuels? How long will our resources last; what will we do when they are depleted? What should we give up to ensure that future generations will have a natural world to enjoy? And much, much more....

Postmaster:
Send address corrections to:
Virginia Division of Mineral Resources
Box 3667
Charlottesville, VA 22903

Virginia Minerals
Second-class postage paid at
Charlottesville, Virginia
ISSN 0042-6652

Many of these decisions will be made by the generation currently in school or by the one to follow early in the next century. Of necessity, these decisions must be good. What then, in a small way, can we in the geologic professions do as individuals to enhance the education of our young people and the efforts of their teachers toward that end? Perhaps Byron Cooper's concept of the "Great Outdoor Laboratory" is the key. Public lands abound everywhere across Virginia, parks and forests, supported and maintained by localities, the Commonwealth, and the federal government. In general, these lands are great places for field trips. They are safer than roadcuts along busy highways; and in general, they are large enough to contain several geology-related features, if only a flood plain, imbricated stream gravels, residual and transported soils, and all sorts of construction materials, such as stone, brick, road gravel, and the aggregate in a blacktop mix. Great outcrops, lofty peaks, scenic vistas, and exotic minerals are nice, but not necessary for an educational guide. What is

needed are well written and illustrated guidebooks with good descriptions and questions that direct students toward making observations, collecting data, and making reasonable interpretations of the geological phenomena observed at the locality selected. The users, the earth science teachers, should be involved from the start, or certainly before the guide is written in final form. The manuscripts should be made so that they can be easily and cheaply copied by the teachers.

If any geologist is interested in supporting their earth-science teachers by preparing a geologic guide to publicly-owned lands in their locality, we will be happy to assist by providing information from our files, publications, and maps. Also, please let us know your projects so that we can advise others if there is a potential for redundancy. And, when you are finished send us a copy of your guidebooks for our information and files.

Prepared by Robert C. Milici, State Geologist