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AERIAL PHOTOGRAPHS IN VIRGINIA

H. Michael Penley

When a region is viewed from an altitude of several thousand feet, the observer can imagine that he is looking down at a large map (Figure 1). Rivers, mountains, and seacoasts are especially outstanding. Streams appear as smooth, winding ribbons; railroads are easy to trace; and towns are easily recognizable by their form. Highways, especially those made of concrete and other light-colored material, are plainly visible. The difference between cultivated fields and other features such as forests is quite conspicuous. Features in cities and towns such as manufacturing centers, street layouts, and arterial road networks are strikingly visible. Other features of the earth's surface such as marshes, forests, large rock outcrops, and many lesser details can be recognized. These are only a few of the features recorded on aerial photographs.

The first aerial photographs in Virginia were taken of the Richmond area in 1862 from a balloon. Since then, the U. S. Coast and Geodetic Survey, the U. S. Geological Survey, branches of the Armed Forces, and private organizations have done vast amounts of research to perfect the quality of aerial photographs and to develop new instruments and techniques for utilizing them. Generally, aerial photographs are of two kinds depending on whether they are taken with the camera pointing vertically or obliquely downward from the airplane. Most of the coverage in Virginia is the vertical type and is at a scale of about 1:20,000; one unit of length on the aerial photograph represents 20,000 of the same units on the ground.

Aerial photographs can be used for many purposes. Geologists study them in order to obtain information about structural features, rock types, and mineral deposits. The aerial photograph offers great advantages for interpreting the regional

Figure 1. Aerial view of Woodstock, Virginia and adjacent area. The meandering North Fork of the Shenandoah River flows from southwest to northeast.

aspects of geomorphology, stratigraphy, and structural geology. Land-form types, as well as drainage patterns, can be seen. Information about the relationship of topography and drainage to the materials of the earth's surface can be derived from the study of photographs.

The hydrologist uses aerial photographs as an aid in studying surface conditions that influence or control the effects of rainfall. Data can be obtained from them to aid in flood control and erosion prevention. Information from photographs can be used to locate adequate supplies of surface water for agricultural, commercial, and industrial purposes and to increase the yield of water from a given watershed. Careful examination of aerial photographs can reveal the locations and trends of fracture zones or faults that may be water bearing, and can be of help in determining the availability of recharge to a given well site. Water runoff, storage, and supply can be estimated from the study of drainage patterns, size of stream channels, and locations of springs and seepage areas.

Aerial photographs have become a vital tool in the prediction and solution of engineering problems. Engineers study physical characteristics of the earth's surface such as drainage, vegetation, erosion, and land use to better evaluate sites for large projects. Knowledge of the proximity to water, electric-power sources, and construction aggregate is essential for the selection of sites for major projects such as large dams, airfields, railways, pipelines, tunnels, harbors, quarries, and industrial plants. City and county governmental agencies use aerial photographs to determine which areas are most suitable for industrial, commercial, and residential development. The location of streets, sewers, and water lines is aided by noting the type of topography as shown on photographs.

Data from aerial-photograph interpretation is very useful in the field of forestry. It can be used in classifying forest stands, planning of reforestation, timber inventory, and wildlife management. Aerial photographs are used to assess damage due to fire, flooding, and insects. Timberland appraisals are also made from photographs for the assessment of property taxes in forested areas. Forest roads and fire trails can be seen on aerial photographs.

Limitations, as well as advantages, of aerial photographs should be considered. It is difficult to derive an exact position on a photograph because of radial distortion; the scale around the edge of a photograph is not exactly the same as the scale in the center. Because of this, precise distances and directions cannot be obtained. Many features may not be visible due to covering shadows, the presence of dense vegetation, and small photo scale.

A stereoscope is useful in interpreting aerial photographs. It consists of two lenses held together by a metal framework that usually can be adjusted to the distance between the user's eyes. With a stereoscope, the observer, by viewing two images of the same object on two photographs taken from slightly different positions, can see the landscape in three dimensions (Figure 2). The lenses in the stereoscope magnify the image, and there is some vertical exaggeration to the relief. For most modern photography, flight lines are planned so that there will be enough overlap of photographs to ensure stereoscopic coverage.

There are many qualitative characteristics of photographic images that the viewer must be aware of to understand and use aerial photographs. The relative positions of objects can be of great value in identifying them. An object can be distinguished by its proximity, or remoteness, to other known objects. Shades of black and white on photographs are indicative of soil conditions, season, and flight altitude. Shapes and sizes of objects can be used in their identification.

Proficiency in photographic interpretation in a certain area can be improved by comparing fea-

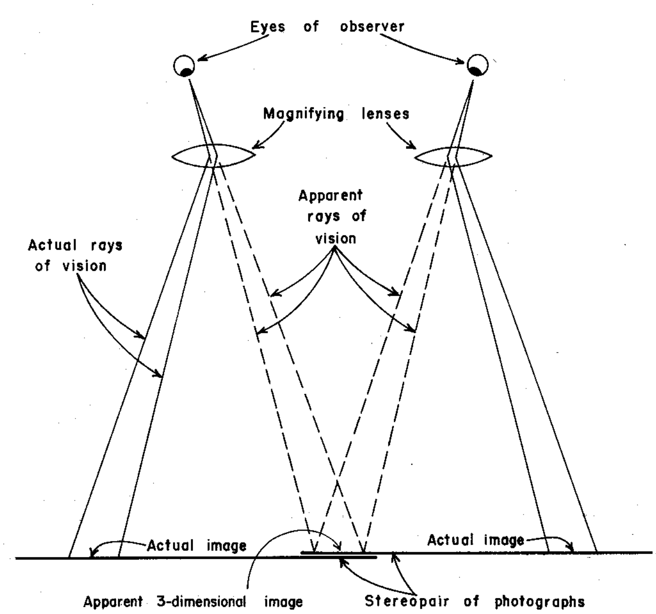

Figure 2. Principle of the stereoscope.

tures on photographs with the same features on the ground. The knowledge of how common natural and artificial objects appear on photographs is of value in their interpretation. Many objects can be readily identified (Figure 3). Improved roads are generally wider than unimproved roads, and have fewer and wider curves. Oiled or asphalt roads appear darker than those surfaced with gravel or concrete. Old concrete roads are darker than new ones. Railroads are generally prominent and are characterized by long straight segments, and by gentle curves. They may be distinguished from roads, in most cases, by the absence of junctions and intersections. A single photograph may

Figure 3. Vertical aerial photograph illustrating natural and man-made features in the Front Royal, Virginia area: 1, island; 2, 3, fence lines; 4, river flood plain; 5, parking lot; 6, underpass; 7, unimproved road; 8, industrial site; 9, baseball diamond; 10, orchard; 11, deciduous trees; 12, hard-surfaced road; 13, river; 14, evergreen trees; 15, subdivision; 16, bridge; 17, school. Scale, about 1:20,000.

The U. S. Forest Service has available aerial photographs of some forested areas in Virginia. The George Washington National Forest was photographed in 1964, and the Jefferson National Forest was photographed in 1965. These photographs are at a scale of about 1:15,840 and are used by professional foresters in classifying forest stands and types, and in planning reforestation.

The Tennessee Valley Authority has made aerial photographs of the watershed of the Tennessee River, a portion of which is in southwestern Virginia. This coverage is vertical, black and white, and has a scale of about 1:24,000. These photographs have been used in the preparation of topographic maps, and some of them date back to the 1930's.

Aerial photographs that have been taken by the U. S. Coast and Geodetic Survey are primarily restricted to the seacoast. Varied scales from about 1:10,000 to 1:40,000 are available. The Coast and Geodetic Survey occasionally uses infrared photography for waterline surveys. On these photographs, water appears black, and there is a sharp line of demarcation between land and water areas. This type of coverage is useful for nautical charting. A limited number of color photographs have been recently taken of parts of the James River by this agency.

In most cases aerial photographs can be ordered from regional offices of the agencies for which they were made. Order forms and price lists are provided by each individual agency. The roll number, print number, and project symbol, which are required for completion of the order forms, can be derived from photographic indices for the area of interest. Photomosaics, or assemblages of photographs that have been pieced together to show a large area, and enlargements of individual prints are also available in some instances. The U. S. Geological Survey Map Information Office, Washington, DC 20242 should be consulted for additional information concerning these and other sources of aerial photographs.

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NEWS NOTES

Hercules Incorporated of Wilmington, Delaware, has announced the proposed construction of a lightweight aggregate plant near Snowden, Amherst County. The multimillion-dollar facilities are expected to be in operation by mid-1970, and will provide lightweight aggregate for use in building blocks and ready-mix concrete. Slate will be quarried at the site, crushed to proper size, and expanded in rotary kilns to produce a lightweight aggregate that is ready for grading and shipping to consumers. This operation will be located in an area where slate was quarried in the 1800's and early 1900's, primarily for roofing purposes. Hercules Incorporated also operates an iron-oxide pigment plant and mines at Hiwassee and an iron-oxide plant at Pulaski, in addition to other industrial facilities in Virginia.

The Port Royal Sand and Gravel Company has begun production at a site near Woodford, Caroline County. The company produces concrete and masonry sand and general purpose sand and gravel.

Vulcan Materials Company, Mideast Division, reopened their quarry near Richpatch, Alleghany County, in late 1968. Limestone from the quarry will be used in the production of crushed stone and riprap, primarily for highway construction.

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EXCHANGE SERVICE ANNOUNCED

The following notice appeared in the March 1969 issue of the ESCP *Newsletter* and is here reprinted, in part, to inform teachers of the availability of a means to procure rock and mineral specimens.

"Elementary and secondary school teachers interested in swapping rocks, minerals, and other earth science curriculum materials are hereby notified that a clearinghouse for earth science materials exchange has been established in Arlington Heights, Illinois.

To take advantage of this free, volunteer service, send a list (with quantities) of minerals, rocks, fossils or other geological materials *you want,* and a list (with quantities) of materials *you can swap,* to Charles A. Wall, Science Department, South Junior High School, 301 West South Street, Arlington Heights, Illinois 60005. Be sure to enclose a stamped, self-addressed envelope with your request.

You will be supplied with the names and addresses of people who can supply your needs on a swap basis."

portray terrain so flat that stream channels are not easily seen, but generally the banks or erosional remnants of drainage features can be recognized. Streams generally appear dark, and sand and gravel along dry stream courses are light colored. The appearance of bodies of water depends upon the relative positions of the sun and the camera at the time of exposure. Light rays from the sun are largely reflected by the surface of the water. If the camera is in line with the reflected rays, the water will appear light. If the camera is not in line with the reflected rays the water will appear dark. Shadows may indicate the relative shape and size of an object, especially the vertical dimensions. The tonal shade of an object may blend with the surrounding landscape, while its shadow may stand out in contrast. Woods usually appear as dark patches with a fine grape-like texture. Tall grass with its long shadows appears darker than short grass; a part of a field of hay or grain that has been cut will appear lighter than an uncut part. A smooth surface such as a barren hillslope is a good reflector of light and usually appears in a light tone. Fences appear as straight lines between cultivated plots or adjacent grazing fields that have different tones.

Most of the aerial photographs available for areas in Virginia have been produced by six agencies: the U. S. Geological Survey; the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service; the U. S. Department of Agriculture, Soil Conservation Service; the U. S. Forest Service; the Tennessee Valley Authority; and the U. S. Coast and Geodetic Survey.

Aerial photographs taken by the U. S. Geological Survey are used in the basic preparation of modern 7.5-minute topographic quadrangle maps. At the present time photographs are available for about 90 percent of Virginia (Figure 4); most of these are vertical and have a scale of about 1:20,000. They are very useful to earth scientists and engineers because they are taken at periods of minimal foliage when details of the earth's surface are not masked by vegetation.

The U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service has aerial photographs of most of the State; counties for which coverage is not available are Alleghany, Bath, Bland, Craig, and Giles. These photographs are black and white, vertical, and have a scale of about 1:20,000; most of them are relatively recent. Their primary application is in crop control, and they are especially useful to the agriculturist because they are flown in the summer when a maximum amount of foliage is visible.

The U. S. Department of Agriculture, Soil Conservation Service has a limited amount of photographic coverage for Virginia. All of these photographs have a scale of about 1:20,000 and were taken during the years of 1943, 1953, and 1954. They are used mainly by conservationists, soil scientists, and engineers who are concerned with soil and water conservation.

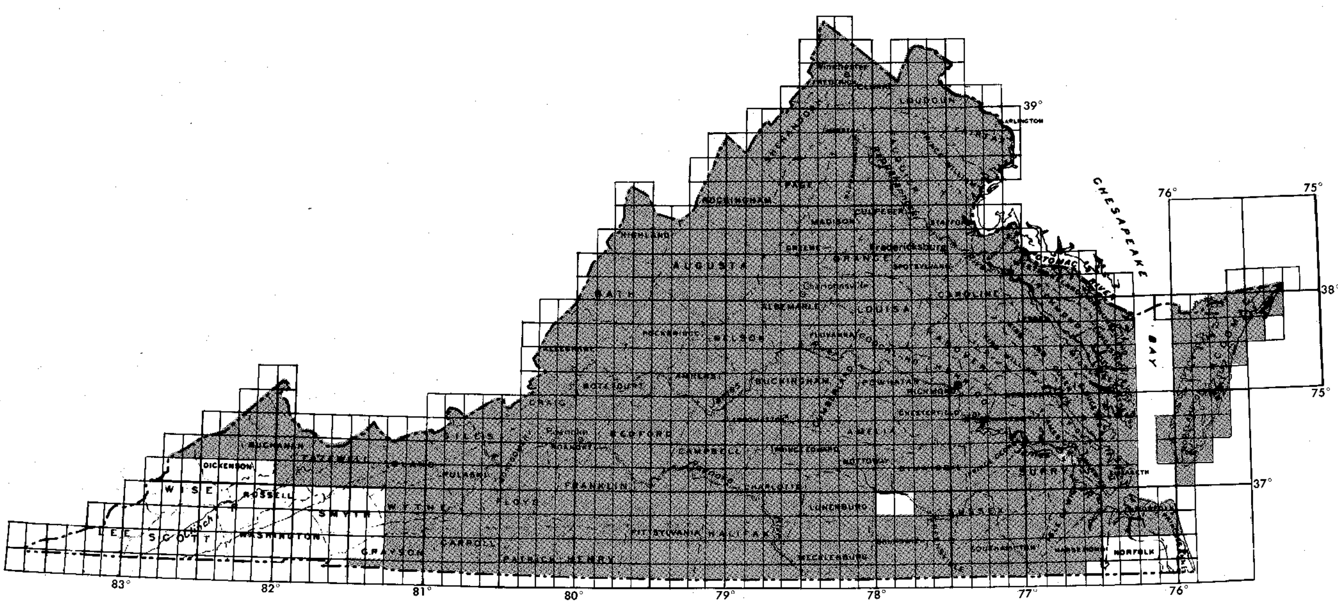

Figure 4. Shaded areas represent current aerial-photograph coverage in Virginia available from the U. S. Geological Survey.

OIL AND GAS DEVELOPMENT IN VIRGINIA DURING 1968

David M. Young[1]

Natural gas production in Virginia during 1968 amounted to 3,388,788 Mcf (thousand cubic feet), compared to 3,827,447 Mcf produced during 1967. Production in Buchanan County was 907,900 Mcf; Dickenson County, 507,867 Mcf; Tazewell County, 1,963,215 Mcf; and Wise County, 9806 Mcf. Oil production in Lee County totaled 2583 barrels, a decrease of 908 barrels from the previous year. During 1968 five wells were drilled in Virginia, accounting for a total of 16,641 feet.

In Bath County, Pennzoil United, Inc., drilled their No. 1 John L. Lawrence test about 5 miles north of Millboro Springs. This test was abandoned as a dry hole at a depth of 405 feet.

A total of 907,900 Mcf of gas was produced in Buchanan County as follows: Ashland Oil and Refining Company, 684,568 Mcf; Cabot Corporation, 54,028 Mcf; P & S Oil and Gas Corporation, 52,138 Mcf; and United Fuel Gas Company, 117,166 Mcf. There was no drilling activity in Buchanan County during 1968. However, a well that was completed in Pike County, Kentucky, 2100 feet northwest of the Buchanan County boundary, is expected to result in a renewal of drilling in 1969. This well, United Fuel Gas Company No. 9483, was drilled through the Berea sand to a total depth of 3914 feet. Zones having shows of gas in the Berea and Maxon sands were fractured in July 1968, resulting in a final open-flow of 21,507 Mcf from the Maxon sand. Four locations in Buchanan County southeast of this well are scheduled for drilling by United Fuel Gas Company in 1969.

The Clinchfield Coal Company, division of The Pittston Company, produced 507,867 Mcf of gas from 42 wells in Dickenson County. A total of 498,747 Mcf was delivered to the Kentucky-West Virginia Gas Company and 9120 Mcf was used in field operations. There was no drilling in the county during 1968.

A location in Highland County, approximately 950 feet south of 38°25′ N. and 1800 feet west of 79°20′ W., is to be drilled in 1969 by Pennzoil United, Inc. This location is on the Bertha Smith farm in the eastern part of the county and is about 35 miles southwest of the Bergton Oriskany field in Rockingham County. (Note: The well was abandoned as a dry hole at a total depth of 3980 feet in March 1969).

[1] Chief geologist, Clinchfield Coal Company, division of the Pittston Company. A. D. Crabtree, State Oil and Gas Inspector, furnished production data.

Table 1.—Summary of drilling in Virginia during 1968.

Operator	Lease	Well No.	Total Depth (feet)	Status (12-31-68)
Bath County				
Pennzoil United, Inc.	Lawrence	1	405	Dry hole
Buchanan County				
United Fuel Gas Co.	Kentland	G3623	—	Location
"	Belcher	G3624	—	"
"	Bull Cr.	G3622	—	"
"	Charles	G3625	—	"
Highland County				
Pennzoil United, Inc.	Smith	1	—	"
King George County				
J. S. C. Drilling Co.	Thompson	1	3250(?)	Dry hole
Tazewell County				
Consolidation Coal Co.	Pocahontas Fuel Co.	13	5380	Gas well
"	"	14	5466	"
Wise County				
Trans State Oil Ltd.	Riggs	1	2140	Fishing

The J. S. C. Drilling Company No. 1 E. T. & S. Thompson test was drilled near Edgehill, King George County, at a location approximately 9000 feet north of 38°15′ N. and 6850 feet east of 77°10′ W. The well was drilled to 3036 feet, and acidizing between 2926 and 3014 feet and fracturing between 2877 and 2928 feet produced no results. While the well was subsequently being deepened, the tools were lost at 3250 feet and fishing operations have been unsuccessful.

Oil production in Lee County declined to 2583 barrels in 1968. The Rose Hill field accounted for 1688 barrels, and one well in the Ben Hur field produced 895 barrels. There was no drilling in the county during the year, although two wells in the Rose Hill field and five in the Ben Hur field are shut down waiting on decisions to deepen or abandon.

Gas production from Tazewell County in the amount of 1,963,215 Mcf was reported by two operators: Consol-Ray Brothers, 1,201,426 Mcf and United Fuel Gas Company, 761,789 Mcf. Two gas wells having a total footage of 10,846 feet were completed during the year by Consolidation Coal Company.

In 1967 the Clinchfield Coal Company sold two gas wells in Wise County to the Penn Virginia Corporation for use in the area of their Wentz coal preparation plant. During the last quarter of 1967, these wells produced 1116 Mcf of gas and in 1968, a total of 9806 Mcf. One new well, the Trans State Oil Ltd. Riggs No. 1, was drilled in Wise County in 1968. The well is located 1.5 miles east of the eastern limits of the town of Big Stone Gap on the plunging nose of the Powell Valley anticline. In June 1968, the well had been drilled to a depth of 1841 feet near the top of the Trenton limestone when equipment was lost in the hole. After more than 2 months, the hole was cleared and drilling resumed. At 2140 feet more difficulty was experienced, and at the end of the year the rig was shut down. A show of oil was reported in the Clinch sandstone from 970 to 985 feet. Early in February 1969, renewed efforts were being made to recover the tools and continue drilling.

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FACTS ABOUT THE EARTH

The following information was taken from a recent news release by the U. S. Geological Survey.

The earth is at least four and one-half billion years old, according to recent estimates. Evidence for this age is contained in the rocks exposed on the earth's surface. The ages of the rocks vary widely, but, like pages in a long and complicated history, the rocks record earth-shaping events of the past such as mountain-building, cycles of erosion and deposition, and sea encroachment.

* * *

Two scales are used to date the various earth-shaping episodes—a relative time scale, based on the sequence of layering of the rocks and the slow but progressive development of life as displayed by fossils preserved in the rocks; and an atomic time scale, based on the natural radioactivity of chemical elements in the rocks.

* * *

In 1785, James Hutton, a Scottish geologist, first proposed the most fundamental principle used to determine the relative ages of rocks; the law of superposition. He proposed that wherever uncontorted layers of rocks are exposed, the bottommost layer was deposited first and is, therefore, the oldest; each succeeding layer is progressively younger.

* * *

In 1798, William Smith, an English engineer, discovered that certain layers of rocks contained fossils unlike those in other layers, and that rocks of the same age could be identified by their similar or related fossil assemblages. By combining the study of fossils (paleontology) with the study of rock layers (stratigraphy), geologists are able to match or "correlate" strata of the same age throughout a large region, and even throughout the world.

* * *

The atomic time scale of the earth's age is an outgrowth of Henri Bequerel's discovery in 1896 of the natural radioactive decay of uranium. Radioactive decay is a spontaneous process in which an atom (the parent) loses particles from its nucleus to form an atom (the daughter) of a different element. The rate of decay is conveniently expressed in terms of the atom's half-life. The atoms (isotopes) of certain elements decay slowly, and several of these are used as atomic "clocks." For example, isotopes of uranium-235 have a half-life of 713 million years; those of potassium-40 have a half-life of 1.3 billion years.

Virginia Division of Mineral Resources
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Second-class postage paid at
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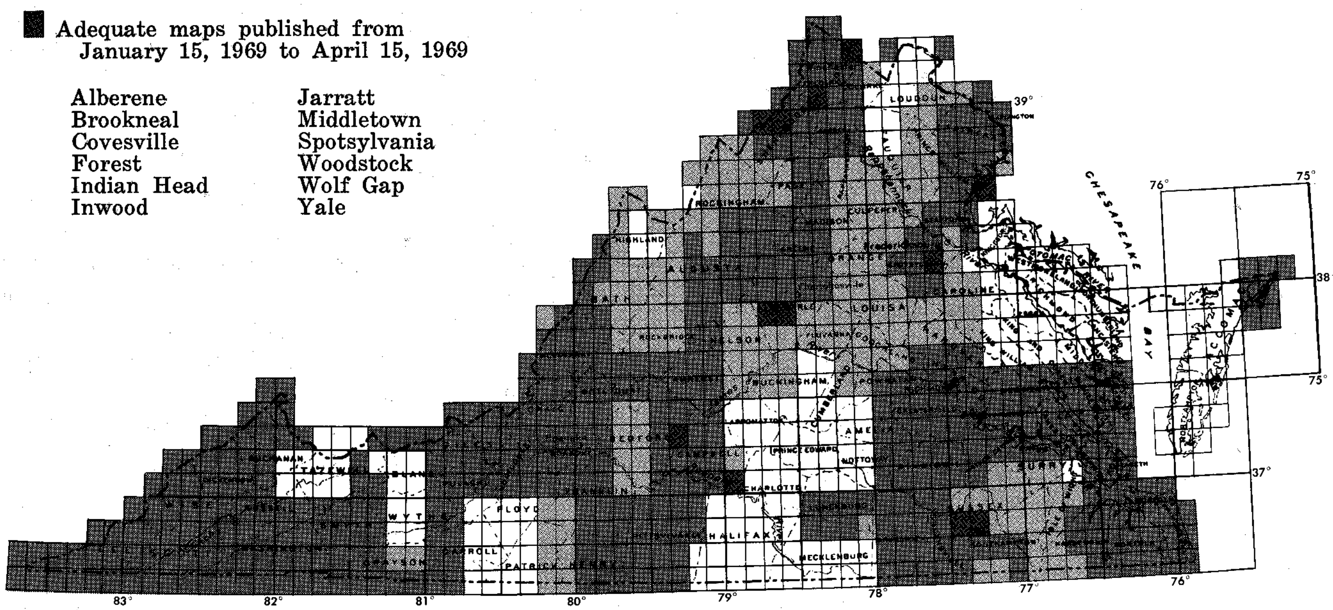
Return Requested

TOPOGRAPHIC MAPS

7.5-Minute Quadrangle Topographic Maps

- Advance prints and revision compilations
- Adequate maps published prior to January 15, 1969
- Adequate maps published from January 15, 1969 to April 15, 1969

Alberene	Jarratt
Brookneal	Middletown
Covesville	Spotsylvania
Forest	Woodstock
Indian Head	Wolf Gap
Inwood	Yale



ADVANCE PRINTS AND REVISION COMPILATIONS

Advance prints and copies of revision compilations are available at 50 cents each from the U. S. Geological Survey, Topographic Division, 1109 N. Highland St., Arlington, VA 22210.

PUBLISHED MAPS

State index is available free. Published maps are available at 50 cents each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.