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DIATOMACEOUS SEDIMENTS IN VIRGINIA

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Diatoms are microscopic unicellular or noncellular organisms that secrete a siliceous bivalve shell. The valves of most diatoms fit together in a manner similar to the two halves of a flat pill box, with a siliceous band or girdle covering the junction. The valves are composed of a hydrous silica similar to the mineral opal that has the general formula $SiO_2 \cdot nH_2O$. Present-day diatoms live under climatic conditions that range from hot to cold, in fresh, brackish, or salt waters and in such varied environments as hot springs, peat bogs, moist soil and in fresh-water pools on oceanic ice floes. At least partial exposure to sunlight is required for their existence. Certain areas, however, afford environmental conditions optimum for the growth of diatoms. The greatest abundance of living diatoms is in cold salt water, such as in the Arctic and Antarctic oceans. In these and other salt-water bodies where temperature, salinity, pH, and other factors present an ideal environment, diatoms occur in concentrations often in excess of 10 million per liter.

Apart from their ubiquitous occurrence, diatoms are unique in that they possess attributes of both the plant and animal kingdoms. They have the ability of photosynthesis, their chief plant-like characteristic, and the ability to store food reserves, their chief animal-like characteristic. Many species also have the power of independent movement. The possession of these dual abilities has led to their being assigned to the Protista, a third kingdom now recognized for microscopic unicellular organisms that exhibit both animal and plant-like characteristics. Diatoms are further classified as belonging to the phylum Chrysophyta and the class Diatomaceae. The class has over 300 genera and between 12,000 and 16,000 species.

After death, diatoms fall to the bottom of their habitat where their organic parts decompose leaving the frustules (shells) which are almost indestructible. Where conditions are exceptionally favorable over a long period of time, accumulation may reach a considerable thickness. If the deposition of other sediments such as clay, silt, sand, and chemical precipitates is slight during this process of accumulation, a very pure diatomaceous ooze may result. When consolidated, this accumulation forms the rock known as diatomite (Figure 1). The term diatomite is used by some for both the consolidated and unconsolidated varieties of the material, whereas others restrict its usage to consolidated types and employ the term diatomaceous earth for the unconsolidated equivalents (Heinrich, 1956, p. 158). Although the term diatomite implies no definite degree of purity, it is often used to denote the purer diatomaceous rocks in commercial as well as geological usage (Bramlette, 1946, p. 12-13). In this paper the term diatomite is applied to consolidated sediments composed principally of diatoms, and the terms diatomaceous mudstone or diatom-

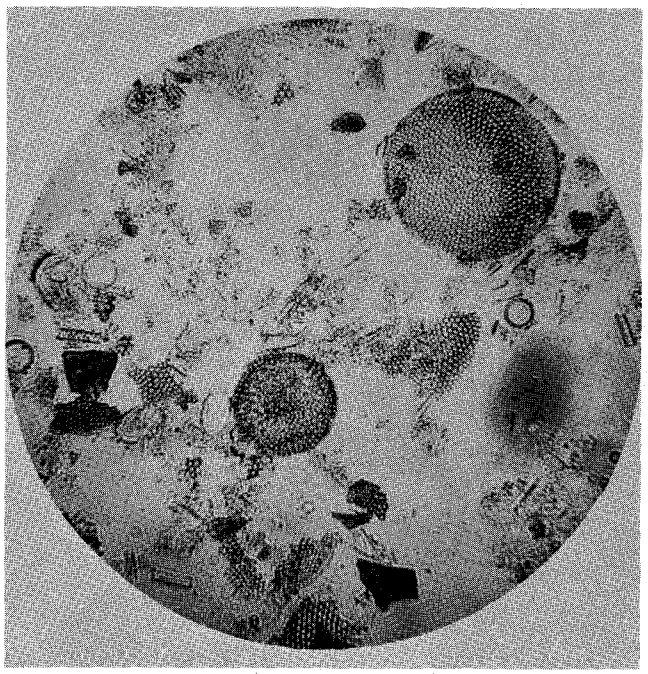

Figure 1. Diatoms from a sample collected near Oak Grove, Westmoreland County (locality R-1988). 424 X.

aceous shale to indurated sediments, the diatom content of which is less than half. Diatomaceous mud or clay is used to denote the unconsolidated equivalents of diatomaceous mudstone or shale.

Diatomite is composed of hydrous silica that, when pure, contains 96 to 97 percent silicon dioxide. The remaining percentage is water that can be driven off at temperatures between 500° and 800° C. The silica is insoluble in most acids but is readily attacked by hydrofluoric acid and caustic alkalies. Pure diatomite is white in color and has a uniform texture and a dull earthy luster. Its true specific gravity is about the same as that of the mineral opal, 2.1 to 2.2. The index of refraction is variable between 1.44 and 1.46. Diatomite is not highly indurated, and pulverizes readily to powder. The apparent density of solid diatomite ranges from 0.4 to 0.7, and the apparent density of loose powder ranges from 0.12 to 0.35. Due to the porosity of the individual diatoms, diatomite has a high power of absorption and will absorb water to the extent of 100 to 300 percent of its weight. Shrinkage at temperatures above 870° C is pronounced due to the alteration of the silica to tridymite. The fusion point ranges from 1400° to 1750° C according to purity and compactness. Impurities, of which the main ones are iron oxides, alumina, lime, magnesia, and organic matter, cause variations in the chemical and physical properties.

The porosity, low apparent density, and chemical inertness of diatomite make it particularly suitable for use as a filter aid, a filler, and in insulating material. The properties peculiar to diatomite are such that few substitutes are suitable. Petkof (1964, p. 490) gives the following approximate breakdown of uses for diatomite in the United States in 1963: filtration, 47 percent; fillers, 23 percent; insulations, 5 percent; and miscellaneous uses, 25 percent.

The major use of diatomite for some 30 years has been in the field of industrial filtration. Its value as a filter medium is due to its high porosity. The open structure of the diatoms allows free passage of the filtrate and at the same time holds back the minute particles, providing clarification and purification of the liquid. A large market exists for diatomite as a filter aid in the chemical and process industries, as well as in the sugar refining, brewing, beverage, dry-cleaning, drug, and metallurgical industries.

The use of diatomite as a filler is due to its high power of absorption combined with its inert qualities. Major filler uses in the order of present importance are in protective and decorative coatings (paints, varnishes, lacquers), paper, insecticides, plastics, asphaltic compositions, and fertilizers. It is also used in printing inks, sealing compounds, explosives, matches, dental investures, and for other miscellaneous filler uses.

Diatomite makes an excellent insulating material. Each microscopic frustule is essentially a closed air space and the individual particles, broken or unbroken, reduce the transfer of heat by convection. Because the particles pack very loosely, the loss of heat by transmission is low. Diatomite is used in the production of insulation materials in the form of bricks, blocks, cements, powders, and aggregates. Other important uses of diatomite are as an absorbent, mild abrasive, source of reactive silica, catalyst carrier, and in various structural materials such as lightweight aggregates, plasters, cements, mortars, and stucco. The material is marketed for hundreds of other minor uses.

The total world production of diatomite in 1963 was 1,610,000 short tons (Petkof, 1964, p. 490-491). Production in the United States, reported by 13 companies, accounted for 482,202 short tons. California led all states producing diatomite with production from mines located in the marine Tertiary deposits in the Lompoc area of northern Santa Barbara County. Nevada

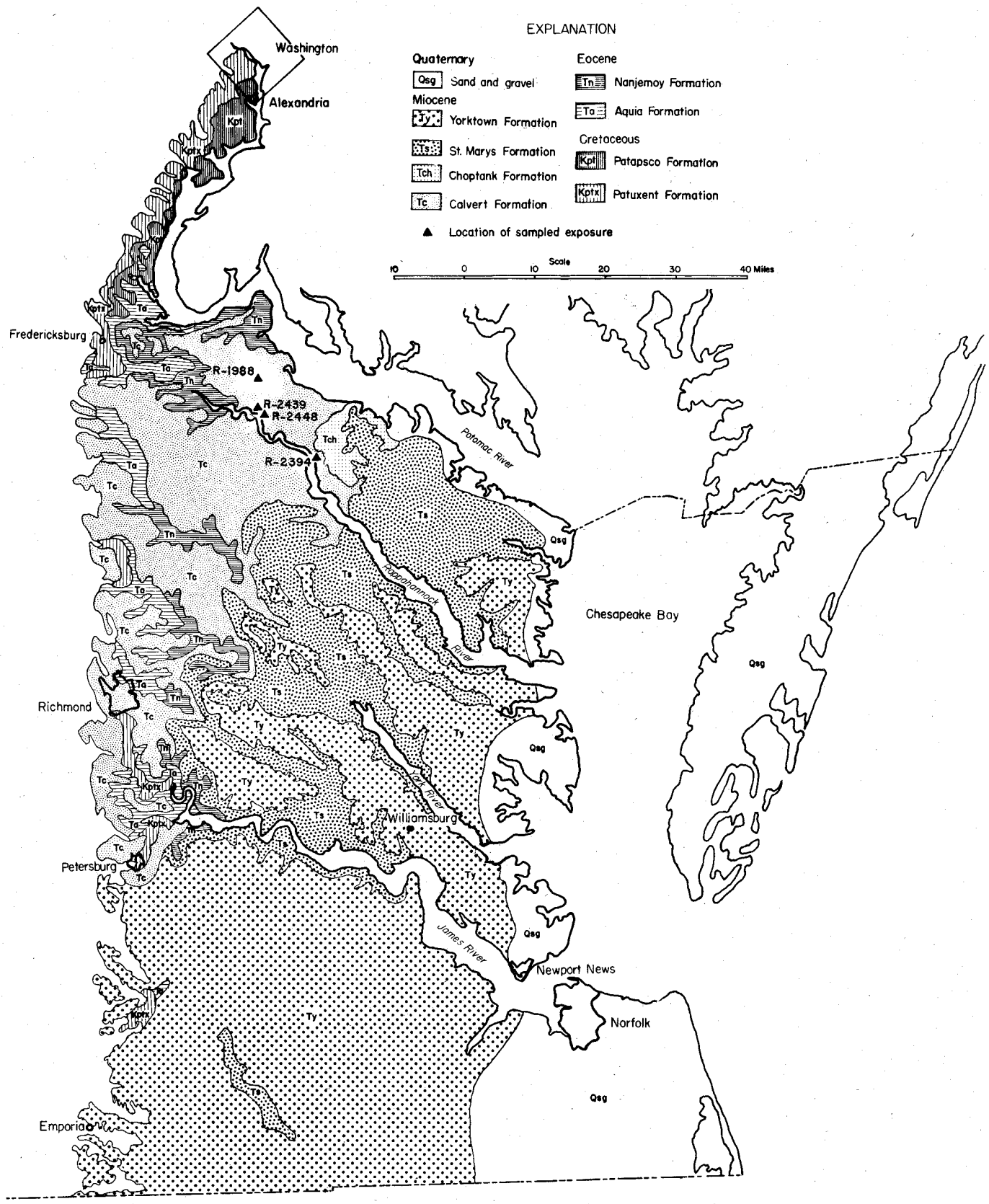

Figure 2. Generalized geologic map of the Coastal Plain in Virginia showing locations of sampled exposures.

ranked second, and small quantities were reported mined from Washington, Maryland, Arizona, and Oregon. The average price per ton obtained from diatomite during 1963 was: filtration, $62.62; insulation, $49.91; and abrasives, $137.00. Imports of diatomite into the United States during 1963 were negligible.

Diatom-bearing beds or deposits in Virginia are of marine origin and occur in the Calvert Formation of middle Miocene age. In Virginia the Calvert underlies the western portion of the Coastal Plain from the Potomac River southward to the James River (Figure 2). The formation consists largely of compact, sandy, diatomaceous mudstone that is dark greenish-gray or white to buff, where weathered. At some localities the mudstone grades vertically into fine-grained buff sands, or into diatomite beds that resemble buff chalk. Throughout most of its extent in Virginia, the Calvert Formation unconformably overlies the Nanjemoy Formation of Eocene age which is composed largely of fine-grained glauconitic sands. However, in the James River basin the Calvert oversteps the Nanjemoy and rests on the Aquia Formation of Eocene age which is composed primarily of medium- to fine-grained glauconitic sands that are fossiliferous, compact, and slightly argillaceous. Farther to the south the Calvert Formation oversteps the Aquia and near Petersburg is in contact with Patuxent sediments of Cretaceous age. In some places along its western margin the Calvert Formation overlaps igneous and metamorphic rocks (Clark and Miller, 1912, p. 126). The Choptank Formation, composed of fine-grained yellow quartz sand, bluish-green sandy clay, and slate-colored clay, which locally form ledges of indurated material, rests unconformably on the Calvert. Exposures of the Choptank Formation are present in a small area in Richmond and Westmoreland counties. The Calvert Formation has a general north-south strike and an easterly dip of approximately 10 feet to the mile. The formation has a maximum thickness of about 150 feet.

Prominent exposures of the Calvert occur in almost vertical cliffs along the Potomac (Figure 3) and Rappahannock rivers (Figure 4). At some locations the cliffs are nearly 100 feet in height. The buff to white diatom-bearing strata in these exposures constitute the most outstanding feature of the Calvert. Other excellent exposures occur along the Mattaponi and Pamunkey rivers and their tributaries west of West Point, in outcrops within the city limits of Richmond,

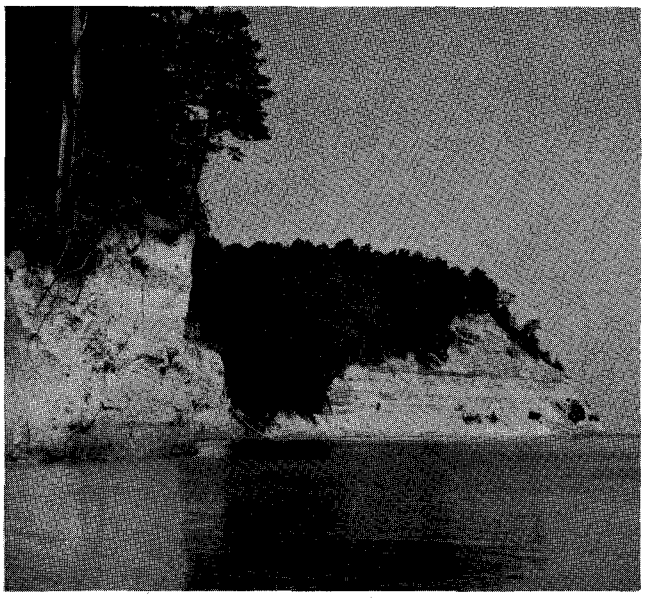

Figure 3. Calvert Formation exposed along Potomac River at the eastern end of Horsehead Cliffs, Westmoreland State Park, Westmoreland County.

and in and around Petersburg. The diatomaceous rocks near the Rappahannock River have a higher diatom content and less clay and other impurities than do the strata in the Richmond-Petersburg area. Locally the material has been called "Bermuda earth" for its occurrence at Bermuda Hundred on the James River, and "Richmond earth" because of its exposure within the city limits of Richmond.

The production of diatomaceous rocks in Virginia has been on a small scale. Until the early

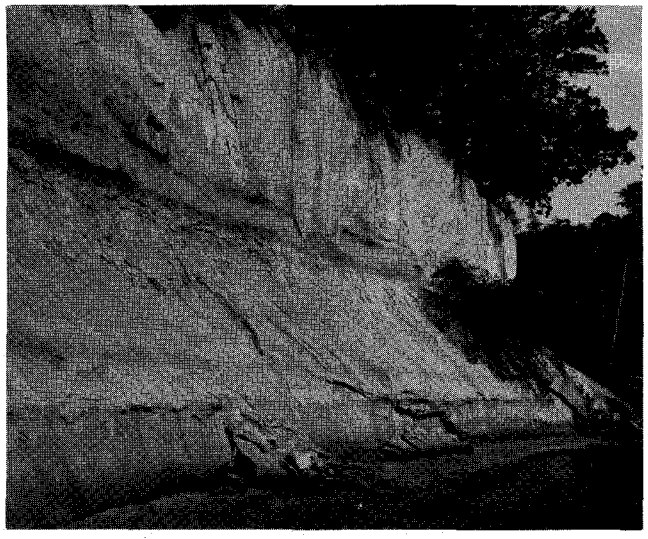

Figure 4. Exposure of Calvert Formation in bluff along Rappahannock River just east of Carters Wharf, Richmond County. Near locality R-2394.

1900's, the microscopic remains of diatoms were incorrectly regarded by investigators as "Infusoria," and diatomaceous deposits were commonly referred to as "Infusorial earth." The U. S. Geological Survey publication, "Mineral Resources of the United States," for 1900 lists no production for that year, but states that "Infusorial earth" had been mined in past years in Virginia. The annual volume for 1901 of the same publication states: "In King George County Virginia, near Wilmont, on the Potomac River [*sic.*], a deposit of infusorial earth is being opened up which is reported to be of a horizontal bed 16 to 30 feet thick and exposed for 1000 feet along river. A considerable part of the material mined is to be used in the manufacture of hollow, furnace, and building brick and an infusorial-earth plastic asbestos cement." The 1902, 1903, and 1904 volumes of "Mineral Resources of the United States" indicate an active production of diatomaceous rocks in the State for these years; Virginia is listed as ranking second in domestic production of diatomite in the year 1903. Records of the Virginia Division of Mineral Resources indicate that "diatomaceous earth" or "infusoria" was mined in King George County by the Vulcan Fire Brick Company of Baltimore, Maryland, during the years 1910, 1911, 1912, 1913, and 1915; by the Quigley Furnace Specialties Company, Inc. of New York City, during 1918; by the Refractory Products Corporation of New York City, during 1921 and 1922; and by the American Diatom Corporation of Virginia, Philadelphia, Pennsylvania, during 1929, 1930, 1933, and 1934. No production of diatomite has been reported in Virginia since 1934.

All past mining of diatomaceous rocks by these companies is recorded as being from Wilmont (Wilmont Wharf), King George County, where a brick plant and other processing facilities were located. However, field investigation reveals mining of the material at other locations along the Rappahannock River in addition to the operation at Wilmont Wharf. Mr. J. Cleveland Grigsby, owner of the Bristol Farm which fronts on the Rappahannock River near Wilmont Wharf, recalls mining activity on his farm as early as 1893. He stated that "diatomaceous earth was removed from the bluffs along the river by driving long poles or wedges into the formation from atop the cliffs and hammering against them to topple the material to the river's edge. It was then carried a short distance by barge to Wilmont Wharf where it was stored in racks for drying." Similar mining operations were performed at various other locations down-river from the plant facilities. Production records do not indicate what products were manufactured from the diatomaceous rocks by the aforesaid companies or the refined state of the material when marketed. Ries (1906, p. 143-144), however, indicates that the most important use of the material was as an abrasive. He states that it was also used with asbestos for the manufacture of boiler coverings and as an absorbent for nitroglycerine in the manufacturing of dynamite. Some was mixed with Pleistocene clay for use at the Wilmont Brick Plant in the manufacture of fire-proofing, boiler brick, and front brick (Ries, 1906, p. 138-139). Watson (1909, p. 101) states that "diatomaceous earth has been dug from time to time in the vicinity of Richmond for commercial use." No records could be found regarding the location where the material was mined or the uses to which it was put.

Due to the inherent impurities, which are primarily clay and sand, the diatomaceous rocks in Virginia are considered by commercial producers of diatomite as unsatisfactory for many of the diatomite products competitive on the current market. A major West Coast producer of diatomite made evaluations for the Virginia Division of Mineral Resources of crude diatomaceous mudstone samples collected from localities R-1988, R-2394, R-2439, (Figure 1) and one sample of diatomaceous mudstone from near Dunkirk, Maryland. Their laboratory tests on the crude earths indicated that all of the samples possess apparent wet densities in the range of 24 to 30 pounds per cubic foot and low G. E. brightness, between 23.5 to 52.0, which would limit the material for several filler applications where color is a factor. Except for the presence of the deleterious clay and quartz sand, the material may otherwise be suitable for most commercial uses. Significant in this respect, is the research that Norman and Ralston (1939) performed on diatomaceous mudstones at the Non-metals Division, U. S. Bureau of Mines, College Park, Maryland. Laboratory studies at the Bureau resulted in the development of a satisfactory froth-flotation process for purifying the usual low-grade rocks of the Miocene beds of Virginia and Maryland. Crude diatomaceous mudstone from near Dunkirk, Maryland, which was composed roughly of one-third each of clay, quartz sand, and diatoms, was used as the raw material. Separation of the material by froth-flotation yielded 32.2 percent sand, 36.4 percent

clay, and 31.3 percent diatoms by weight. The laboratory method was later tested in a small pilot plant set up at a typical low-grade diatomaceous mudstone deposit at Lyons Creek Wharf, Maryland, which produced 12 to 15 tons of high-grade diatomite. The relatively high cost of transporting diatomite from producing localities in the Western United States to eastern consumers makes development of eastern deposits desirable. The savings realized in the freight differential may offset the costs of more elaborate beneficiation processes.

The following descriptions are of exposures that are typical of the diatom-bearing beds observed in the Calvert Formation between the Potomac and Rappahannock rivers, an area commonly referred to as the "Northern Neck." The locations of the exposures are shown on Figure 1. Detailed sections in this area are described by Clark and Miller (1912, p. 129-135).

Locality: R-1988 *County*: Westmoreland

Trench dug down a bluff along Mattox Creek, located approximately 2.5 miles northwest of Oak Grove, 0.5 mile south of State Road 657.

Topographic map location:

Rollins Fork quadrangle (7.5 minute series)

Sampled exposure is located at lat 38° 12′ 17″ N. and long 77° 2′ 39″ W.

Property owner:

Chesapeake Company, West Point, Virginia

Lithology	Thickness in Feet
(Top of trench)	
Pleistocene (?)	
Sand, yellowish, grades from fine- to coarse-grained quartz; alternates with clay (estimated)	16
Miocene (Calvert Formation)	
Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand; less than 5% diatoms	4
Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand; estimated 20% diatoms	6
Diatomite, buff; contains fine-grained quartz sand; estimated 60% diatoms	4
Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand; estimated 15% diatoms	8
Bottom of trench (near elevation of Mattox Creek)	
Total	38

Locality: R-2394 *County*: Richmond

Bluff on north bank of Rappahannock River, 0.9 mile south of Carters Wharf.

Topographic map location:

Champlain quadrangle (7.5 minute series)

Sampled exposure is located near lat 38° 3′ 29″ N. and long 76° 55′ 1″ W.

Property owner:

Mr. J. W. Roberts, P. O. Box 9138, Richmond, Virginia

Lithology	Thickness in Feet
Miocene (Calvert Formation)	
Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand; estimated 20% diatoms	11
Clay, brown; contains medium-grained quartz sand; grades into diatomaceous mudstone above and diatomite below (estimated)	11
Diatomite, buff to white; contains fine-grained quartz sand; estimated 60% diatoms	6
Diatomaceous mudstone, tan; contains fine-grained quartz sand; estimated 40% diatoms	4
Diatomaceous mudstone, buff; contains fine-grained quartz sand mottled with yellow ocherous clay; estimated 20% diatoms	6
Sand, greenish-gray when wet, very fine-grained, argillaceous; contains a trace of glauconite	2
Bottom of bluff	
Total	40

Locality: R-2439 *County*: King George

Bluff on north bank of Rappahannock River, 350 feet west of the King George-Westmoreland county line.

Topographic map location:

Rollins Fork quadrangle (7.5 minute series)

Sampled exposure is located at lat 38° 9′ 46″ N. and long 77° 3′ 48″ W.

Property owner:

Mr. J. Cleveland Grigsby, Bristol Farm, Rollins Fork, Virginia

Lithology	Thickness in Feet
Top of bluff (near 120 foot contour)	
Pleistocene	
Clay, sand, and gravel (estimated)	30
Miocene (Calvert Formation)	
Clay, buff; contains fine- to medium-grained quartz sand	40

Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand and minor amount of feldspar; estimated 5-10% diatoms	16
Diatomite, buff to white; contains fine-grained quartz sand and minor amount of feldspar; estimated 50-60% diatoms	16
Diatomaceous mudstone, buff; contains fine- to medium-grained quartz sand; estimated 20% diatoms	2
Mudstone, buff; contains fine- to medium-grained quartz sand	8
Sand, dark-tan, fine- to medium-grained	3
Bottom of bluff	
Total	115

Locality: R-2448 *County*: Westmoreland

Bluff on north bank of Rappahannock River, 1400 feet east of the King George-Westmoreland county line.

Topographic map location:

Rollins Fork quadrangle (7.5 minute series)

Sampled exposure is located at lat 38° 9′ 39″ N. and long 77° 3′ 31″ W.

Property owner:

Mr. Paul Schadell, P. O. Box 1, Oak Grove, Virginia

Lithology	Thickness in Feet
Miocene (Calvert Formation)	
Sand, grayish-brown, very fine-grained, well-sorted	2
Sand, tan, argillaceous, very fine-grained, well-sorted	4
Sand, brown, argillaceous, fine-grained, well-sorted; contains minor mica and minor amounts of bladed gypsum near top; alternates with grayish-brown sand having similar character	16
Sand, light-gray to gray with greenish cast, argillaceous, fine-grained, well-sorted; contains some phosphatic material and mica; less than 5% diatoms	6
Diatomaceous clay, light- to medium-gray with greenish cast, slightly silty and micaceous near top; estimated 15-25% diatoms	4
Diatomaceous clay, light- to medium-gray with greenish cast; less than 10% diatoms	8
Sand, gray with greenish cast, argillaceous, fine-grained	2
Bottom of bluff (near high-tide line)	
Total	42

The contact between the Nanjemoy and Calvert formations at this locality (R-2448) is not well exposed but may be at the top of the lowermost sand; no glauconite was present in samples of this sand. A better exposed, but relatively inaccessible, outcrop of Calvert is present in steep bluffs just down-river from this locality.

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News Notes

The pit and plant facilities of Carroll Rock Company located near Steeles Tavern, Augusta County, were acquired in May 1965 by Southwest Materials, Inc., Salem, Virginia. The new owners will continue to mine and process gravel for aggregate purposes.

The Holston River Quarry, Inc. is operating a quarry in limestone near Blacklick, Wythe County. The company is utilizing a portable plant to produce crushed stone for use in road construction and other purposes.

A world-record shipment of coal left Hampton Roads on May 29, 1965, aboard the first of a new class of supercolliers. The Norwegian vessel, Sigtina, bound for the Netherlands, carried about 72,000 net tons of coal that had been loaded at the Lambert Point facility in Norfolk. The shipment exceeded by almost 20 percent the previous record of 61,474 tons for any single ship. The vessel, which is 796 feet long and 105 feet wide and draws about 40 feet 4 inches of water, sailed at high tide in order to clear the bottom of the channel which is listed as 40 feet deep. Even larger ships are to be built in the future for coal-hauling purposes.

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MARTINSBURG FORMATION IN WEST-CENTRAL VIRGINIA

E. K. Rader[1] and J. J. Ryan[2]

The Martinsburg Formation of Middle and Late Ordovician age was originally named Martinsburg shale for outcrops in the vicinity of Martinsburg, West Virginia (Geiger and Keith, 1891, p. 161). At the type locality the Martinsburg Formation is considered to be Trentonian age (Twenhofel and others, 1954, p. 276), but in west-central Virginia the formation consists additionally of beds that are Edenian and Maysvillian in age.

In west-central Virginia six stratigraphic sections were measured (Ryan, 1963). In each of sections 2, 5, and 6 the outcrops represent at least 75 percent of the formational thickness; section 1, approximately 60 percent; and sections 3 and 4, less than 50 percent (Figure 5). Sections 3 and 4 are used primarily for correlation of the Maysville Member. The rocks weather rapidly and generally do not form continuous outcrops.

The Martinsburg is divided into three members: the Trenton, Eden, and Maysville. Lithologically, the boundaries between members are transitional. The Martinsburg ranges in thickness from 1600 feet on Monterey Mountain in Highland County (Figure 6, section 1) to 1360 feet on Catawba Mountain in Roanoke County (Figure 6, section 6), and to 1210 feet at Cliff Dale Chapel in Alleghany County (Figure 6, section 5).

The Trenton Member of the Martinsburg Formation can be subdivided into two lithologic units. The lower unit is primarily interbedded black, dense, argillaceous limestone and calcareous shale with numerous beds of coquinoid limestone. The upper unit is black, dense, nodular or cobbly limestone interbedded with various amounts of black, calcareous shale. In Alleghany and Roanoke counties the upper unit is 160 feet thick. Toward the northeast in Bath and Highland counties there are several tongues of cobbly limestone separated by thick sequences of calcareous shale and argillaceous limestone. The lower contact of the Trenton Member is exposed only in sections 5 and 6. At Cliff Dale Chapel (section 5) the Trenton conformably overlies the Eggleston Formation, and at Catawba Mountain (section 6), overlies the Bays Formation. The thickness of the Trenton Member is 730 feet on Monterey Mountain (Figure 6, section 1), 430 feet at Cliff Dale Chapel (Figure 6, section 5), and 570 feet on Catawba Mountain (Figure 6, section 6). Most of the thinning of the Martinsburg from northeast to southwest corresponds to a thinning of the Trenton Member. The more characteristic fossils in the Trenton are the ostracodes, *Pseudorakverella altalirata* Rader (1965) and *Ctenobolbina?* sp.; the trilobite, *Cryptolithus tesselatus;* and the "hemispherical bryozoans," *Praesopora, Monotrypa* and *Mesotrypa.* A few specimens of the ostracode, *Ceratopsis* cf. *C. intermedia,* occur in the Trenton; it is abundant in the Eden Member. One specimen of the ostracode, *Eurychilina* sp., was collected near the base of section 5.

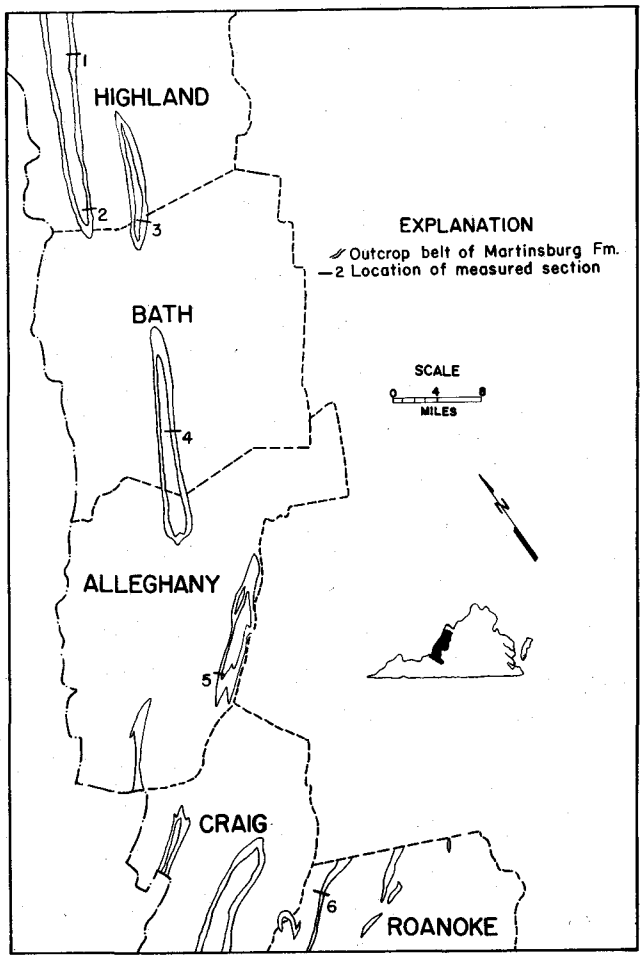
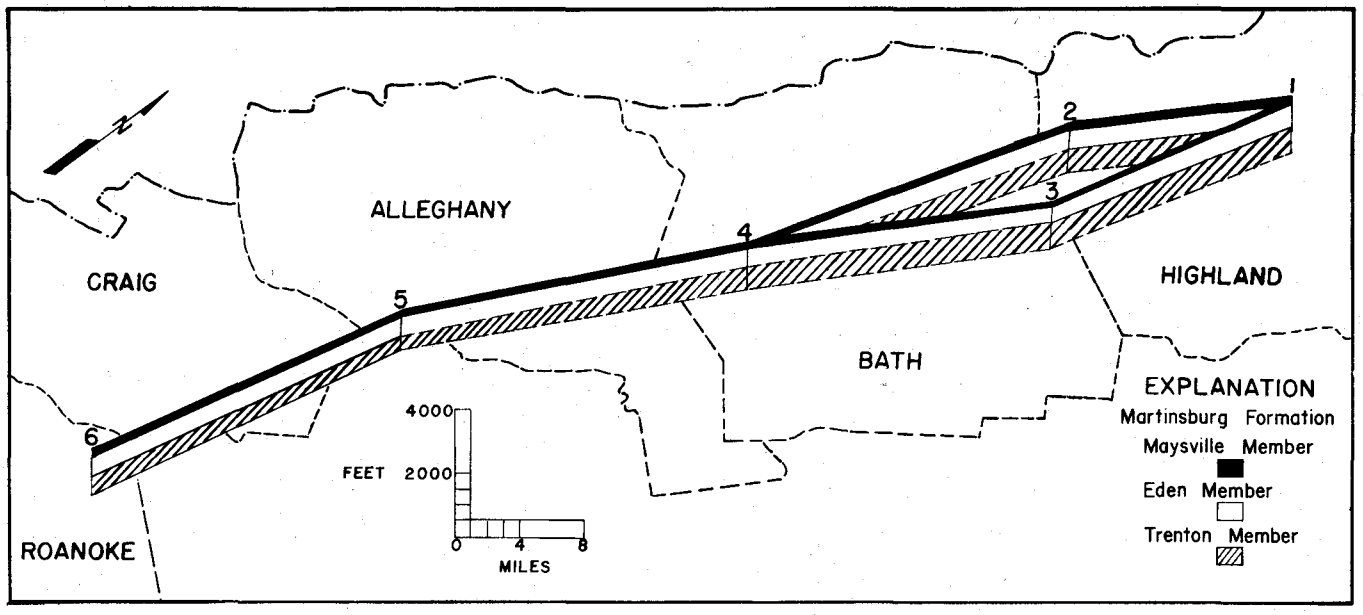


Figure 5. Locations of measured sections and outcrops of the Martinsburg Formation.

[1] Virginia Division of Mineral Resources.

[2] Graduate student, Florida State University, Tallahassee, Florida.



Section

1. West flank of Monterey Mountain, Highland County, along U. S. Highway 250.
2. West flank of Back Creek Mountain, Highland County, along old C.C.C. road.
3. West flank of Jack Mountain, Bath County, along old C.C.C. road.
4. West flank of Warm Springs Mountain, Bath County, along Delafield Road from Hot Springs to the crest of Warm Springs Mountain.
5. Cliff Dale Chapel, Alleghany County, from 0.17 mile southwest of Cliff Dale Chapel on State Road 617 to 0.25 mile southeast of Cliff Dale Chapel on State Road 616.
6. West flank of Catawba Mountain, Roanoke County, along U. S. Highway 311.

Figure 6. Relationship of Trenton, Eden, and Maysville members of the Martinsburg Formation in west-central Virginia.

The Eden Member is transitional both lithologically and faunally between the underlying Trenton and the overlying Maysville. The major rock types are siltstone and shale with minor amounts of coquinoid limestone in the lowermost 300-500 feet. The upper portion of the formation is predominantly siltstone with interbedded sandstones. The thickness of this member decreases southwestward from 700 feet at section 1 to 500 feet at section 3, and from there increases southwestward to 700 feet at section 5 and 660 feet at section 6 (Figure 6). The Eden Member typically contains the ostracode, *Ceratopsis* cf. *C. intermedia;* the trilobite, *Cryptolithus bellulus;* and the brachiopods, *Zygospira* and *Resserella. Cryptolithus bellulus* was found in four of the sections studied; however, except for one bed in section 1, it is rare. Also, a few specimens of *Cryptolithus tesselatus* and "hemispherical bryozoans," which occur in the underlying Trenton, are present. Nowhere in the sections are these common above the uppermost cobbly limestone.

The Maysville Member is predominantly green, fine-grained, thin-bedded sandstone with interbedded siltstones. Some red sandstone and siltstone beds and iron-flecked "Oswego-like" thin- to thick-bedded lenses of sandstone occur in the upper part. In the lower part there are beds of shale; in Highland County there are also a few thin lenses of coquinoid limestone in the basal portion. A few of the sandstone beds contain well-rounded quartz pebbles up to 5 mm in diameter. The contact between the Maysville Member and the overlying Juniata Formation is transitional and is arbitrarily placed above the uppermost fossil occurrence. In the northern portion of the area the contact appears to be conformable, but to the southwest the Juniata is absent and the Maysville Member is overlain by the Tuscarora Formation. The Maysville decreases in thickness from 180 feet on Monterey Mountain (Figure 6, section 1) to 132 feet on Catawba Mountain (Figure 6, section 6). The occurrence of fossils is primarily restricted to a few fossil-

iferous zones separated by thick units barren of organic remains. The brachiopods, *Orthorhynchula stevensoni* and *Lingula nicklesi* are the characteristic fossils of the Maysville. Several genera of pelecypods and gastropods are also abundant. Many of the gastropod species belong to the genus *Lophospira.*

The shaly portions of the Martinsburg Formation have characteristics that may be satisfactory for brick and tile. Unweathered Martinsburg shale is a possible source of raw material for lightweight aggregate (Calver, Hamlin, and Wood, 1961, p. 2). Petroleum in small quantities has been found in the Trenton Member in the Rose Hill and Ben Hur areas of Lee County.

References

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New Publications

Information Circular 10. CHARACTERISTICS OF THE EVERONA FORMATION IN VIRGINIA by Tinsley Mack. 16 p.
Price: $0.25

The Everona Formation, generally considered Upper Cambrian in age, extends from the Rockfish River northeastward across parts of Albemarle, Louisa, Orange, Culpeper, Fauquier, and Loudoun counties to the Potomac River, a distance of approximately 120 miles. Because of the deep weathering in the Piedmont area, outcrops of carbonate strata are difficult to locate and generally are well exposed only along stream beds. The six major rock types in the Everona Formation and the relative percentages of each are: (1) banded limestone, 60 percent; (2) massive limestone, 10 percent; (3) slaty limestone, 8 percent; (4) ferruginous limestone, 4 percent; (5) marble, 9 percent; and (6) black slate, 9 percent. Quarries and prospects where the Everona is exposed are described, and chemical analyses of representative samples from each of the quarries and prospects are reported.

Mineral Resources Report 6. ANALYSES OF CLAY, SHALE, AND RELATED MATERIALS — SOUTHWESTERN COUNTIES by Stanley S. Johnson, Marion V. Denny, and D. C. Le Van. 210 p.
Price: $1.25

This report contains results of tests and determinations of properties required to evaluate the potential ceramic and non-ceramic uses of 120 samples of clay, shale, and coal refuse from localities in southwestern Virginia. The counties sampled for this report are Bland, Buchanan, Dickenson, Giles, Lee, Pulaski, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe. Preliminary sample evaluation was conducted in a muffle furnace and continuous tests were made. The tests indicate that 46 samples are potentially suitable for brick, 13 for common or inside brick, 2 for glazed brick, 1 for flue brick, 7 for decorative brick, 17 for tile, 6 for decorative tile, 3 for quarry tile, 2 for drain tile, 1 for flue tile, 12 for pottery, 7 for artware pottery, 1 for earthenware, 1 for insulating material, 1 for use in glazing, 60 for lightweight aggregate, and 1 for aggregate.

Progress of Topographic Mapping

The following compilation and maps (Figures 7-9) indicate the progress of the topographic mapping program through June 30, 1965.

	No. of Quadrangles	Percent of State
Total number of 7.5′ quadrangles	803	100
Number of 7.5′ quadrangles of recent aerial photography	440	54.8
Number of 7.5′ quadrangles in progress	433	53.9
Number of 7.5′ stereocompilations	191	23.8
Number of 7.5′ composites	25	3.1
Number of 7.5′ published modern maps 7/1/64 to 6/30/65	41	5.1
Number of 7.5′ published modern maps	163	20.3
Total number of 7.5′ stereocompilations, composites, and published maps	379	47.2

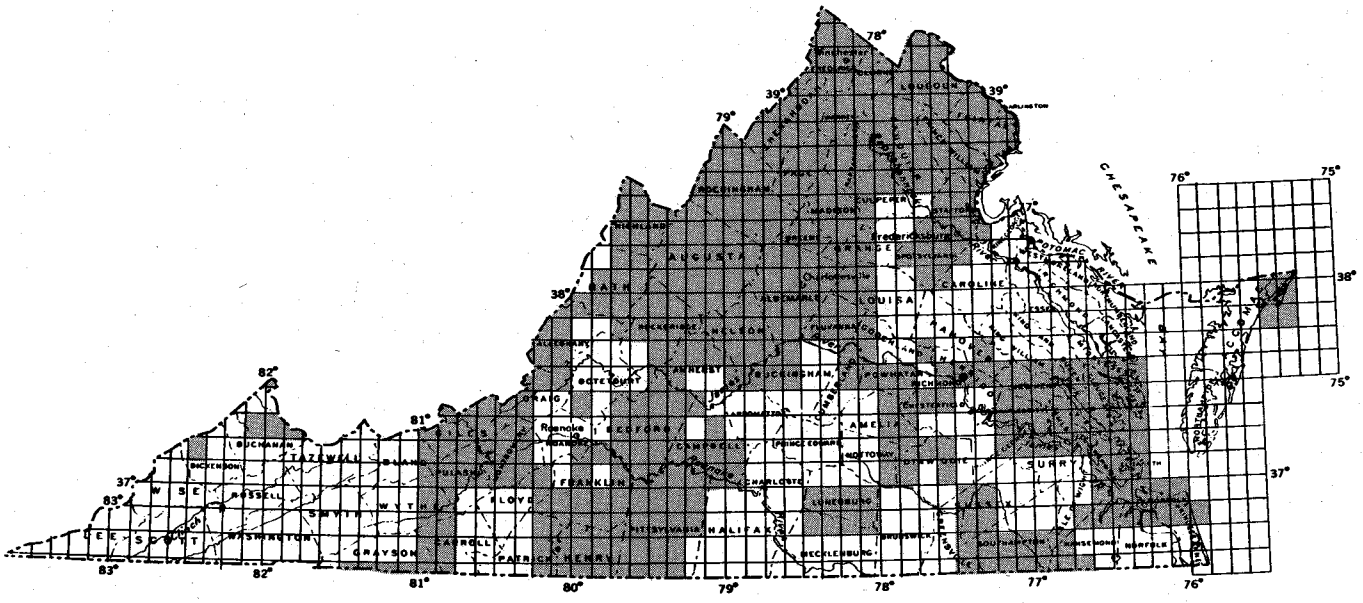

Figure 7. Shading indicates areas where some phase of topographic mapping was in progress as of June 30, 1965.

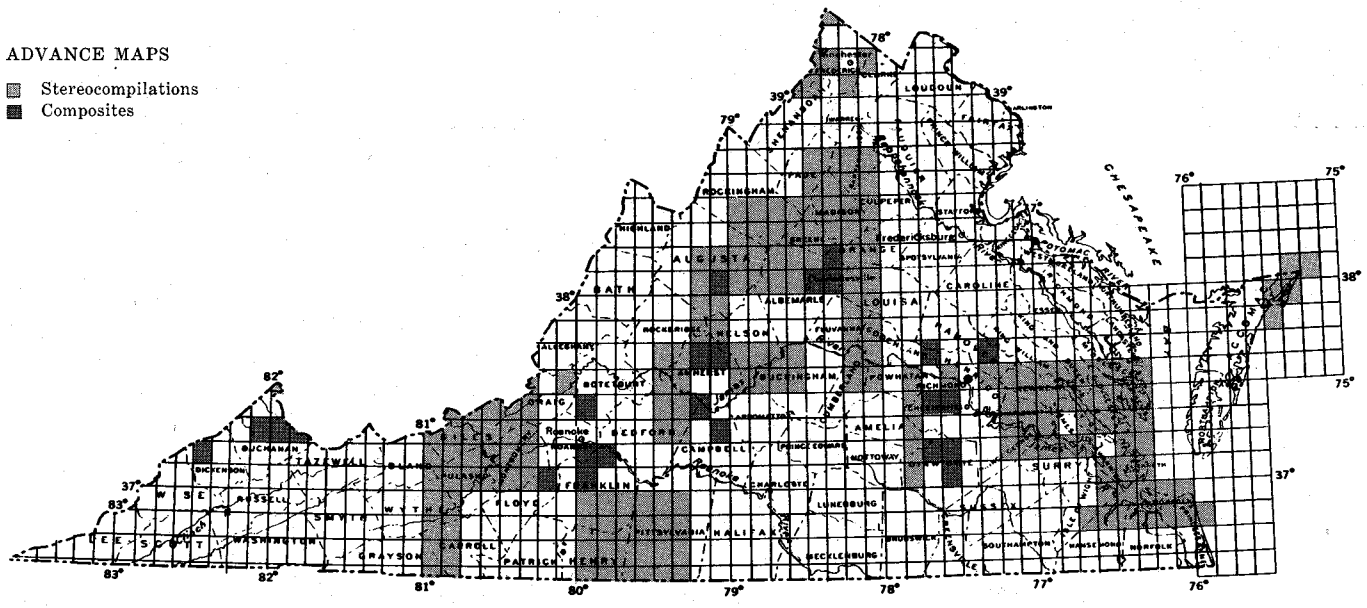

Figure 8. Areas where advance maps are available. Stereocompilations are advance maps that have not been field checked and have no names. Composites are advance maps that have been field checked and have names. Advance prints (blue line) of topographic maps are available at 50 cents each from the U. S. Geological Survey, Topographic Division, 1109 N. Highland St., Arlington, Virginia.

Division of Mineral Resources
Box 3667
Charlottesville, Virginia

Form 3547 Requested

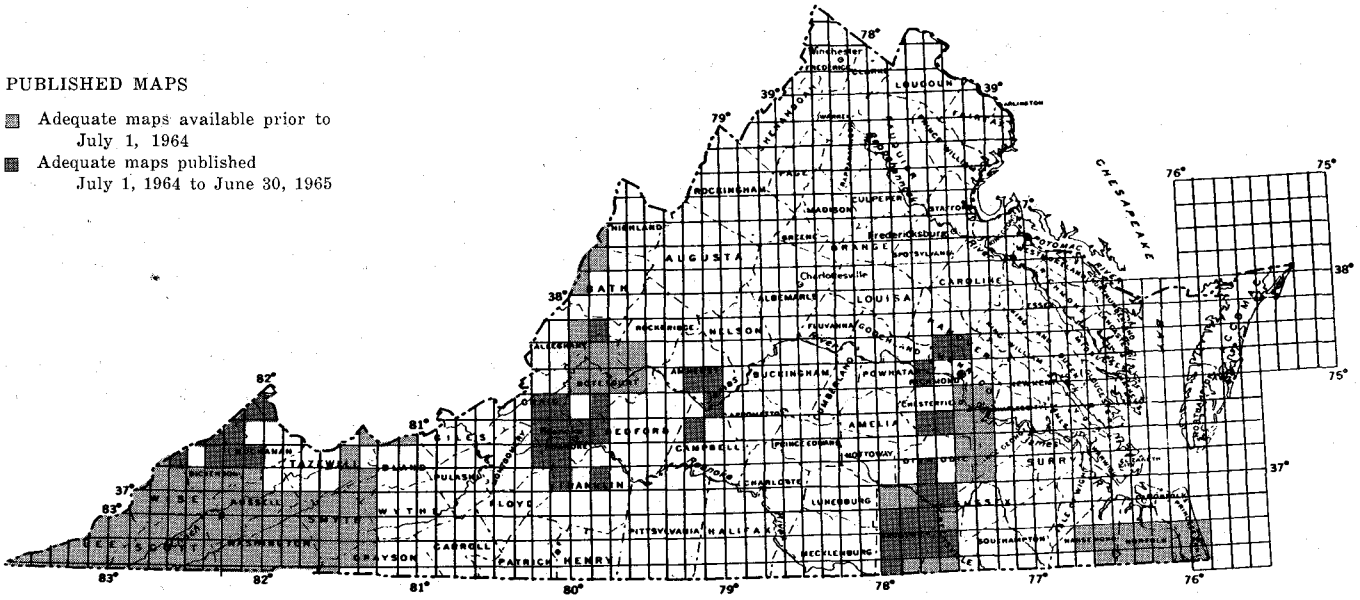

Figure 9. Areas where maps that conform to modern standards are available. Published maps are available at 30 cents each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, Virginia 22903. A State index to topographic maps is available free.