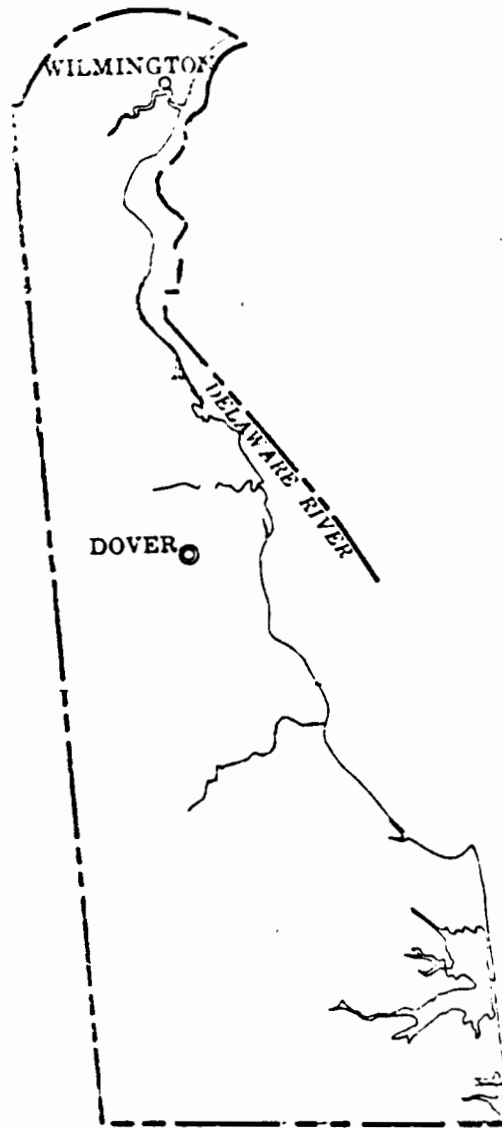


DELAWARE: ITS ROCKS, MINERALS, AND FOSSILS



**Helpful Hints
for Identification and Collection**

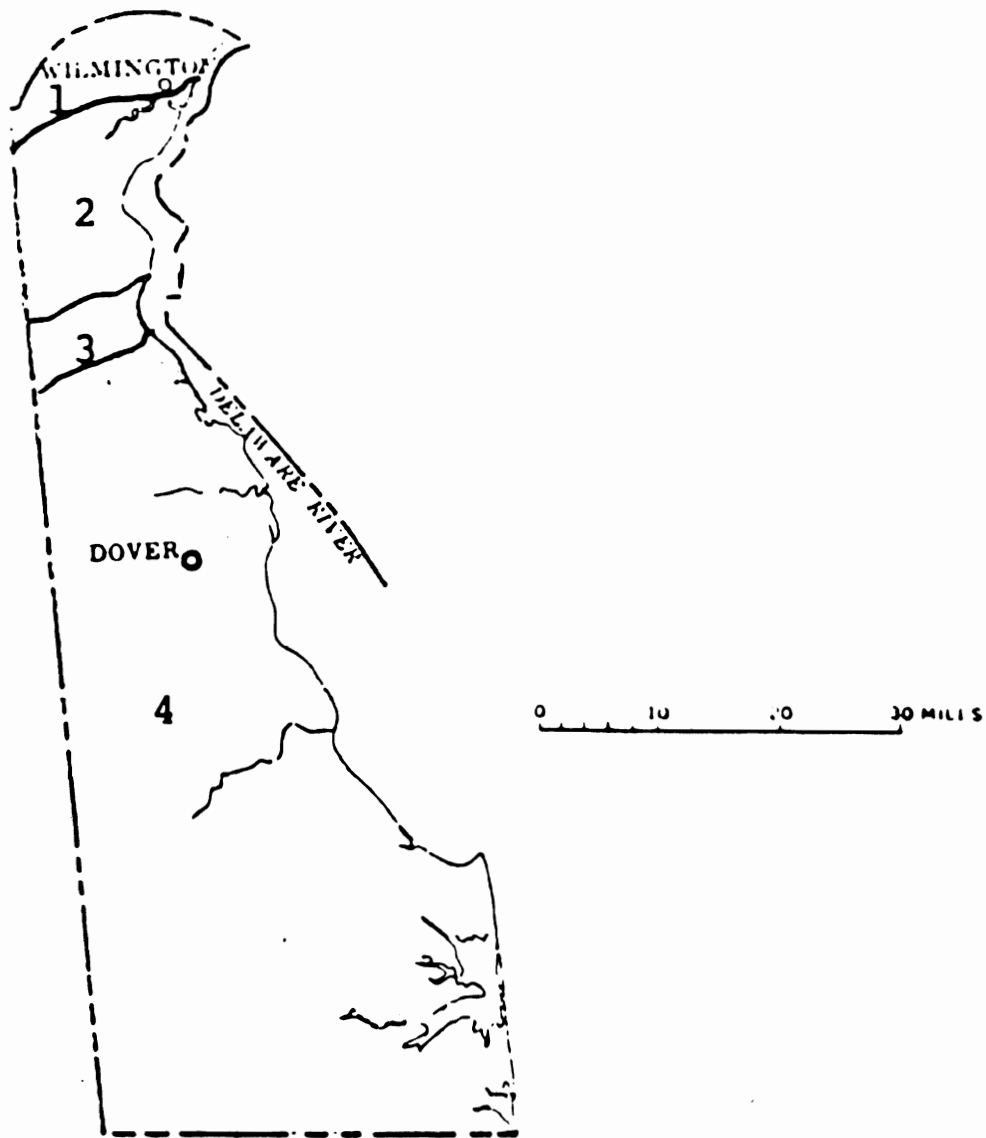
**Delaware Geological Survey
University of Delaware
State of Delaware
1992
Special Publication No. 19**

DELAWARE GEOLOGICAL SURVEY

The program of the Delaware Geological Survey, University of Delaware, includes research, exploration, and service. In accordance with statute, the charges and goals that have provided the basic framework of the activities of the DGS are:

1. Systematic investigation of all aspects of the geology of Delaware.
2. Exploration and study of all waters, minerals, and other earth resources of present or potential economic value.
3. Investigation of the physiographic features of the State and their application to the economy.
4. Preparation of reports describing the geology and earth resources of Delaware.
5. Preparation of geologic maps illustrating the characteristics and resources of the State.
6. Consideration of other aspects of geology that may be deemed of value to the citizens of Delaware.
7. Recommendation of such legislation as may be required to assure the optimum and equitable utilization of our geologic resources.

The Survey maintains a file of well records, geophysical logs, and Sample Library, all of which may be consulted by contacting Survey staff.



KEY OF GEOLOGIC FORMATIONS

Post Miocene sands and gravels cover most of the Coastal Plain.

4 - Miocene Epoch Coastal Plain sediments.

3 - Paleocene-Eocene Epoch Coastal Plain sediments.

2 - Cretaceous Period Coastal Plain sediments.

1 - Paleozoic Era Piedmont crystalline rocks.

GEOLOGIC HISTORY OF DELAWARE

Severe metamorphism has obscured the exact age relationships of the hard, crystalline rocks of the Piedmont in northernmost Delaware. This regional metamorphism is a product of crustal upheavals that built the Appalachian Mountain System. The major events in the evolution of these rocks occurred between 500 and 200 million years ago.

A great period of time, of which there is no record in Delaware, passed before the deposition of the oldest sediments of the Coastal Plain (all of Delaware except the northernmost part). During the latter part of Jurassic or Early Cretaceous time, about 120 million years ago, streams carried clays and sands from the Appalachians, which lay to the northwest, and deposited them as the red clays, silts, and sands of the Potomac Formation in Delaware. The white sands and lignitic black silts of the younger Magothy Formation form a distinctive marker over the Potomac Formation indicating the transition from the older nonmarine sediments to the younger marine deposits.

The sea now encroached upon the land and remained over most of Delaware until at least Middle Eocene time, 50 million years ago. The oldest sediments deposited form the Matawan Group, consisting of the Merchantville, Englishtown, and Marshalltown formations.

Above the Matawan is the Monmouth Formation, called Mt. Laurel at the surface. These Cretaceous formations are exposed in the Chesapeake and Delaware Canal and are fossiliferous.

In the northern half of the Delaware Coastal Plain the time boundary between the Cretaceous and Paleocene-Eocene (ca 63 million years ago) is located within the Homerstown Formation. No Oligocene deposits are known to be present, and it is believed that the sea retreated from the area.

During the Miocene, the sea returned to cover much of the Coastal Plain and deposition of sediment resumed. A sequence of silt containing two sand intervals, forms most of the Chesapeake Group. Additional sands and silts occur toward the southeast where the Chesapeake attains its maximum thickness in Delaware of over 1,000 feet. Sands within the Chesapeake are sources of ground water and are named from oldest to youngest, the Cheswold, Frederica, Manokin, and Pocomoke aquifers. No sediments of proven Pliocene age are known from the Coastal Plain.

During Pleistocene time, less than about one million years ago, the advance and retreat of the continental glaciers brought about changes in sea level and in the sediment amounts carried by streams which drained into Delaware. The Columbia Formation, consisting mostly of coarse sand with gravel, was deposited on the stream-channeled surface formed on the truncated edges of the Cretaceous and Tertiary beds and thus is a sheet of irregular thickness that covers much of the Coastal Plain. During a later phase of higher-than-present sea level, the sea reworked these continental deposits in the southern part of the State. The latest, Holocene "Recent", sea level rise, starting 15,000 years ago, has resulted in marsh-filling adjacent to the coast. Total maximum thickness of all Coastal Plain sedimentary units is over 10,000 feet (at Fenwick Island).

ROCKS AND MINERALS

Minerals are naturally occurring, inorganic substances with characteristic physical and chemical properties. Common examples found in Delaware are quartz (hard, glassy luster), mica (cellophane-like pieces), and feldspar (waxy or pearly luster, cleavage).

In nature minerals are usually found in mixtures with other minerals. A natural specimen containing several minerals is called "a rock." A common example is granite, which is a mixture of quartz, feldspar, mica, and usually other dark minerals.

ROCKS

The rocks that underlie Delaware are found in two geologic provinces:

-The Appalachian Piedmont ("foot of the mountains") north of a line between Newark and Wilmington, and the Atlantic Coastal Plain, south of that line.

-The Piedmont contains schists, gneisses, pegmatites, gabbro, and other igneous and metamorphic rocks. They can be found exposed in many road cuts in northern New Castle County. usually the upper part of the Piedmont rocks are highly weathered. The Coastal Plain contains unconsolidated gravels, sands, and clays. These sedimentary rocks can be found in innumerable sand and gravel pits south of the Newark-Wilmington area.

PERMISSION TO ENTER IS USUALLY REQUIRED.
Sand and gravel are Delaware's major mineral industries. Over \$6 million worth is extracted yearly.

MINERALS

The collecting of minerals in Delaware is not nearly as fruitful as collecting fossils.

However, there are some places of interest to the mineral collector in Delaware. Sand and gravel pits in the Coastal Plain frequently have interesting pebbles brought into Delaware as glacial outwash within the last million years. These are commonly black, tan, or reddish chert, sometimes containing Paleozoic fossils from the Appalachians.

Small garnets are found in rocks of the Piedmont, particularly in Wooddale Quarry, near Hoopes Reservoir.

PERMISSION REQUIRED FROM LAND OWNER.

White kaolin clay in this area was formerly used for fine china. The clay can be seen in pits between Hockessin and Yorklyn.

Serpentinite is exposed on Road 269 on the west shore of Hoopes Reservoir near Mt. Cuba.

**ACCESS TO HOOPES RESERVOIR IS VERY LIMITED,
BY LAW.**

Limonite, goethite, and other iron minerals are found in the Pleistocene gravel pits of the Coastal Plain, and in weathered gabbro in Iron and Chestnut Hills.

One of the most interesting of the State's minerals is glauconite (greensand). It is found in old pits in the Odessa-Middletown area. It is a complex potassium, iron, aluminum silicate mineral. Delaware greensand, particularly near Odessa, may be up to 95 percent glauconite, some of the purest in the world. The other constituents are mostly quartz.

Greensand was formerly used by farmers in Delaware as a fertilizer because it is a source of potash. In New Jersey and Maryland it is now mined for use as a soil conditioner and in water softening cartridges.

Research indicates that greensand may be useful in treating industrial waste water and landfill leachate.

DELAWARE STATE MINERAL

By action of the Delaware General Assembly in March 1977, Sillimanite was selected as the State Mineral of Delaware.

Sillimanite is a white, brownish, or greenish, aluminum silicate (Al_2SiO_5) found in intensely metamorphosed rocks. In Delaware it is found in the Hoopes Reservoir and Brandywine Springs.

ADDITIONAL INFORMATION

The Delaware Geological Survey is unable to provide samples of the rocks and minerals mentioned above with the exception of greensand. The Delaware Mineralogical Society (P. O. Box 533, Newark, DE 19711) has members who actively trade mineral specimens.

We suggest that requests for sillimanite and other minerals be sent to them.

FOSSILS

Fossils are any evidence, direct or indirect, of a pre-existing plant or animal in the rock record. The most popular area for collecting fossils in Delaware is the Chesapeake and Delaware Canal area. Other areas are indicated on the map on page 14.

DESCRIPTIONS OF CRETACEOUS FORMATIONS

MOUNT LAUREL - Kml

GRAY, GREEN, TO RED-BROWN, GLAUCONITIC, FINE TO MEDIUM QUARTZ SAND WITH SOME SILT, EXTENSIVELY BURROWED BY CRUSTACEANS AND MOLLUSKS, VERY ABUNDANT GASTROPODS, PELECYPODS, AMMONITES AND OTHER FOSSILS

MARSHALLTOWN - Kmt

DARK GREENISH-GRAY, MASSIVE, HIGHLY GLAUCONITIC, VERY SILTY FINE QUARTZ SAND, ABUNDANT MOLLUSKS

ENGLISHTOWN - Ke

LIGHT GRAY AND REDDISH-BROWN, FINE SAND, BURROWED, SPARINGLY FOSSILIFEROUS, ECHINIODS FOUND

MERCHANTVILLE - Kmv

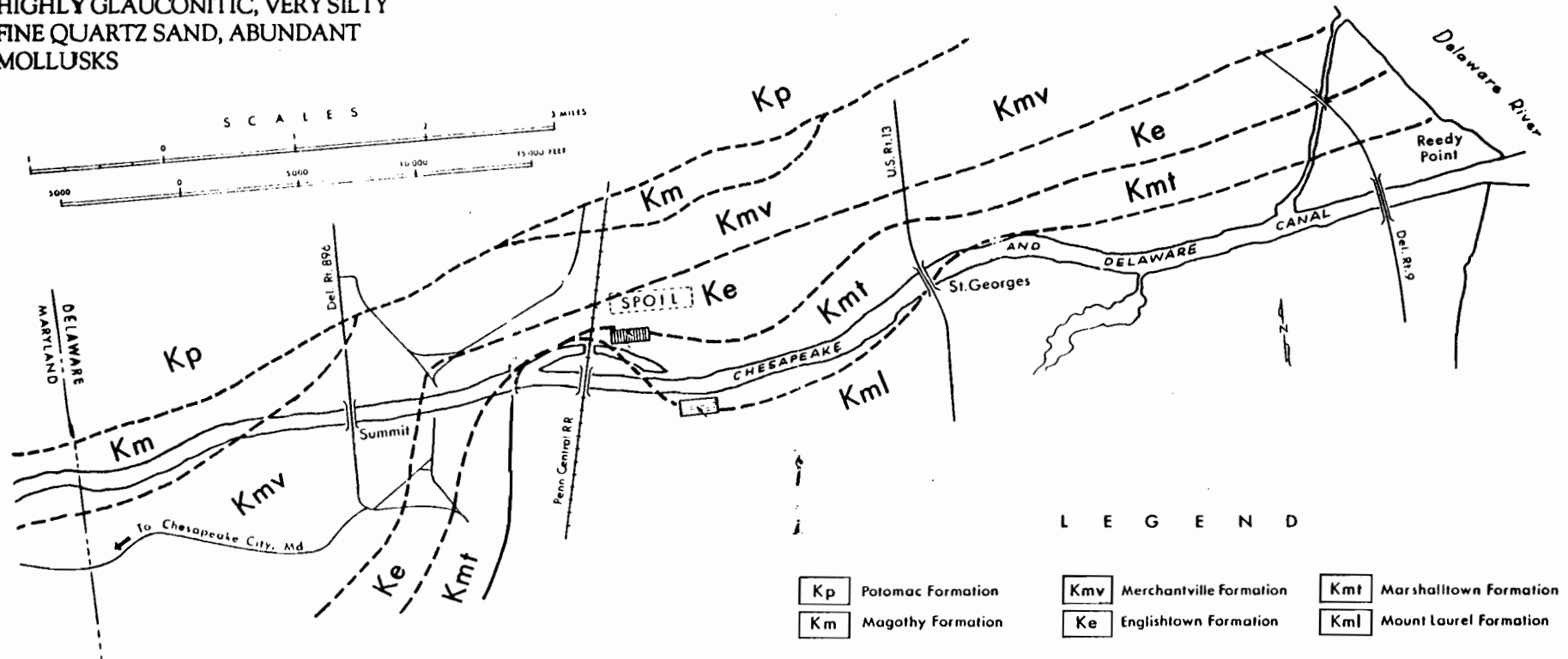
DARK GRAY TO BLUE, MICACEOUS, GLAUCONITIC SANDY SILT AND FINE SAND, VERY STICKY WHEN WET, LARGE AMMONITES AND MOLLUSKS

MAGOTHY - Km

WHITE AND BUFF, QUARTZ, SAND; GRAY TO BLACK, CLAYEY SILT CONTAINING MUCH LIGNITE AND SULFIDE MINERALS, NO MARINE FOSSILS

POTOMAC - Kp

VARIEGATED RED, GRAY, PURPLE, YELLOW, AND WHITE SILTS AND CLAYS, SAND, NO MARINE FOSSILS



FOSSIL COLLECTING IN THE CANAL AREA

The Chesapeake and Delaware Canal has been one of the most prolific fossil collecting areas in the northern Atlantic Coastal Plain. In recent years collecting at the C & D Canal has been less fruitful than when this guide was first issued.

The Canal cuts have exposed several highly fossiliferous formations of Cretaceous age. Cretaceous time covered a period from about 63 million years ago to nearly 135 million years before present time. Fossils found here represent life forms which existed for a good portion of that distant period of time and lived in a shallow sea or intertidal environment.

As these fossils tell us of the past and as the Canal exposures are unique for their learning value, collectors are urged to observe the rules and regulations covered herein. By doing so you will help us preserve this valuable natural textbook. Pits and other privately owned properties should be entered only by obtaining the owner's permission.

**FEDERAL LAW PROHIBITS COLLECTION OF
FOSSILS FOR COMMERCIAL PURPOSES ON
FEDERAL LANDS.**

TYPES OF FOSSILS

Most fossils found in the Canal area are called "steinkerns." These are internal molds left when the shell filled with mud which later hardened and the shell dissolved. However, many original shells are also preserved.

Fish and reptilian bones, including vertebrae and teeth also are found in the Cretaceous deposits, mostly in the Marshalltown and Mount Laurel formations.

Specimens of the types of fossils found here are on display at the Delaware Geological Survey Building, University of Delaware, Newark, Delaware. A display may also be found at the Iron Hill Museum, Old Baltimore Pike, Newark, Delaware, and at the Corps of Engineers Museum in Chesapeake City, Maryland.

CAUTION

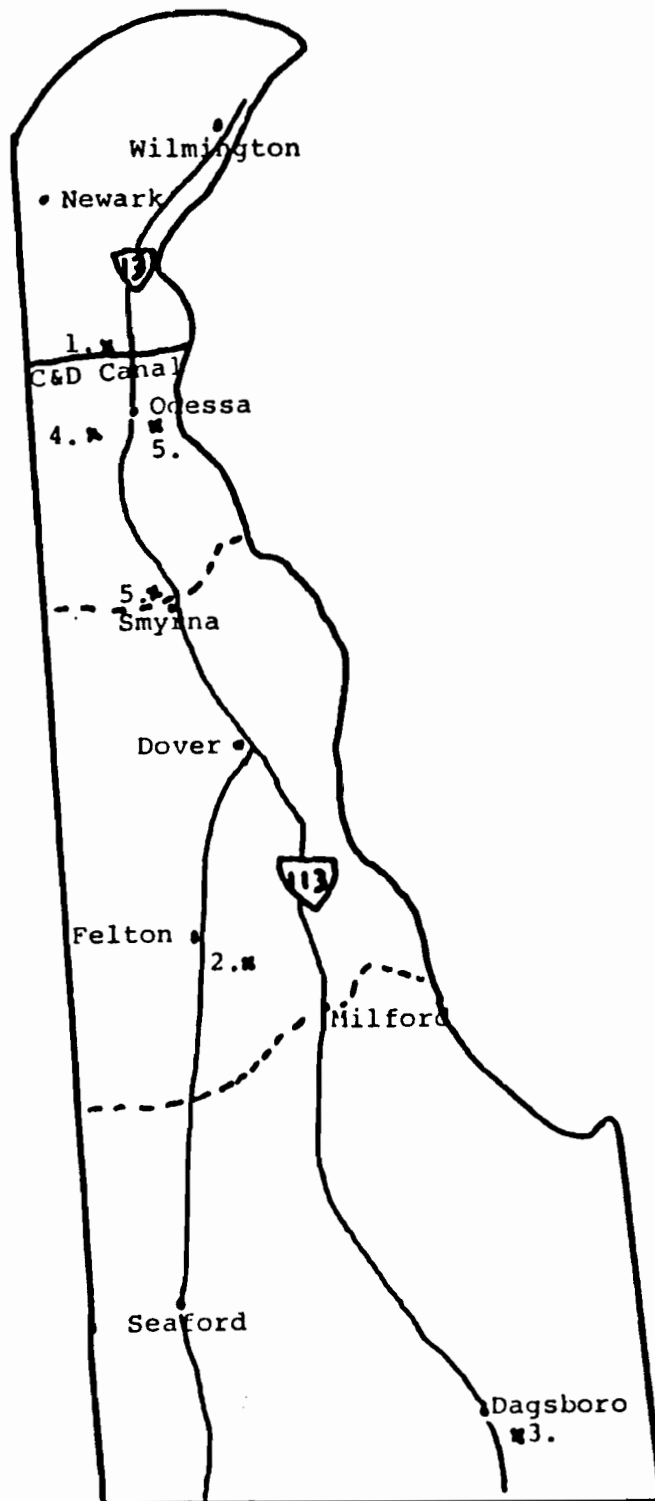
It is recommended that fossil collection **NOT** be done in the Canal slopes below the rock protection. Canal sides and bottom fall away rapidly, and wading in this zone can be hazardous. Please observe the warning signs posted along the Canal and in the designated collection areas.



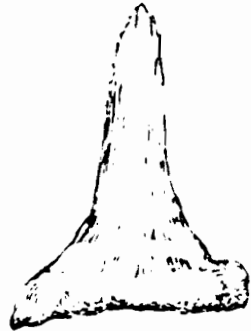
SELECTED FOSSIL COLLECTING LOCATIONS (PLEASE SEE MAP OPPOSITE)

- 1 - CRETACEOUS FOSSILS - FOUND ALONG THE CHESAPEAKE AND DELAWARE CANAL IN THE SPOIL DUMPS AND OCCASIONALLY IN CANAL BANKS.
- 2 - MIOCENE FOSSILS - FOUND POORLY PRESERVED AT COURSEY AND KILLEN PONDS IN BANKS AT WATER LEVELS.
- 3 - PLEISTOCENE MARINE FOSSILS - FOUND IN PARTICULAR ABUNDANCE WHERE HIGHWAY 113 CROSSES PEPPER CREEK AT DAGSBORO.
- 4 - PLEISTOCENE PLANT IMPRESSIONS - FOUND IN STATE SAND AND GRAVEL PIT JUST SOUTH OF MIDDLETOWN ON HIGHWAY 896.
- 5 - SILICIFIED WOOD - FOUND IN ODESSA AND SMYRNA AREAS IN BASE OF GRAVEL PITS AND OCCASIONALLY IN PLOWED FIELDS. SOME MIOCENE MOLLUSCS AND VERTEBRATES HAVE BEEN FOUND IN THE SMYRNA AREA.

MAP SHOWING FOSSIL COLLECTING LOCATIONS IN DELAWARE.



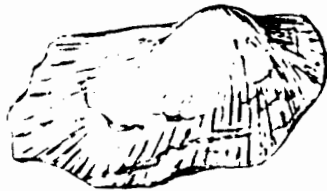
EXAMPLES OF FOSSILS FOUND ALONG
THE C & D CANAL



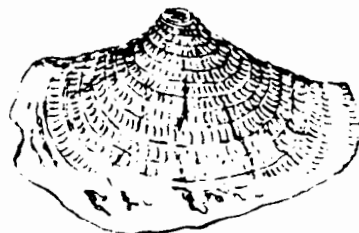
SHARK'S TOOTH



TEREBRATULINA
COOPERI



NEMODON
ENFAULENSIS



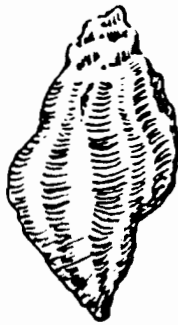
CYMELLA
BELLA



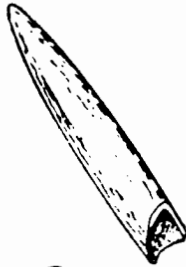
BELISCALLA
CRIDERI



CALLIOMPHALUS
SP.



RHOMBOPSIS
MARYLANDICUS



BELEMNITELLA
AMERICANA



OSTREA
MEENTERICA



EXOZYRA
PONDEROSA

HELPFUL PUBLICATIONS

- *Groot, J. J., Organist, D. M., and Richards, H. G., 1954, Marine Upper Cretaceous formations of the Chesapeake and Delaware Canal: Delaware Geological Survey, Bulletin No. 3, 64 p.
- Groot, J. J., and Penny, J. S., 1960, Plant microfossils and age of nonmarine Cretaceous sediments of Maryland and Delaware: *Micropaleontology*, v. 6, no. 2, p. 225-236.
- Lauginiger, E. M. and Hartstein, E. F., 1983, A guide to fossils sharks, skates, and rays from the Chesapeake and Delaware Canal area, Delaware: Delaware Geological Survey Open File Report No. 21, 64 p.
- Lauginiger, E. M., 1988, Cretaceous fossils from the Chesapeake and Delaware Canal: A guide for students and amateurs: Delaware Geological Survey Special Publication No. 18, 57p.
- Morton, S. C., 1829, Description of the fossil shells which characterize the Atlantic Secondary Formation of New Jersey and Delaware: *Academy of Natural Science Philadelphia Journal*, v. 6, p. 72-100.
- Owens, J. P., Minard, J. P., Sohl, N. F., and Mello, J. F., 1970, Stratigraphy of the outcropping Post-Magothy Upper Cretaceous formations in southern New Jersey and northern Delmarva Peninsula, Delaware and Maryland: U. S. Geological Survey Professional Paper 674, 60 p.

*Pickett, T. E., 1970, Geology of the Chesapeake and Delaware canal area: Delaware Geological Survey Geologic Map Series No. 1, scale 1:24,000.

Pickett, T. E., Kraft, J. C., and Smith, Kenneth, 1971, Cretaceous burrows - Chesapeake and Delaware Canal, Delaware: Journal of Paleontology, v. 45, no. 2, p. 209-211.

Pickett, T. E., 1972, Guide to common Cretaceous fossils of Delaware: Delaware Geological Survey Report of Investigations No. 21, 28 p.

Richards, H. G., et al., 1958, The Cretaceous fossils of New Jersey: New Jersey Geological Survey Bulletin 64, Part 1.

*Richards, H. G., and Shapiro, Earl, 1963, An invertebrate macrofauna from the Upper Cretaceous of Delaware: Delaware Geological Survey Report of Investigations No. 7, 37 p.

Spoljaric, Nenad, and Jordan, R. R., 1966, Generalized Geologic Map of Delaware: Delaware Geological Survey, revised 1976.

Woodruff, K. D. 1986, Geohydrology of the Chesapeake and Delaware Canal Area, Delaware, Sheet 1, Basic Geology: Delaware Geological Survey Hydrologic Map Series No. 6, scale: 1:24,000.

* * * * *

Out-of-Print Reports

Publications which are out-of-print and no longer available for distribution are marked with an asterisk(*). These items may be examined at many libraries or at the Survey office.

Revised 1992

Compiled by T. E. Pickett and D. C. Windish
Originally published in cooperation with
Delaware Division of
Economic Development in 1980.