VIRGINIA MINERALS

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
Richmond, Virginia

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SURVEY COMPLETED IN SOUTHWEST VIRGINIA

The results of the aeromagnetic survey of southwestern Virginia (Figure 1) have been delivered by Aero Service Corporation. The geophysicist's interpretation concludes that there are 16 areas where the subtler flexures of the magnetic contours suggest minor relief on the basement surface which, if attended by structures in the sedimentary rocks, may be of interest as petroleum or natural gas prospects. These flexures may also be caused by minor compositional changes in the basement rocks. In addition, there is a small surface or near-surface anomaly of sufficient intensity to warrant investigation as a non-ferrous ore prospect. The report consists of five isomagnetic maps, scale 1:100,000 and one composite, scale 1:250,000; a geophysicist's report including five interpretative maps, scale 1:100,000 and one composite, scale 1:250,000. The isomagnetic maps, the geophysicist's report and the interpretative maps are offered as a unit at the cost of reproduction, $20.00. Sets of the maps and report are sold at the Division's offices, Charlottesville.

Arrangements are being made to reproduce the original data and it will be possible to purchase copies of the magnetometer profiles and altimeter tapes at the cost of reproduction. For additional information contact, Virginia Division of Mineral Resources, Box 3667, Charlottesville, Virginia.

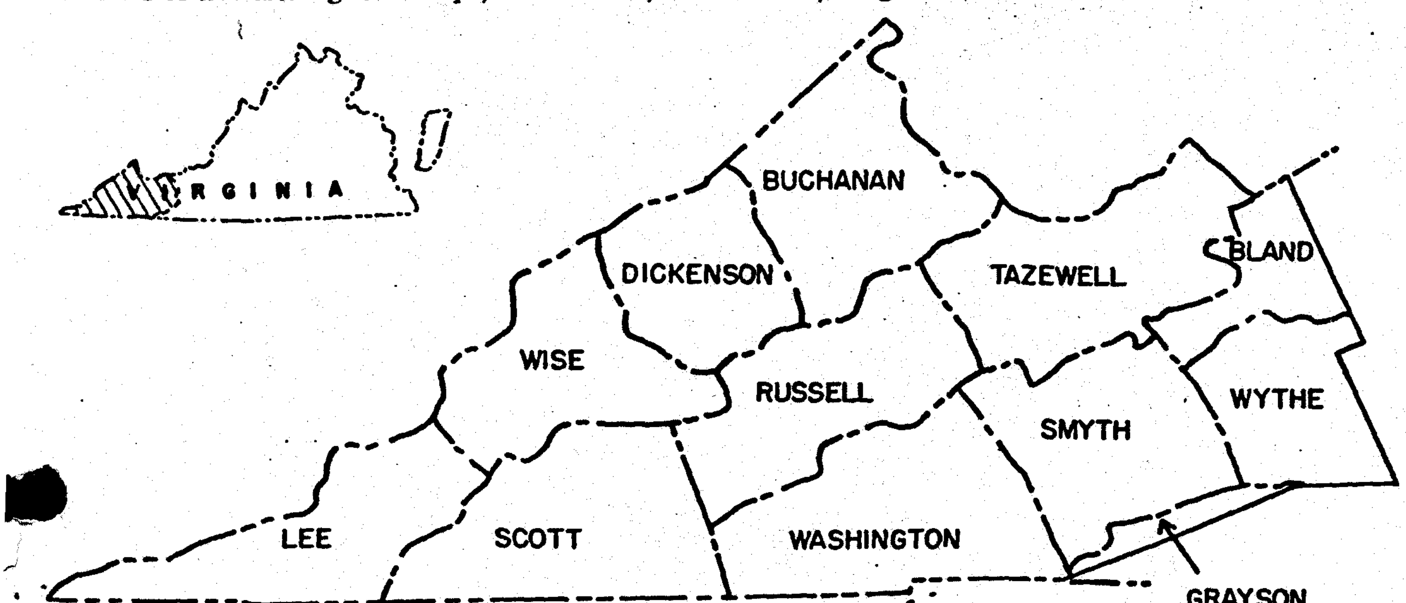


Figure 1—Area included in aeromagnetic survey of 5000 square miles in southwestern Virginia

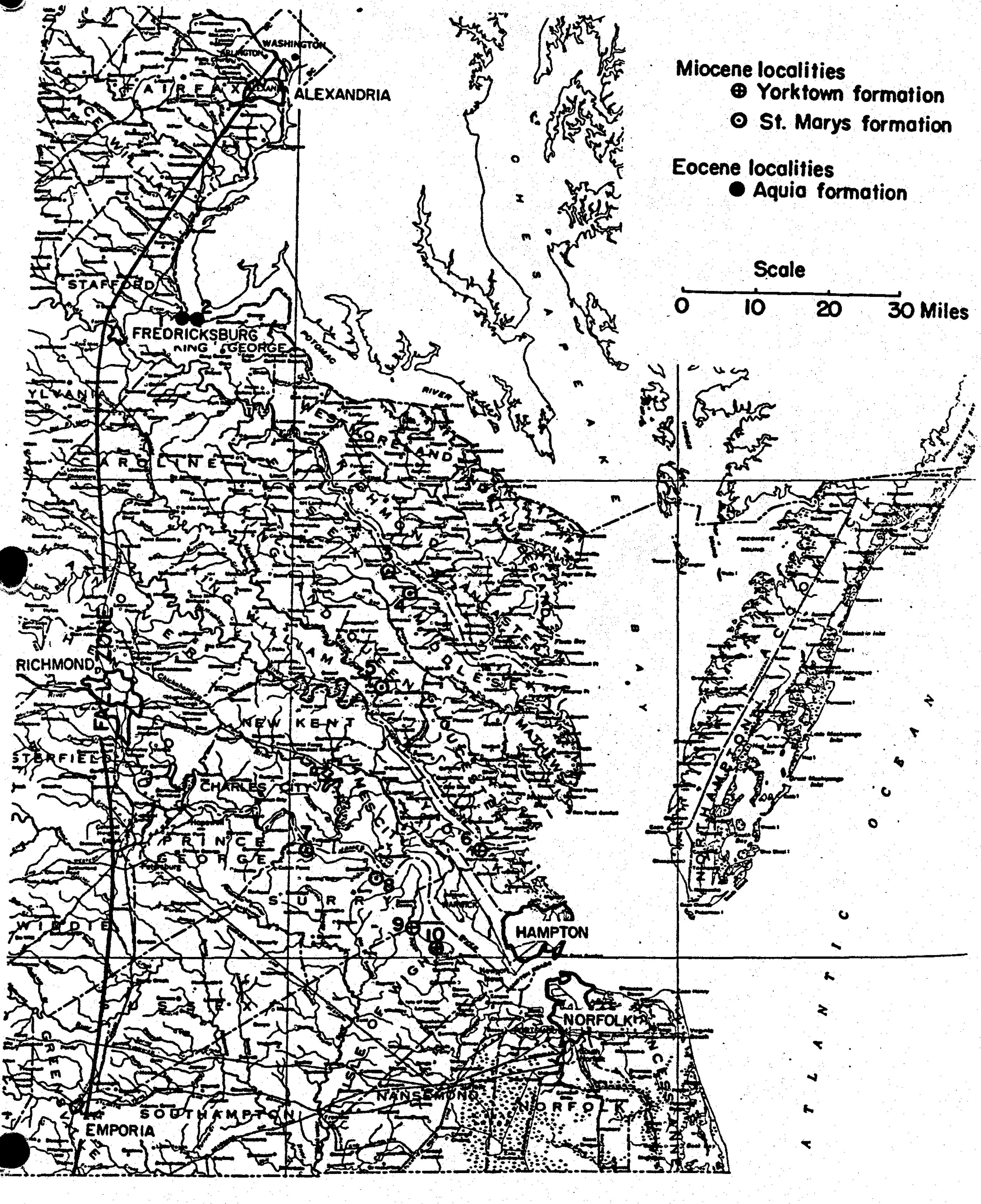


Figure 2—Selected Tertiary fossil localities of the Virginia Coastal Plain

SELECTED TERTIARY FOSSIL LOCALITIES OF THE VIRGINIA COASTAL PLAIN

JAMES L. RUHLE

The Virginia Coastal Plain contains several prolific fossil bearing localities which students and collectors have visited for many years. Certain fossil localities have become "classics" and are featured in many geology textbooks and technical publications. Several of these localities are readily accessible and contain an abundance of well preserved fossils (Figure 2). Other localities are difficult to find and are accessible only by boat.

Geologic time is divided into many units (Table 1), with respect to the presence of fossil remains and disintegration of radioactive elements. Portions of this time are recorded in the Coastal Plain of Virginia, and are manifested in distinctive rock units, or formations. The oldest formation was deposited on the crystalline rocks, with successive deposition of younger formations. Deposition, however, is rarely continuous throughout geologic time, resulting in interruptions in the geologic record.

The magnitude of geologic time is conceivable when one studies the biological relationships of living and fossil organisms, and investigates the

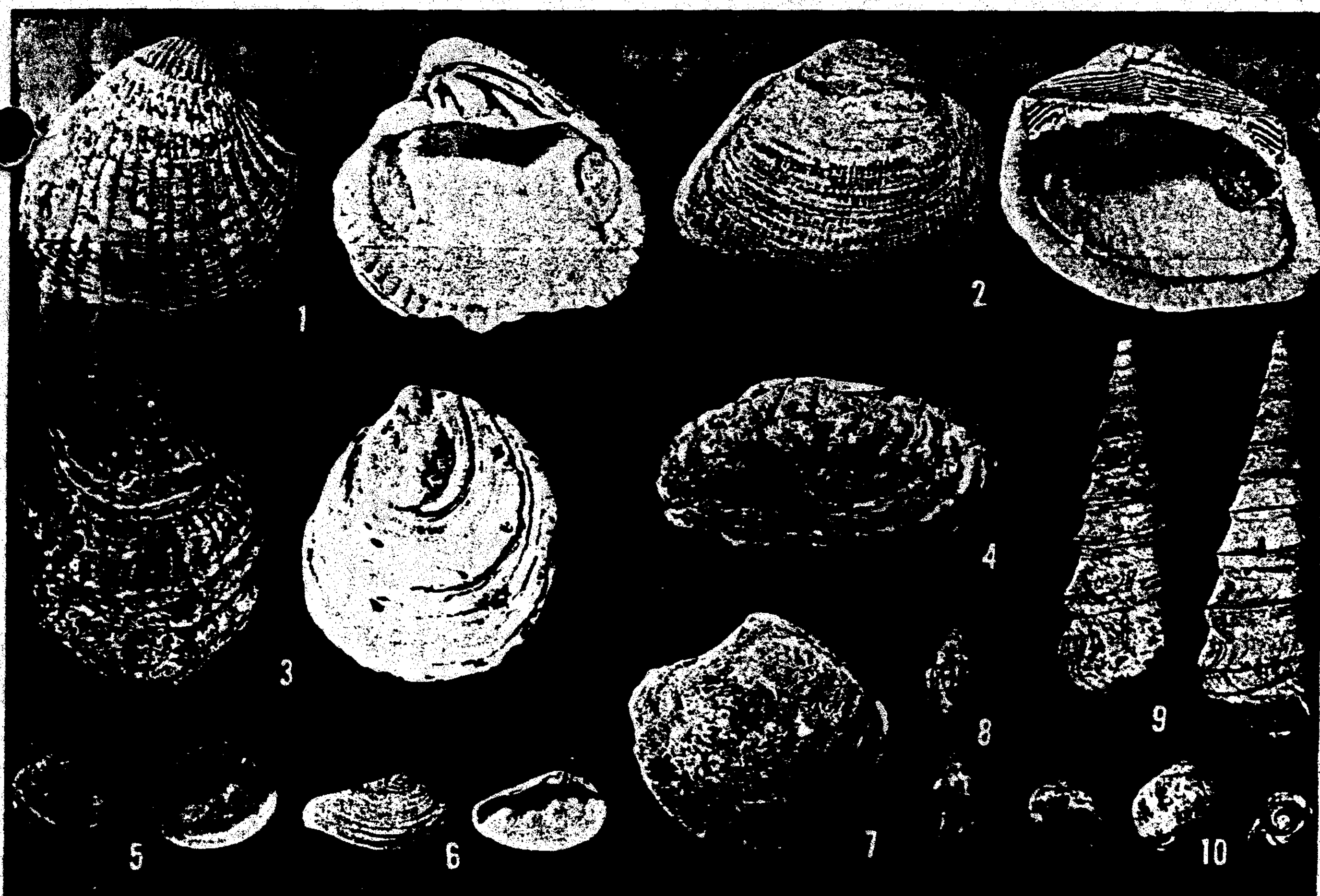


Figure 3—Principal fossils from the Aquia formation, all illustrations are x 1/2

Pelecypods—1. Venericardia planicosta var. regia 2. Cucullaea gigantea 3. Ostrea compressirostra 4. Panopea elongata 5. Meretrix ovata var. pyga 6. Crassatellites alaeformis 7. Dosinopsis lenticularis
Gastropods—8. Strepsidura subscalarina 9. Turritella mortoni 10. Lunatia marylandica

TABLE I. GEOLOGIC TIME TABLE

	Period	Epoch	Estimated Age in Years	Coastal Plain Formations
Cenozoic Era	Quaternary	Recent		Terrace gravels and sands
		Pleistocene	12,000 yrs. to 1 million yrs.	
	Tertiary	Pliocene	1-11 million	Brandywine formation
		Miocene	11-25 million	unconformity Yorktown formation (locality nos. 6, 9, & 10 St. Marys formation (locality nos. 3, 4, 5, 7, & 8) Choptank formation Calvert formation
		Oligocene	25-40 million	Not reported
		Eocene	40-60 million	unconformity Chickahominy formation (sub-surface) Nanjemoy formation Aquia formation (locality nos. 1 & 2)
		Paleocene	60-70 million	Mattaponi formation (sub-surface)
Mesozoic Era	Cretaceous		70-135 million	unconformity Patapsco formation unconformity Patuxent formation
	Jurassic		135-180 million	unconformity Sedimentary and igneous rocks
	Triassic		180-225 million	
Paleozoic Era	Permian Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian		225-270 million 270-305 million 305-350 million 350-400 million 400-440 million 440-500 million 500-600 million	unconformity Crystalline rocks of undetermined age
Precambrian			600 million+	

sequence and changes of fossil assemblages with time. The parade of past life recorded in vast thicknesses of layered deposits, the development of thousands of new species with advancing time, and the extinction of whole fossil assemblages, can only be referenced in terms of millions of years. More recently, studies of radioactive decay of certain elements, such as uranium, thorium, potassium, strontium, and carbon, have been used by geologists to aid in measuring time. The rates of radioactive decay are well established, and regardless of the surrounding conditions, the rate for a given element is constant. As a result measurements have been made of elements in geologic formations, and the ages set forth in the geologic time table are substantiated by these measurements.

The rock formations of the Virginia Coastal Plain (Table 1) were intermittently deposited during the Cretaceous, Tertiary, and Quaternary periods, and consist of both marine and non-marine sediments. Rocks of the Tertiary epochs, with the exception of the Oligocene, are present although Pliocene and Pleistocene terrace gravels often overlap and cap the older formations. These rock formations are tilted gently eastward; most of them are exposed on the surface but two of them, the Mattaponi and Chickahominy formations, are known only from rock samples obtained during the drilling of wells.

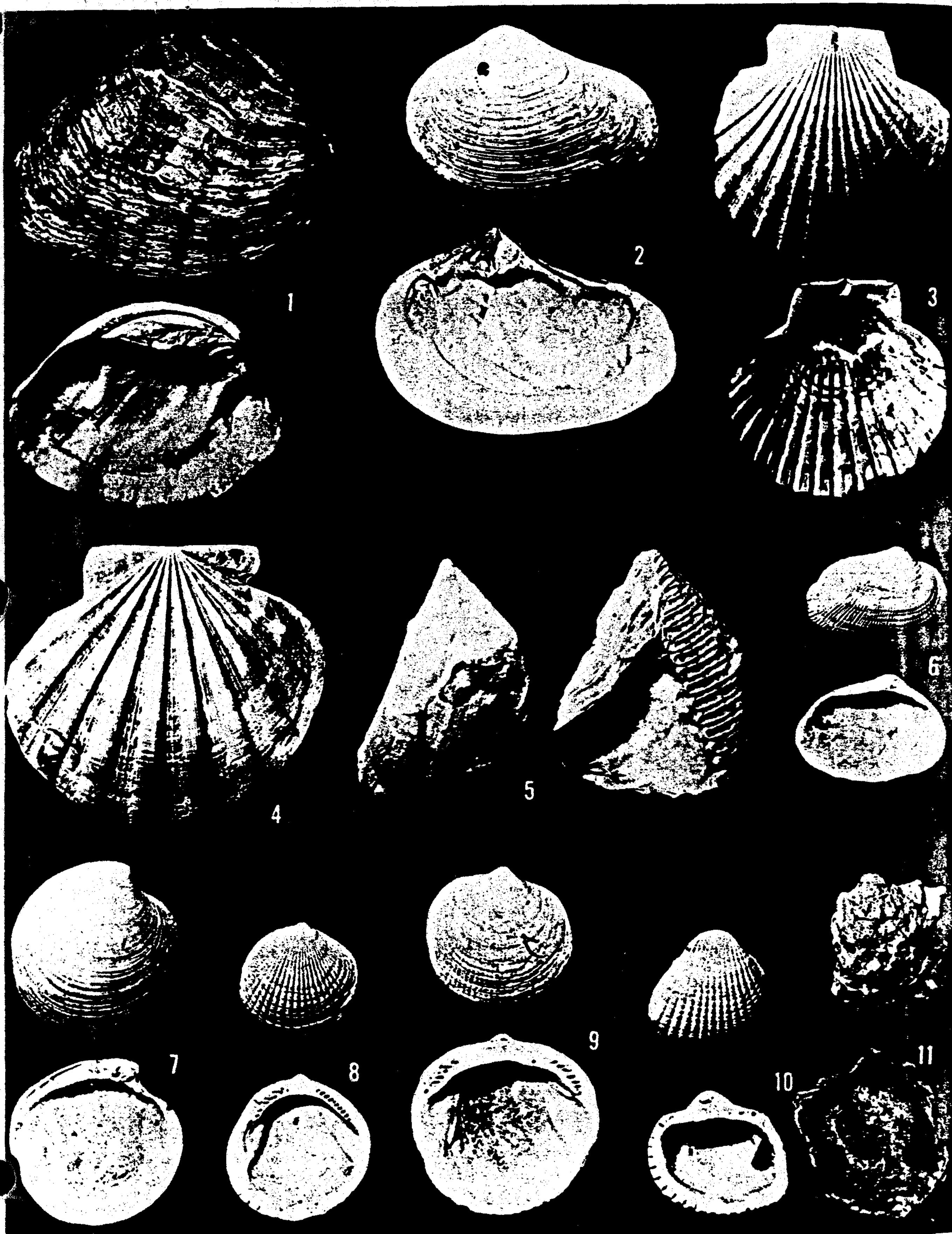
Fossils are the remains or traces of animals or plants which lived before the end of prehistoric time. Paleontologists classify fossil plants and animals into certain groups or phyla in much the same way biologists classify living organisms. These phyla are divided into subphyla, classes, orders, and families. A family is composed of certain genera, made up of separate species, and occasionally sub-species or varieties.

The majority of the Tertiary fossils in the Virginia Coastal Plain are marine invertebrates, belonging to the phylum Mollusca, and are clams (pelecypods) and snails (gastropods). Other groups of invertebrates include barnacles and ostracods of the phylum Arthropoda; chambered univalves, the phylum Cephalopoda, lamp shells, the phylum Brachiopoda; corals, the phylum Coelenterata; corallines, the phylum Bryozoa; and Foraminifera, the phylum Protozoa. Shark teeth, ray dentures, whale bones, turtle plates, and crocodile teeth constitute the vertebrate remains.

The most significant and abundant fossils are illustrated in Figures 3, 4, and 5. The principal species of the Aquia formation are illustrated in Figure 3; those of the St. Marys and Yorktown formations, in Figures 4 and 5. Most of these fossils are composed of their original shell material and have remained unaltered for millions of years. Sediment may fill openings in fossils and occasionally solidify as internal casts, while the shell material disintegrates. *Panopea elongata* and *Dosinopsis lenticularis* (Figure 3, nos. 4 and 7) are examples of internal casts.

Certain species are restricted to one formation, and therefore are valuable stratigraphic markers, or index fossils. *Turritella mortoni*, for example (Figure 3, no. 9), is an index fossil for the Aquia formation. *Isognomon maxillatum* (Figure 4, no. 5) does not occur above the St. Marys formation, and therefore can be used to differentiate between the St. Marys formation and the overlying Yorktown formation which otherwise have very similar fossils. Occasionally, a new species may be found which has never been previously recorded. Such a fossil is designated as the "type" for a new species. Although the probability of finding a type is rare, the possibility still exists. The types of a great many species have been found in the Virginia Coastal Plain and many of these are carefully preserved in the U. S. National Museum, Washington, D. C.

Ten selected fossil localities (Figure 2) within three Tertiary formations, the Aquia formation of Eocene age, and the St. Marys and Yorktown formations of Miocene age are listed. These formations were deposited in shallow seas that inundated eastern Virginia during the geologic past. All of the localities are along rivers or tributaries and contain, at certain horizons, an abundance of fossil shells. The outcrops are constantly subjected to erosion and the formations are likely to be well exposed for a great many years. One of these localities near Yorktown, from which the Yorktown formation was named, is known as a "type locality." Another example of a type locality, not included in the listing because of its inaccessibility, is that of Aquia Creek at its confluence with the Potomac River, from which the Aquia formation was named.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Potomac River Basin

1. South bank of Potomac River, just up stream from Belvidere Beach, King George County.
   Pleistocene
   Coarse-grained sand....3 feet
   Eocene
   Aquia formation
   Greensand, weathered near top; contains *Ostrea compressirostra*, *Turritella mortoni*, *Cucullaea gigantea*, *Venericardia planicosta* var. *regia*, *Meretrix ovata* var. *pyga*, *Crassatellites alaeformis*, etc....17 feet

   At this locality many fossils, particularly *Turritella mortoni*, have weathered out of the outcrop, and are concentrated along the beach.

2. South bank of Potomac River at Fairview Beach, King George County.
   Eocene
   Aquia formation
   Indurated chunks of greensand containing numerous fossil molds and casts, particularly of *Turritella mortoni*....5 feet

Rappahannock River Basin

3. South bank of Rappahannock River, just down stream from the termination of State Road 644, near Bowlers Wharf, Essex County.
   Pleistocene
   Medium-grained sand....20 feet
   Miocene
   St. Marys formation
   Dark clayey sand; contains *Spisula rappahannockensis* and *Arca idonea*. *Spisula rappahannockensis* is particularly abundant....6 feet

4. South bank of Rappahannock River, just up stream from the termination of State Road 600, at Butylo, Middlesex County.
   Pleistocene
   Coarse-grained sand interlaminated with clay....20 feet
   Miocene
   St. Marys formation
   Medium to fine-grained sand; contains *Isognomon maxillatum*, *Chlamys jeffersonia*, *Chlamys madisonia*, *Kuphus calamus*, *Balanus concavus*, *Turritella alticostata*, *Arca centenaria*, etc....8 feet

York River Basin

5. Stream cut at Corbin Creek, just south of State Highway 14, and two miles northwest of Centerville, King and Queen County.
   Pleistocene
   Medium to fine sand and gravel....5 feet
   Miocene
   St. Marys formation
   Shell layer embedded in dark clayey sand; contains *Isognomon maxillatum*, *Chlamys jeffersonia*, *Calliostoma philanthropum*, *Turritella alticostata*, *Balanus concavus*, *Dentalium attenuatum*, *Ecphora quadricostata*, *Discinisca lugubris*, *Anomia aculeata*, *etc.*....5 feet

   Isognomon maxillatum comprises more than half of the shell bed.

6. South bank of the York River, just down stream from Yorktown, York County.
   Miocene
   Yorktown formation
   Medium-grained sand, cross-bedded shell marl, and dark sandy clay; contains over one-hundred fossil species, among which commonly occur *Crepidula aculeata costata*, *Chlamys jeffersonia*, *Glycymeris subovata*, *Mercenaria tridacnoides*, *Arca incile*, *Dosinia acetabulum*, *Arca centenaria*, *Turritella alticostata*, etc....40 feet

   Some species, such as *Crepidula aculeata costata* and *Turritella alticostata*, are concentrated in zones, and can be traced along the river bank for several miles.

Figure 4—Principal fossils from the St. Marys or Yorktown formations, all illustrations x 1/2 except number 1 and 5 that are x 1/3

Pelecypods—1. Mercenaria tridacnoides 2. Crassatellites undulatus 3. Chlamys madisonia 4. Chlamys jeffersonia 5. Isognomon maxillatum 6. Pleiorytis centenaria 7. Dosinia acetabulum 8. Glycymeris subovata 9. Glycymeris americana 10. Arca idonea 11. Ostrea disparilis

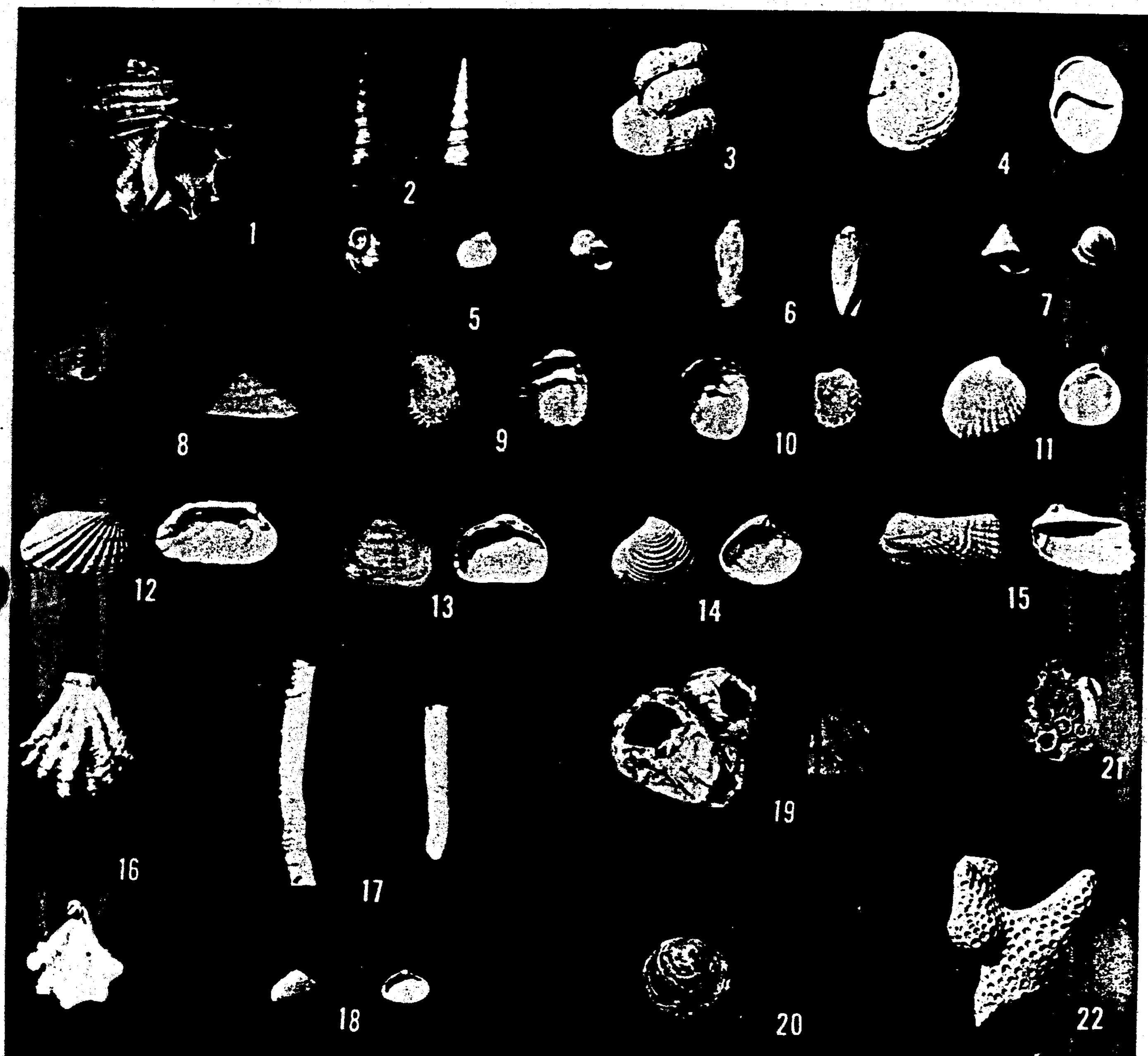

Figure 5—Principal fossils from the St. Marys or Yorktown formations, all illustrations are x 1/2 except numbers 11, 14, 16 and 18 that are x 2/3:

Gastropods—1. Ecphora quadricostata 2. Turritella alticostata 3. Lemintina virginica 4. Crepidula plana 5. Polynices heros 6. Oliva litterata 7. Calliostoma philanthropum 8. Diodora redimicula 9. Crepidula aculeata costata 10. Crucibulum constrictum

Pelecypods—11. Venericardia granulata 12. Carditamera arata 13. Arca centenaria 14. Astarte undulata 15. Arca incile 16. Plicatula marginata 17. Kuphus calamus 18. Spisula rappahannockensis

Arthropod—19. Balanus concavus

Brachiopod—20. Discinisca lugubris

Çolelenterates—21. Astrangia lineata 22. Septastrea marylandica

James River Basin

7. South bank of James River, along State Road 1202, one mile east of Claremont, Surry County.
   Pleistocene
   Medium to fine-grained sand..........20 feet
   Miocene
   St. Marys formation
   Shell mass embedded in medium to fine-grained sand; contains *Chlamys jeffersonia, Chlamys madisonia, Ostrea disparilis, Dosinia acetabulum, Isognomon maxillatum, Astarte undulata, Venericardia granulata*, etc.......20 feet

   There is also an excellent exposure of the same material in a road cut a short distance to the east, along State Road 609, just up stream from Sunken Marsh Creek.

8. South bank of James River just up stream from the termination of State Road 636, at Cobham Wharf, Surry County.
   Miocene
   St. Marys formation
   Shell mass embedded in medium to fine-grained sand; contains *Chlamys jeffersonia, Chlamys madisonia, Venericardia granulata, Crassatellites undulatus, Arca centenaria, Glycymeris subovata, Dosinia acetabulum, Ostrea disparilis, Ecphora quadricostata, Turritella alticostata*, etc...................................15 feet

   Many fossils, particularly *Chlamys jeffersonia*, have weathered out of the outcrop, and are concentrated along the beach.

9. South bank of James River, one-half mile up stream from the termination of State Road 621, at Fergussons Wharf, Isle of Wight County.
   Miocene
   Yorktown formation
   Shell mass, well indurated.........15 feet
   Dark sandy clay; contains *Dosinia acetabulum, Turritella alticostata, Crepidula aculeata costata, Chlamys jeffersonia, Chlamys madisonia, Arca incile*, etc...20 feet

10. South bank of James River, just down stream from the termination of State Road 673, at Morgarts Beach, Isle of Wight County.
    Miocene
    Yorktown formation
    Shell mass, indurated...................5 feet
    Dark clayey sand, weathered near top, contains *Ostrea disparilis, Turritella alticostata, Dosinia acetabulum, Glycymeris subovata, Ecphora quadricostata*, etc...............................15 feet

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New Publications

Bulletin 77. GEOLOGY AND MINERAL RESOURCES OF ALBEMARLE COUNTY by Wilbur A. Nelson. 92 p. with geologic map in color. Price: $3.75

Albemarle County is near the central part of Virginia on the western edge of the Piedmont physiographic province. It has an area of 735 square miles. The northwestern edge of the county follows the crest of the Blue Ridge Mountains. The southern edge is at the James River. It is bounded on the north by Greene and Orange counties, on the east by Louisa and Fluvanna counties, on the south by Buckingham County and on the west by Nelson and Augusta counties.

Albemarle County is covered by rocks which, in its western half, are primarily igneous and metamorphic in character. The eastern part of the county is covered by sedimentary and igneous rocks which have been subjected to different degrees of metamorphism. Throughout the county the rocks outcrop in broad belts extending in a northeast-southwest direction.

The major structural feature is the Southwestern Mountain-Blue Ridge anticlinorium. This is a great recumbent anticlinorium with drag folds, bounded on the east by Southwestern Mountain, composed of Catoctin greenstone, and on the west by the Blue Ridge Mountains, composed, in part, of overturned Catoctin greenstone. This anticlinorium is very complex in its structural features. It is bisected by the Mechum River graben, a down-faulted belt of metamorphosed rocks, composed of the Rockfish conglomerate, the Lynchburg gneiss, the Charlottesville formation, and the Swift Run formation, designated in this report as the Mechum River formation.

The most important mineral resources are the soapstone and serpentine quarries along the Nelson-Albemarle County line, extending northward to Alberene. Other quarries produce crushed stone for construction purposes. Building sand is obtained from the Rivanna River near Charlottesville. There is an abandoned lead-zinc mine near Faber and an abandoned iron-copper mine near Stony Point. An abandoned magnetic iron ore mine near North Garden furnished ore to the nearby Olds furnace before Revolutionary times. An abandoned graphite mine is near Nortonsville. There are several abandoned slate quarries in the Blenheim area east of Southwestern Mountain. A number of abandoned limestone quarries occur in the eastern part of this county, in the Everona limestone belt. This limestone was used formerly in making lime for agricultural use, and mortar in the construction of the original buildings at the University of Virginia. Residual clays in Charlottesville were used in making the brick for the original Jeffersonian buildings at the University of Virginia. Later a brick plant operated in Charlottesville until 1944. Clays, which are suitable for making brick, occur around Crozet and Keswick.

Ground water resources in most of the county are from fair to good, depending on the geology and topography.

Min. Res. Rept. 4. OIL AND GAS WELLS DRILLED IN VIRGINIA PRIOR TO 1962 by D. C. LeVan. 47 p. Price: $0.75

This report summarizes data on all wells reported to have been drilled in search of oil or gas in Virginia prior to January 1, 1962. As of that date a total of 375 wells are known to have been drilled in 24 counties. This drilling has resulted in the discovery of oil in Lee County and in the discovery of natural gas in Scott, Washington, Rockingham, Buchanan, Dickenson, Wise, Russell, and Tazewell counties.

Rept. of Invest. 2. GEOLOGY OF THE WILLIAMSVILLE QUADRANGLE VIRGINIA by Kenneth F. Bick. 40 p. with geologic map in color. Price: $2.50

The rocks of the Williamsville quadrangle, Virginia (bounded by parallels 38° 00′ and 38° 15′ and meridians 79° 30′ and 79° 45′) range in age from Early Ordovician to Late Devonian. Ordovician rocks outcrop only in the northwest part of the quadrangle in the center of a large anticline that has been breached by erosion; in ascending order, the Ordovician formations present are the Beekmantown formation, Lurich formation, Lincolnshire limestone, Big Valley formation (new name), McGlone formation, Moccasin formation, Edinburg formation, Martinsburg formation, and Juniata formation. The Ordovician rocks aggregate about 2100 feet in thickness. The remainder of the quadrangle is underlain by Silurian and Devonian clastic rocks, with the exception of approximately 500 feet of dominantly carbonate rocks of Late Silurian and Early Devonian age; the total thickness of Silurian and Devonian is about 8000 feet.

Deformation of the rocks of the Williamsville quadrangle occurred during the Appalachian orogeny of Permian age. The structure is characterized by folds, with minor associated faults. The major fold pattern of the area consists of anticlinoria on the southeast and northwest, separated by a synclinorium; many smaller folds are superimposed, in a complicated pattern, on the major folds. The northwest limbs of the anticlinoria dip more steeply than the southeast limbs, and many of the smaller folds are locally overturned to the northwest. Evidence suggests that this picture of a relatively simple folded terrain may be in error; the quadrangle may be underlain by one or more subsurface thrust faults, and the folds observed at the surface may continue downward only to the uppermost thrust plane.

The Williamsville quadrangle contains large reserves of impure limestone and high-calcium limestone that are suitable for many industrial purposes. Sands of ceramic quality are also probably present in the Ridgeley and Clinch sandstones.

Rept. of Invest. 3. GEOLOGY OF LURAY CAVERNS VIRGINIA by John T. Hack and Leslie Durloo, Jr. 43 p. Price: $0.50

Luray Caverns, Page County, Virginia, lie at shallow depth in Cave Hill a short distance west of the town of Luray. The enclosing rocks consist of granular crystalline dolomite belonging to the lower part of the Beekmantown dolomite of Early Ordovician age. The hill is on the western limb of a broad syncline whose axial plane strikes northeast. Within the limits of the cavern system the structure is rather simple. The eastern part is an open syncline with dips less than 6°. In the western part the dips are steeper—as much as 15° to the east. The entire cavern is confined to a zone only 100 feet thick and, although all the cave is not confined to one bed, the bedding strongly controls the shape of individual rooms and groups of rooms. Much of the solution appears to have occurred in coarse-grained crystalline dolomite.

The caverns contain no deposits that indicate former presence of large flowing streams, and most of the cave deposits including flowstone, mud, and some sand and gravel composed of chert fragments could have been transported and deposited by very small discharges of water. Nearly all the material in the deposits could have and probably did originate in the enclosing rocks. Flowstone in the form of stalactites, of stalagmites, of fanlike aprons along the walls, and of layered deposits on the floor is the most extensive deposit. The mud deposits, taken together, do not occupy a very large volume of the cave. They form several cone- or fan-shaped mud flows that issue from openings in the ceiling, and also are interlayered on the floor with the flowstone.

In several places the flowstone deposits appear to have collapsed as a result of solution and the formation of rooms beneath them, indicating that some of the cave originated in the vadose zone. Niches on the walls and ceilings, and rinds of mud and silica on some walls indicate that solution and weathering are still going on, but probably to a very minor degree. It is believed that Luray Caverns formed by selective solution of certain favorable dolomite beds. Solution which has been going on for a long period of geologic time probably began below the water table but continued as the topographic surface above the cave was lowered and the cave came to be in the vadose zone.

Additions to Staff

Mr. Clarke Jones was employed by the Division on July 16 to assist in preparation of geologic maps and reports pertaining to the Piedmont area. After a four-year tour of duty as a pilot with the U. S. Air Force, he attended the University of Tennessee where he received the B.S. and M.S. degrees in 1960 and 1962, respectively. Mr. Jones is married and has a daughter.

On July 1, Mr. Eugene K. Rader joined the Division to assist in the topographic mapping program. He will maintain a record of the status of each map as it is compiled and will help in transferring geologic data to the topographic maps. While studying for his B.A. and M.S. degrees, which he received from the University of Virginia, he worked as a laboratory assistant. He was active in Sigma Gamma Epsilon and was the recipient of the W. A. Tarr Award in 1960. Mr. Rader is married and has a son.

Mr. Carroll Smith was employed to help with geologic studies pertaining to the economic phase of the Division's activities and to make periodic visits to rock and mineral producers. Previously he had been employed by the Division where he compiled maps and charts and aided in laboratory duties. Mr. Smith received his B.A. degree in 1960 from the University of Virginia. He was recently married.

Age Determinations

The age of mica in two metamorphic rocks collected in the Piedmont province of Virginia was determined. Using the potassium-argon (K-Ar) method, biotite from a sample of slate obtained from the Arvonia-Buckingham Slate Company quarry in Buckingham County is reported to be 324± 12 million years old. Muscovite, from a sample of schist collected along the James River about 4.5 miles northwest of Bremo Bluff in Fluvanna County, is calculated to be 287± 18 million years old. Because the rocks in which the micas occur were deformed, and some of the constituent minerals were changed, these age determinations of the micas are thought to indicate an age of metamorphism rather than the actual age of the rock. These ages are comparable with that of the biotite from the Columbia granite, VIRGINIA MINERALS, May 1962, reported as Carboniferous in age.

Division of Mineral Resources
Box 3667
Charlottesville, Virginia

Form 3547 Requested

Geographic Center of Virginia Located

The Map Information Office of the U. S. Geological Survey, Washington, D. C., has redetermined the geographic center of the Commonwealth of Virginia. In a recent calculation the center is noted as being at 78° 37.5′ longitude and 37° 30.6′ latitude. This would be a point 2 miles south and then 0.5 mile west of Mount Rush, Buckingham County, which is at the junction of State Highway 24 and U. S. Highway 60. Mount Rush is located on the Buckingham quadrangle topographic map.

Mineral Industries

The Lone Star Cement Corporation completed construction of a new, highly-automated cement plant at South Norfolk in May 1962. The new plant, adjacent to the company's older facilities which were built in 1924, and later improved, will add 1,000,000 barrels of cement per year to the existing 1,300,000 barrel annual capacity of the South Norfolk operation. The design of the new plant features a central control system with automatic controls throughout, and permits operation either separately or in conjunction with the older equipment. Marl and clay obtained near Chuckatuck, Nansemond County, are transported by barge to South Norfolk where they are used as raw materials for the cement manufacturing process. The company also operates a cement plant near Cloverdale, Botetourt County, and has operations in other states and in South America for the production of Portland and special purpose cements.

The Southside Brick Works, Inc., Richmond, Virginia, has been purchased by the General Shale Products Corporation of Johnson City, Tennessee. Operations will be continued as the Southside Division of General Shale Products Corporation. The General Shale Products Corporation also operates structural clay products plants in Smyth and Tazewell counties, Virginia.