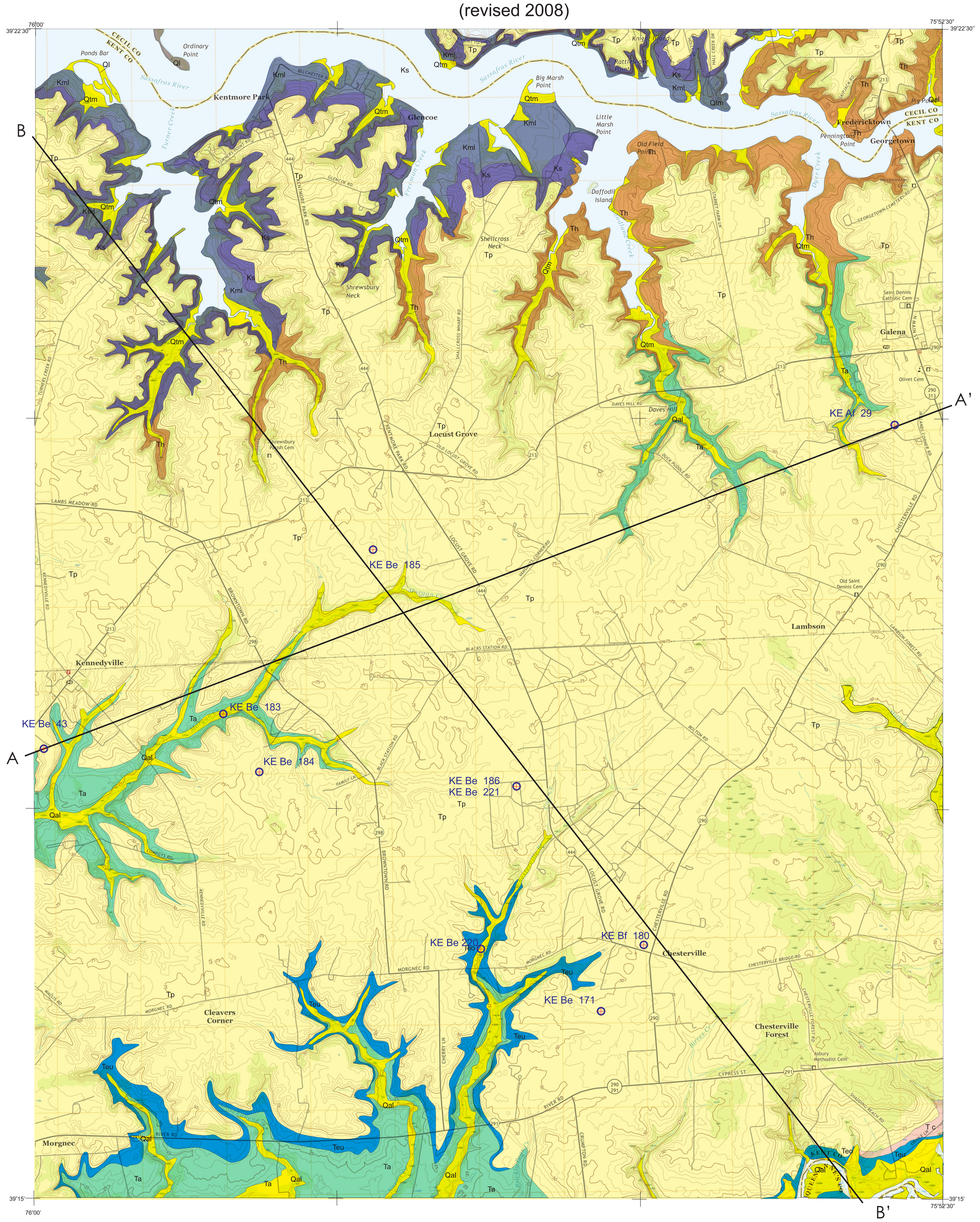
Geologic Map of the Galena Quadrangle, Maryland

by
John M. Wilson
2006
(revised 2008)

**OPEN FILE MAP
Subject to Revision**



SCALE 1:24 000

CONTOUR INTERVAL 5 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

DESCRIPTION OF MAP UNITS

Quaternary

Qm — **Tidal Marsh deposits -** Interbedded sand, silt, and clay rich in organic matter. Thickness generally less than 30 feet.

Qal — **Alluvium -** Stream deposits consisting of sand, silt, clay, gravel, and organic matter. Locally contains boulders and other colluvial deposits. Thickness generally less than 40 feet.

Ql — **Lowland deposits -** Yellow-brown, thin-bedded, fine-grained sand and silt, micaceous and locally glauconitic. Deltaic and flood-plain deposits. Thickness ranges from 0 to 20 feet.

Tertiary

Tp — **Pensauken Formation-** Light yellow to orangish tan, in places oxidized to deep reddish brown, feldspathic, fine to coarse, cross-bedded sand, with thin to thick beds of gravel. Base of formation characterized by gravelly channel-lag deposits. Upper part of formation is generally a fine to medium sand and loam, but may include gravelly beds and stringers. Clasts include vein quartz, crystalline rocks, sandstones and siltstones. Thickness ranges from 0 to about 40 feet. Locally thicker in paleochannels.

Tc — **Calvert Formation - (Miocene) -** Clay, slightly silty, medium greenish gray (5GY 4/2), very stiff, plastic. Calvert sediments occur cuts of the Chester River. Thickness less than 10 feet.

Teu — **Unamed unit-** Fine to medium glauconitic quartz sand, dusky brown in color. Questionably Eocene in age. Thickness ranges from 0 to 20 feet.

Ta — **Aquia Formation -** Fine- to medium- grained, glauconitic quartz sand,clayey in places, dark to light green and yellow where fresh, weathers to yellow brown and dusky dark orange. Thickness ranges from 0 to 140 feet.

Th — **Hornerstown Formation -** Very dense, fine-grained, silty and clayey, olive black, glauconitic sand, Glauconite comprise from 60 to 90 percent of sand. Dark green polylobate grains of glauconite are marginally altered to limonite. Thickness ranges from 10 to 70 feet.

Cretaceous

Ks — **Severn Formation -** Olive-black to olive-brown glauconitic sand with phosphate nodules commonly present. Fossils include *Belemnitella americana* and *Exogyra cancellata.* Thickness ranges from 15 to 30 feet. .

Kml — **Mount Laurel Formation -** Medium light gray to light olive gray, fine- to medium- grained, glauconitic, quartz sand. Shelly and calcareous in places. Weathers yellow to yellow brown. Fossils include *Belemnitella americana* and *Exogyra cancellata.* Thickness ranges from 50 to 70 feet.

Formations in Cross-Sections Only

Kma — **Marshalltown Formation -** Greenish black, fine-grained, glauconitic, silty sand. Glauconite makes up to 90 percent or sediment. Glauconite grains are dark green and polylobate. Thickness is about 20 feet. Known from subsurface only.

Ket — **Englishtown Formation -** Olive gray and dark yellowish brown, fine- to medium-grained, silty sand. Locally, micaceous, glauconitic and lignite-bearing. In places, partia/lly lithified with limonite cement. Generally coarsens upward from underlying Merchantville Formation. Thickness is about 15 feet. Known from subsurface only.

Kmt — **Merchantville Formation -** Medium dark gray to dark gray, very fine, silty and clayey micaceous and glauconitic sand. Becomes very dense and more clayey with depth. Thickness is about 70 feet. Known from subsurface only.

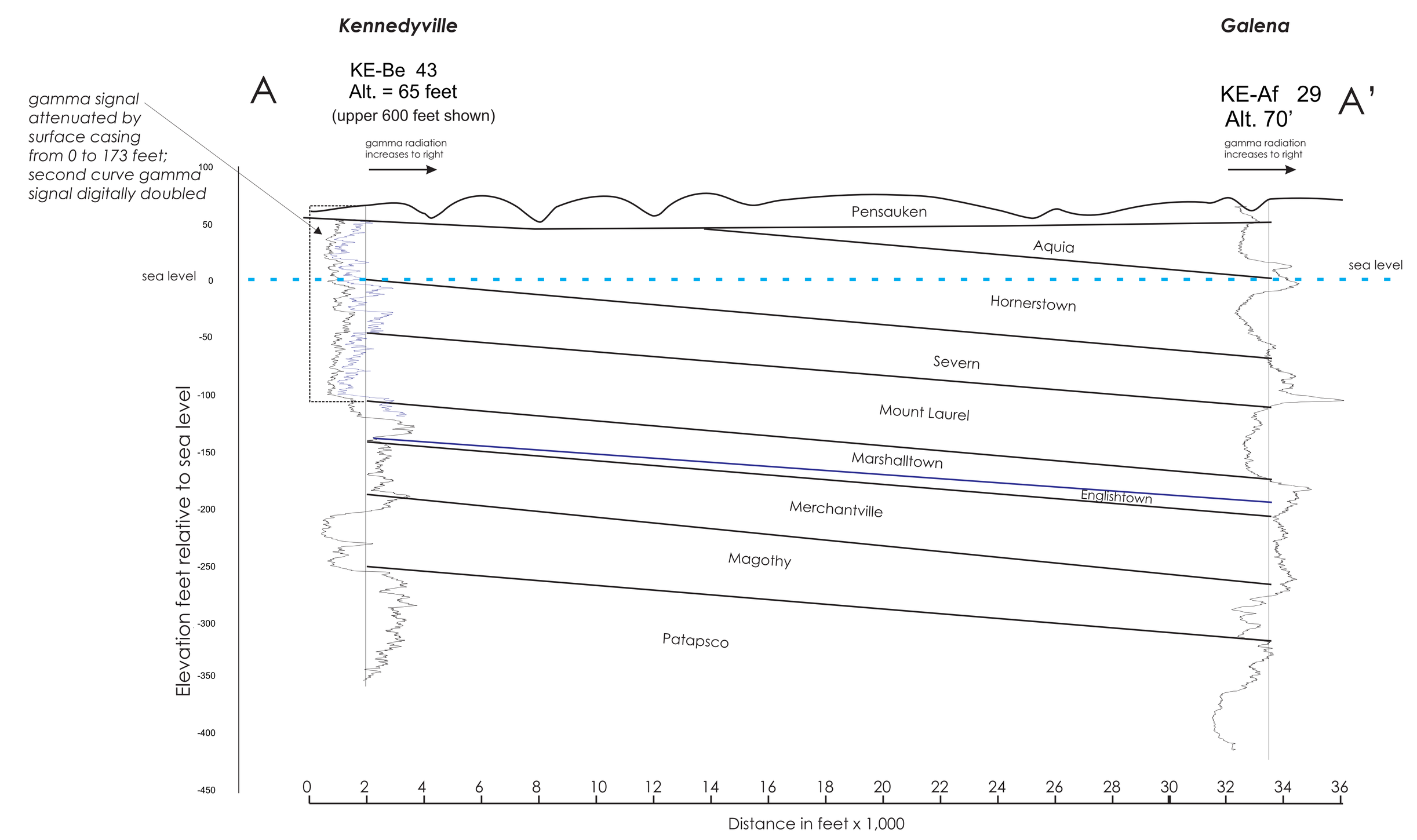
Kmg — **Magothy Formation -**White to light gray and buff, fine to medium-grained quartz sand. Sand is lignitic in places with flattened carbonized logs present. Unit also contains black to dark gray pockets of clays and silty sands. Sands are cross-stratified in places. Light gray to light pinkish gray, plastic clay present just below contact with overlying Merchantville Formation. Thickness is approximately 50 feet. Known from subsurface only.

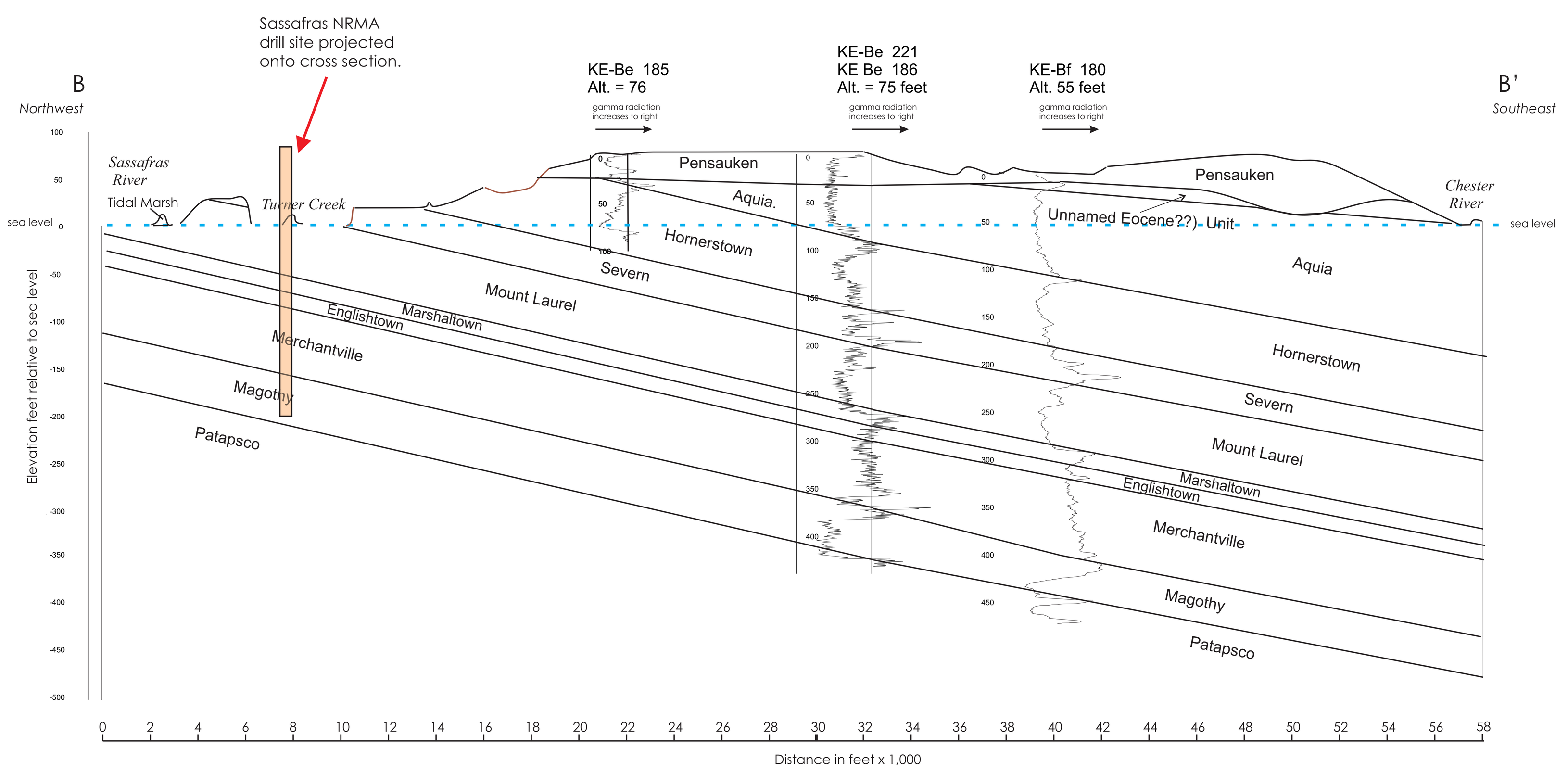
Kp — **Potomac Group -** Patuxent and Arundel formations undifferentiated. Patapsco Formation is brown to yellow-brown, fine- to medium-grained, quartz sands that is silty and gravelly in places. Locally unit is multicolored to mottled, red-brown to, purple and gray, dense clays. Sands often shows planar and cross-stratification. In places, dark gray clays may contain carbonized plant fossils, lignite and carbonized logs. Thickness ranges from about 1,000 feet in the northwestern part of the quadrangle to 1,500 feet in the southeastern part. Known from subsurface only.

MAP SYMBOLS

KE Be 221 — Well or testhole location and number

A — A' — Line of section - see Plate 2 for cross sections



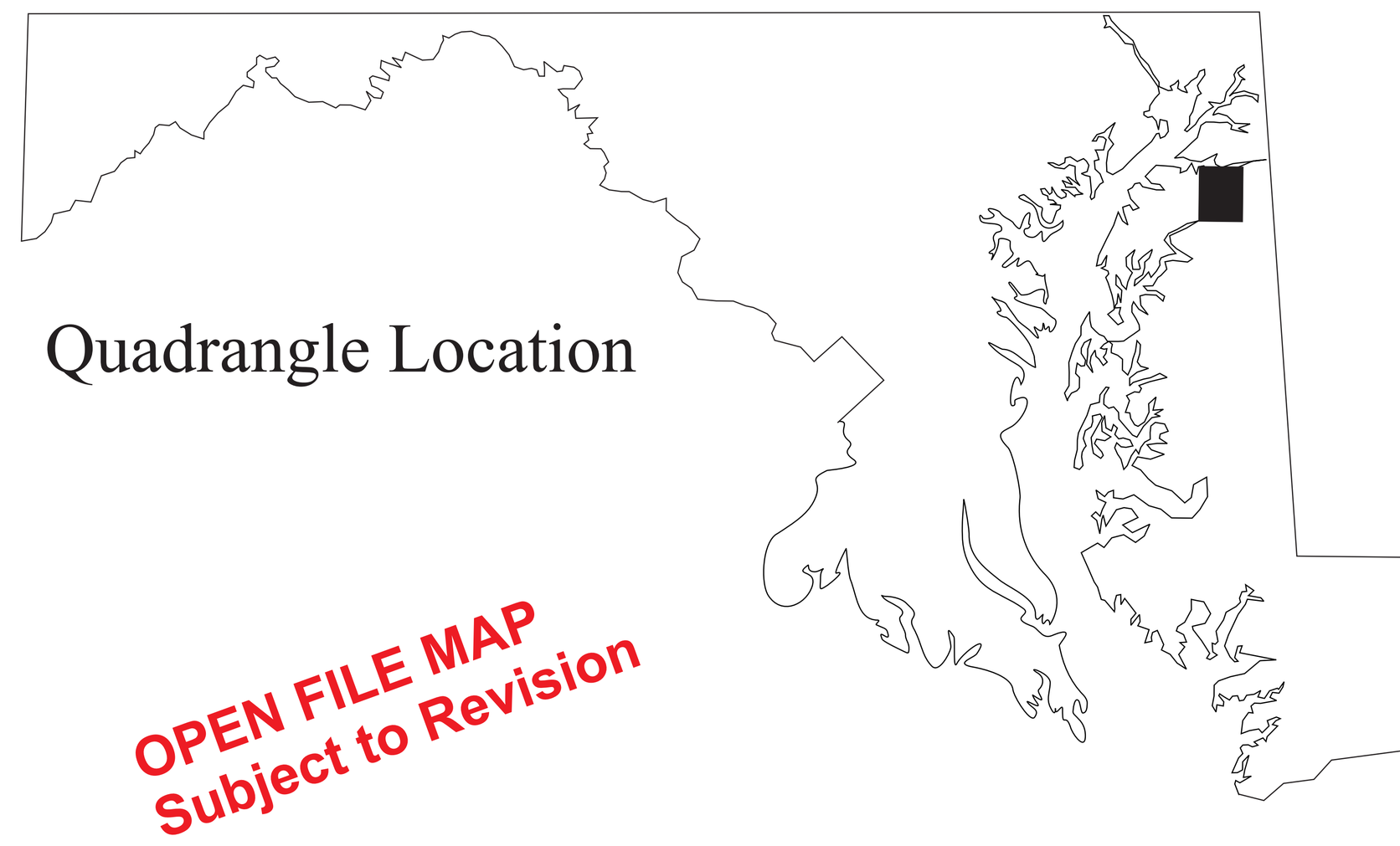


INTRODUCTION

The Galena quadrangle lies on the northwest flank of the Salisbury Embayment in the Atlantic Coastal Plain Province (fig. 1). The region is locally known as the upper Eastern Shore of Maryland because it is the northern section of Maryland's Coastal Plain that lies east of the Chesapeake Bay. The Salisbury Embayment is an open to the east, down-warped sedimentary basin. Sediments in the embayment range in age from Triassic to Holocene. These sediments thicken from a few feet in the Fall Zone, the boundary between the Piedmont Plateaus Province and the Coastal Plain Province, to over 7,000 feet at Ocean City, Maryland (figs. 1 and 2). Basement rocks do not outcrop in the quadrangle, but were penetrated at a depth of 1,504 feet below sea level in drill hole KE Be 33 at Kennedyville on the western border of the quadrangle. Drill cuttings recovered from the bottom of KE Be 33 were a muscovite-biotite-plagioclase-quartz gneiss (Hansen and Edwards, 1979). These rocks are similar to the schist and gneiss outcropping to the west in the eastern Piedmont of Maryland, and indicates that Piedmont rocks continue eastward under the Coastal Plain (Hansen and Edwards, 1979; 1986). Depth to basement ranges from about 1,400 feet below sea level in the northwest corner of the Galena quadrangle to about 2,000 feet below seal level in the southeast corner.

In the Galena Quadrangle, exposed sediments range in age from Cretaceous to recent. Sands and clays of the Upper Cretaceous Mount Laurel Formation are exposed along the banks of the Sassafras River in the western part of the quadrangle. The Upper Cretaceous Severn Formation also is exposed in the upper parts of bluffs along the river, overlying the Mount Laurel and underlying the Plio-Pleistocene sand sheets of the Pensauken Formation that cap the bluffs. Proceeding eastward along the Sassafras River, the Lower Paleocene Hornerstown Formation is exposed in places. Not outcropping, but only occurring in the subsurface in the Galena quadrangle, are the Lower to Upper Cretaceous Patapsco Formation, and the Upper Cretaceous Magothy, Merchantville, Englishtown, and Marshalltown Formations. These units and the relation of the overlying Tertiary units are shown in cross-section A-A'. In the subsurface and exposed in stream valleys in the northern, western, and southwestern parts of the quadrangle is the Upper Paleocene Aquia Formation. In the sourtheastern parts of the quadrangle the Oligocene Old Church Formation is tentatively mapped as outcropping along the stream valleys on the northern banks of the Chester River.

The regional depositional strike of the pre-Pensauken units trends southeast - northwest at a bearing of about north-40°-east. The regional dip of the Eocene (?) age units is about 35 feet per mile while that of the age unit is about 20 feet per mile. The Plio-Pleistocene age Pensauken Formation has truncated and capped the gently dipping older units over much of the quadrangle. The Pensauken forms a broad gravelly-sand sheet that averages about 15 to 35 feet thick. Thicker paleochannels infilled with Pensauken sands are probalby present in parts of the quadrangle, mapping of these paleochannels is still preliminary. Quaternary alluvium and tidal marsh deposits are common along streams and tidal rivers. The deposits mapped as the informal unit Quaternary lowland deposits" consist of esturarine and fluvial sands and clays.



**OPEN FILE MAP
Subject to Revision**

Adjoining 7.5-minute quadrangles
(Galena quadrangle shaded)

1	2	3	1 Spesutie 2 Earlville 3 Cecilton
4	(shaded)	5	4 Betterton 5 Millington
6	7	8	6 Chestertown 7 Church Hill 8 Sudlersville

DEPARTMENT OF NATURAL RESOURCES
Jeannie Haddaway-Riccio
Secretary

MARYLAND GEOLOGICAL SURVEY
Richard A. Ortt
Director

STATE OF MARYLAND
Lawrence J. Hogan
Governor

Boyd K. Rutherford
Lieutenant Governor

GEOLOGIC CROSS SECTIONS

The cross sections are keyed into natural gamma logs of the boreholes and the datum used is sea level. Gamma log deflections to the right indicate increasing gamma radiation, and in general, the greater the gamma log response, the more clayey, or higher the content of gamma-ray emitting minerals such as glauconite or uranium-bearing phosphate nodules in in the sediment. The differing gamma response with depth makes the gamma log a useful tool in correlating the units in the subsurface as different units can have characteristic gamma-log signatures because of their mineralogy. Resistivity, induction, and conductivity logs, along with core, cuttings and paleontological data were used with the gamma logs to make the correlations on the cross sections. Data from core holes KE Be 221 drilled in 2006 as part of the STATESMAP supported mapping of the Galena quadrangle were integrated and correlated with other subsurface data in the Galena quadrangle and with data from core hole KE Bf 180 (Hansen, 1992) and data from four core holes drilled as part of a ground-water study in area (Bachman, Krantz, and Bohlke, 2002). Section A-A' runs southwest to southeast across the quadrangle somewhat oblique to the regional strike from test hole KE Be 43 at Kennedyville to well KE Af 29 at Galena. Section B-B' is a dip section that runs northwest to southeast through the quadrangle from outcrops in bluffs along the Sassafrass River southeastward through coreholes KE Be 185, KE Be 186, KE Be 221, and KE Be 180 to the banks of the Chester River. Table 1 list the boreholes used to construct the cross sections and geologic map.

CRETACEOUS UNITS

Potomac Group – Lower to Upper Cretaceous (Patuxent and Arundel Formations undifferentiated, Patapsco Formation and Raritan Formation)

The Lower to Upper Cretaceous Potomac Group is of mostly fluvial origin, but part of the section does record do record fluvio-deltaic influences and occasional marine incursions. Units of the Potomac Group present in the subsurface of the Galena quadrangle are the Lower Cretaceous Patuxent and Arundel Formations undifferentiated and the Lower to Upper Cretaceous Patapsco Formation and possibly sands assigned to the Upper Cretaceous Raritan Formation. The sediments of the Potomac Group are mostly brown to yellow, fine to medium, quartz sands, that are silty and gravelly in places, and thick multicolored, mottled, red, brown, purple, and gray, dense clays. Sands often show planar and cross-stratification. As can be seen in well KE Af 29, the upward fining sands of the Potomac Group form important aquifer sands in the region. The Potomac Group in KE Be 43 at Kennedyville is 1,280 feet thick and thickens to about 1,600 feet in the southeastern section of the quadrangle. The upper section of the Potomac Group shown on sediments penetrated in KE Bf 180 and Be 221 are assigned to the Patapsco Formation and in KE Bf 180, a unit within the Potomac Group. Brenner in Hansen (1992) assigned the sample taken at 461 feet in KE Bf 180 to the upper Cretaceous Raritan Formation based pollen analysis indicating a Middle Cenomanian (Zone IV) stage assignment. The sample taken at 478 feet in KE Bf 180 was determined by Brenner to be upper Albian (Zone IIC) which places the sample in the upper part of the Patapsco Formation.

Magothy Formation – Upper Cretaceous

Overlying the Potomac Group sands is the Magothy Formation. Sediments of the Magothy are white to light gray and buff, fine to medium, in places sucrosic, quartz sands, and black to dark gray clays with some silty sand. Lignite and flattened carbonized logs are relatively common. The Magothy is marginal marine, more specifically a fluvio-deltaic strand line deposit. The Magothy represents the beginning of a major late Cretaceous marine transgression and general sea level rise. In the Galena quadrangle, the Magothy is about 55 feet thick and is only present in the subsurface. In corehole, KE Bf 18 on section B-B', the base of the Magothy is placed at the base of a gravelly sand at 448 feet based on lithology and correlation with KE Be 221. Hansen (1992) placed the sand from 422 feet to 448 feet in the Raritan Formation. Hhowever, the Raritan-age pollen was found at 461 feet and the bracketing positive pollen sample in KE Bf 180 was determined by Brenner (Hansen 1992) to be middle Campanian to early Cenomanian indicating a Magothy Formation assignment at 419 feet. As Hansen (1992) observed the "Raritan question" in Maryland remains unresolved. In the subsurface, a blocky gamma log signature with a sharp erosive base often characterizes the Magothy. Sands of the Magothy Formation form a major aquifer in the region.

Merchantville Formation – Upper Cretaceous

Overlying the Magothy is the Merchantville Formation. The Merchantville is a medium gray to black, mica and glauconite bearing, silty and fine clayey sand and silt. The basal Merchantville represents a deeper water environment than the Magothy. In the lower part of the section the Merchantville is more clayey and becomes increasingly dense with depth. The Merchantville generally coarsens upward indicating a general shallowing during deposition. The Merchantville is about 70 feet thick in the quadrangle. The lower part of the Merchantville is very carbonaceous in corehole KE Be 221. Overlying the Merchantville in the central and southeastern parts of the quadrangle in a generally gradational contact is the Englishtown Formation.

The contact of the Merchantville with the underlying Magothy is unconformable and in outcrop and coreholes from southern Cecil County, the contact is characterized by a burrowed surface, pyritized nodules, small pebbles and lignite. A light gray to light pinkish gray, stiff plastic clay is in places found just below the contact.

Englishtown Formation – Upper Cretaceous

The Englishtown Formation is a silty and sandy unit that forms the uppermost regressive part of the Merchantville sequence The Englishtown Formation is an olive-gray and dark yellowish brown, fine to medium, silty sand, micaceous, lignite-bearing and sparingly glauconitic. In places, it is partially lithified with limonite cement. In KE Be 43, the Englishtown Formation does not appear to be present and in the southeastern coreholes, the Englishtown appears to be a more silty than to the north of the Sassafras River in Cecil County. This is apparently caused by a facies change. The Englishtown ranges from 0 to about 20 feet thick in the Galena Quadrangle, and is only present in the subsurface.

Marshalltown Formation – Upper Cretaceous

The Marshalltown Formation overlies the Englishtown Formation, and where the Englishtown is not readily identifiable, the Merchantville Formation (see KE Be 43). The Marshalltown is a green-black, fine silty sand, heavily glauconitic (60 to 90 percent glauconite). The glauconite grains are dark green and polylobate. The unit averages about 18 feet thick. The glauconite derived gamma kick of the Marshalltown is characteristic when juxtaposed between the underlying Englishtown and Merchantville Formations and the overlying Mount Laurel Formation, The Marshalltown gamma-kick forms a useful marker bed for correlation in this part of the section. The Marshalltown is only present in the subsurface in the Galena quadrangle.

Mount Laurel Formation – Upper Cretaceous

The Upper Cretaceous Mount Laurel Formation is a medium light gray to olive gray, fine to medium, glauconitic quartz sand that is shelly and calcareous in places. Glauconite makes up about 15 percent of the sand fraction and macrofossils include *Belemnitella americana*, and *Exogyra cancellata* (Conant, 1990). The Mount Laurel weathers to yellow and yellow brown. The Mount Laurel outcrops along the Sassafras River in the Galena quadrangle, and to the west in the adjacent Betterton quadrangle (Minard 1974). The maximum thickness in the Galena quadrangle is about 70 feet. The Mount Laurel Sand is a major aquifer in the region. Outcrops of the Mount Laurel are present along the Sassafras River.

Severn Formation – Upper Cretaceous

The late Maastrichtian Severn Formation is mostly an olive-black to olive-brown heavily glauconitic sand and sandy clay and fine to in places medium sand. The Severn is about 35 feet thick in the Galena Quadrangle, and is characterized by three Formation gives a prominent gamma spikes on the gamma log from KE Be 221. Phosphate nodules are common in the lower interval, it may be that uranium in the these nodules causes the very prominent gamma spike characteristic of the basal Severn Formation. The Severn Formation in the Galena quadrangle represents a relatively deepwater environment with slow deposition as a condensed marine section in the basal 12 to 15 feet. The upper 15 to 20 feet of the formation appear are generally more sandy and indicative of a more active depositional environment. Sediments assigned to the Severn Formation are present in outcrop along the Sassafras River

The contact between the Severn Formation with the overlying lower Paleocene Hornerstown Formation is placed about 15 feet higher KE Bf 180 than Hansen (1992) placed the contact. This is based on lithology and correlation with KE Be 221 which has a more definitive gamma response than KE Bf 180, a log that appears to have smoothed when it was run and consequently attenuated the upper gamma spike that represents the contact with the overlying Hornerstown Formation.

Table 1: Wells and test-holes in the Galena Quadrangle

Well Number	Altitude (Feet)	Depth (Feet)	Log Depth (Feet)
KE Af 129	70	476	482
KE Be 43	65	1,672	1,672
KE Be 183	68.9	85.0	64.7
KE Be 184	66.6	91.5	90.9
KE Be 185	6.1	94.8	93.6
Ke Be 186	74.5	129.9	127.8
KE Be 220	65.9	277	275
KE Be 221	75	430	430
KE Be 171	44.4	450	422.4
KE Bf 180	55	480	473

TERTIARY UNITS

Hornerstown Formation – Lower Paleocene

The early Paleocene (Danian) Hornerstown Formation is about 70 feet thick in the Galena Quadrangle. The lower 15 feet is a dusky dark green, heavily glauconitic sand that overlies the Cretaceous (Maastrichtian) Severn Formation in the Galena Quadrangle. The Hornerstown Formation grades upward to a fine- to medium-grained in places coarse, glauconitic quartz sand. Gamma logs often show a high gamma kick in the lower part of the Hornerstown Formation reflecting a very high glauconite content, and some phosphate nodules. The uppermost Hornerstown Formation then becomes more clayey and glauconitic as is shown on the cross-sections by the increasing gamma log response in the upper part of the formation just below the contact with the overlying Aquia Formation. The Hornerstown is used as an aquifer in the region. The middle and upper sands of the Hornerstown have been historically included in the Aquia aquifer because prior to Hansen's (1992) assignment of these sands to the Hornerstown based on biostratigraphic data, the upper 45 to 50 feet of the Hornerstown section were considered part of the Aquia Formation. Biostratigraphic data (Keller, G., written communication, 2005) from cores taken at 112 and 114 feet in KE Be 186 are Danian in age. KE Be 186 is at the same location as KE Be 221, but only reached a depth of 130 feet. Correlations shown in B-B' place that interval in the upper part of the Hornerstown.

Aquia Formation – Upper Paleocene

The late Paleocene (Thanetian) Aquia Formation overlies the Hornerstown Formation in the southern and central part of the quadrangle. The Aquia is a fine to medium, glauconite-bearing quartz sand, clayey in places, that is dark to light green and yellow where fresh. The unit weathers to a yellow brown and dusky dark orange.

The Aquia Formation is shown as terminating in the northern section about 0.5 miles north of the town of Galena in the northeastern part of the quadrangle, and just south of Kennedy Formation is truncated by the overlying and flat lying Pensauken Formation. The Aquia Formation therefore does not outcrop along the Sassafras River in the Galena Quadrangle. This differs from the distribution previously shown for the Aquia Formation on the Geologic map of Kent County (Clark, 1915) and the geologic map of Cecil County (Conant, 1990). Sediments shown as the Aquia Formation in the Galena Quadrangle are placed in the Hornerstown Formation on this map.

Unnamed Unit - Eocene (?)

This unit is a fine to medium glauconitic quartz sand. Hansen (1992), based on biostratigraphic data, determined that the Oligocene-age Old Church Formation was present in KE Bf 180 from 18.5 to 23 feet below land surface. McClaughlin (personal communication, 2007) indicated an Eocene age is more likely. Lithologically these glauconitic sand are difficult to distinguish from the underlying glauconitic sands of the Aquia Formation, especially where weathered. The distribution of this unit shown on the Galena Quadrangle is based on extrapolation from that interval in the KE Bf 180 and correlation with logs to the east-southeast of KE Bf 180 in the neighboring Millington Quadrangle.

Pensauken Formation - Pliocene - possibly Pleistocene

The Pliocene to possibly Pleistocene Pensauken Formation is a light-yellow to orange-tan, oxidized to reddish-brown, feldspathic, fine- to coarse-grained, cross-bedded sand, with localized thin to thick beds of gravel. Gravelly channel-lag deposits characterize the base of the formation. The upper part of the formation is generally a fine- to medium-grained sand and loam, but may include gravelly beds. Pebble clasts include vein quartz, crystalline rocks, quartzite, and sandstone and siltstone. Thickeness in quadrangle ranges from 10 to 40 feet, but with possibly thicker paleochannel deposits. Mapping of the paleochannels is incomplete at this time, but a paleochannel trend in Cecil County, to the northeast of the Galena quadrangle (Conant, 1990), may continue into this quadrangle. The Pensauken is a fluvial deposit possibly representing deposits of the ancestral Delaware River

QUATERNARY UNITS

Lowland deposits

Yellow-brown, thin-bedded, fine-grained sand and silt, micaceous and locally glauconitic. Deltaic and flood-plain deposits make up most of the formation. Thickness ranges from 0 to 20 feet.

Tidal marsh deposits

Holocene tidal marsh deposits generally consist of interbedded sand, silt, and clay rich in organic matter. The thickness of the deposits is generally less than 30 feet.

Alluvial deposits

Alluvium along streams consists of sand, silt, clay and gravel with some organic material. Locally the deposits may contain boulders, slope-wash and other colluvial deposits. The thickness is generally less than 40 feet.

REFERENCES CITED

Bachman, L.J., Krantz, D.E., Bohlke, J., 2002 , Hydrogeologic framework groundwater geochemsitry, and assessment of nitrogen yield from abase flow in two agricultural watersheds, Kent County, Maryland, U.S. EPA report EPA/600/R-02/008 January 2002, 93 p.

Bachman, L.J., and Wilson, J.M., 1985 The Columbia aquifer of the Eastern Shore of Maryland: Maryland Geological Survey Report of Investigations 40, 144 p.

Conant, L.C., The Coastal Plain of Cecil County, in Higgins, M.W., and Conant, L.C., The Geology of Cecil County Maryland: Maryland Geological Survey Bulletin 37, p. 117 – 183.

Hansen, H.J., and Edwards J., 1979, New data bearing on the significance of the Upper Chesapeake Bay magnetic anomaly: Maryland Geological Survey Report of Investigatons 30, 44 p.

Hansen, H.J., and Edwards, J., 1986, The lithology and distribution of the pre-Cretaceous basement rocks beneath the Maryland Coastal Plain: Maryland Geological Survey Report of Investigations 44, 27 p.

Hansen, H.J., 1992, Stratigraphy of Upper Cretaceous and Tertiary sediments in a core-hole drilled near Chesterville, Kent County, Maryland: Maryland Geological Survey Open-File Report No. 93-02-7, 38 p.

Acknowledgements: This map partially funded by the U. S. Geological Survey, National Cooperative Geologic Mapping Program. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.

Geologic field mapping conducted in 2006-2008. Map layout and contact modification by D.K. Brezinski, 2020.

Version: GALEN2021.OF
Released April 2021