

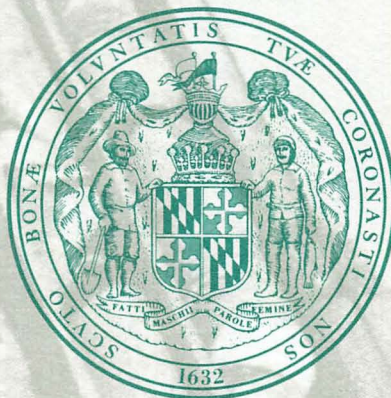
Department of Natural Resources
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

REPORT OF INVESTIGATIONS NO. 44

THE LITHOLOGY AND DISTRIBUTION OF PRE-CRETACEOUS BASEMENT ROCKS BENEATH THE MARYLAND COASTAL PLAIN

by

Harry J. Hansen and Jonathan Edwards, Jr.



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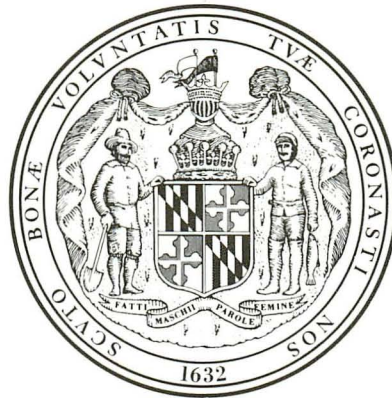
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**THE LITHOLOGY AND DISTRIBUTION
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ABSTRACT

The Maryland Coastal Plain is underlain by a basement complex consisting of Precambrian to Paleozoic crystalline rocks and Mesozoic rift-basin sedimentary and igneous rocks. This report contains a compilation of cuttings and core descriptions from significant Coastal Plain wells that were drilled into the basement complex. These data help in the interpretation of regional magnetic and gravity maps and provide a basis for preliminary speculations concerning the distribution of lithotectonic terranes in the buried basement complex.

Three distinct belts of crystalline rocks have been tentatively mapped in the buried basement complex of Maryland. These belts strike with increasing angularity to the Fall Line from northeast to southwest. The Inner Belt exhibits lithologic and geophysical patterns similar to the adjacent, outcropping Piedmont. It is dominated by rocks of the Wissahickon Group, apparently overlain in places by stacked thrust sheets of the Baltimore Mafic Complex and James Run Formation. The Middle Belt, which does not outcrop in Maryland, strikes southwestward where it appears to correlate with rocks associated with the Fredericksburg Complex and Petersburg Granite that outcrop along the eastern margin of the Virginia Piedmont. In Maryland the Middle Belt generally yields gneissic and granitoid basement rock samples, which is consistent with the generally featureless magnetic gradient associated with it. The Outer Belt in Maryland is marked by a series of *en echelon* gravity and magnetic anomalies that are apparently truncated by the Middle Belt. The occurrence of low-grade metamorphic rocks in the Outer Belt suggest that it may have been accreted to the continental margin subsequent to the Ordovician (Taconic) orogeny that tectonically transported and metamorphosed the exposed Piedmont. If so, the boundary between the Middle and Outer Belts may represent a major, Late Paleozoic suture zone.

Buried Mesozoic rift-basin sedimentary rocks have been penetrated by wells drilled in the Middle Belt at a few localities in Charles, Prince George's and Anne Arundel Counties. Along strike in Virginia similar occurrences have been correlated with the outcropping rocks of the Late Triassic Taylorsville basin. Consolidated "red beds" have also been encountered in several deep wells drilled on the Delmarva Peninsula. It is suspected, however, that these rocks may be younger than the Mesozoic rift-basin sediments, occurring rather at the base of the Coastal Plain wedge above the break-up unconformity.

In Maryland structural contours drawn on the pre-Cretaceous basement rock surface show a pronounced strike change near the boundary between the Middle and Outer lithotectonic Belts. This change in strike from northeast, north of the boundary, to north-south, south of the boundary, defines the south flank of the Salisbury Embayment and suggests that it may be controlled by reoccurring movements along a Paleozoic suture zone. A reflection seismic survey in St. Mary's County recorded a 250-foot, up-to-the-south offset of the top-of-basement surface near the suspected suture zone.

INTRODUCTION

The Coastal Plain of Maryland is underlain by a basement complex that is made up of rocks similar to those exposed in the adjacent Piedmont region. These constitute a crystalline rock terrane that ranges in age from Late Precambrian to Paleozoic and rift-basin terranes of sedimentary and igneous rocks of suspected Triassic to Jurassic age. Except in areas immediately adjacent to the Fall Line actual samples of these rocks have been recovered in only a few widely spaced wells, drilled over a period of about 40 years.

Significant Coastal Plain wells penetrating the basement complex are located in figure 1. Table 1 contains descriptions of the basement lithologies penetrated by these wells. For the most part only geologists' descriptions have been compiled, although in some cases drillers' logs are included to provide altitude control on the top-of-basement surface. These wells were drilled for a variety of reasons, such as exploration for ground water, hydrocarbons, geothermal resources, underground gas storage facilities, and geotechnical

data for nuclear power plant siting. Except for the latter, the primary purpose of the drill holes was not to sample and analyze basement rock; any such samples recovered were only incidental. Therefore, the quality of the geologists' lithologic descriptions varies widely, ranging from simple visual field descriptions of drill cuttings to detailed petrographic analyses of core samples. Nonetheless, the individuals involved in each of these many projects recognized the scientific value of sampling basement rock and each endeavored to do so, given the operational constraints of his project.

The information assembled in this report on the nature of the basement rocks beneath the Coastal Plain of Maryland will be of assistance in the interpretation of regional magnetic and gravity surveys, and should influence the structural and lithologic inferences made from the geophysical data. Likewise, the well data can provide additional tests of current tectonic theory concerning the areal distribution and timing of convergent continental margins and rift basins.

ACKNOWLEDGMENTS

This report contains a compilation of basement rock descriptions made by numerous geologists over a period of several decades. The contributions made by these geologists are noted in table 1 and in the References section.

Earlier drafts of this report were reviewed by Peter D. Muller of the State University of New York (Oneonta), and by Eugene K. Rader and James F. Con-

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The manuscript and table 1 were typed by Donajean Appel. The maps contained in this report were drafted by Cynthia Lang-Bachur.

ROCKS OF THE EXPOSED EASTERN PIEDMONT

Precambrian and Paleozoic Crystalline Rocks

Crystalline rocks of Precambrian and Paleozoic age are exposed in the eastern Piedmont of Maryland in the form of a large, arcuate, doubly plunging structure called the Baltimore-Washington anticlinorium (fig. 2). Along the axis of this structure are several anticlinal culminations, each of which consists of a core of Precambrian Baltimore Gneiss surrounded by younger, Paleozoic-age metasedimentary rocks of the Glenarm

Supergroup. Overlapping the southeastern flank of the anticlinorium is a series of thrust slices made up predominantly of mafic and ultramafic rocks of the Baltimore Mafic Complex and metavolcanic rocks of the James Run Formation.

Metasedimentary rocks of the Lower Glenarm Supergroup unconformably overlie the 1.1-billion year old (Grenvillian) Baltimore Gneiss basement and are considered to be of Cambro-Ordovician age (Fisher and others, 1979, p. 33-37). However, no supporting

evidence for this age exists in the Piedmont of Maryland and correlation of these rocks with rocks of known Paleozoic age in Pennsylvania is equivocal. The lowest unit in the Glenarm is the Setters Formation. This is composed primarily of micaceous quartzite but also contains members of garnetiferous muscovite schist and of biotite-quartz gneiss. Overlying the Setters is the Cockeysville Formation, predominantly a calcareous unit made up of interlayered calcitic marble, dolomitic marble, and schistose phlogopitic marble.

The Upper Glenarm Supergroup is composed of a thick sequence of dominantly metaclastic rocks, called the Wissahickon Group, and consists of two facies: the Loch Raven Schist and the Oella Formation. The Loch Raven is primarily a fine- to medium-grained biotite-plagioclase-muscovite-quartz schist, commonly with garnet porphyroblasts and locally with staurolite or kyanite. The Oella consists of fine-grained biotite-oligoclase-quartz gneiss with thin laminations of schist similar to that in the Loch Raven. At the top of the Glenarm Supergroup, these pelitic rocks are succeeded by a *mélange* sequence consisting of garnetiferous schist, fine-grained metagraywacke, quartzite, amphibolite, diamictite with granule- to cobble-size clasts, and masses of mafic and ultramafic rocks (Crowley, 1976; Muller and Edwards, 1985).

Along the western side of this *mélange* is a belt of phyllitic quartzose rocks, between 1 and 3 miles in width, that appears to be a major shear zone or tectonic boundary and which divides the eastern and western regions of the exposed Piedmont in Maryland (Muller and Edwards, 1985). Rocks of the western Piedmont grade westward from fine-grained plagioclase-chlorite-muscovite-quartz schist to quartz-chlorite-muscovite phyllite with thin layers of quartzite and sporadic occurrences of thin-bedded, dark bluish-gray, phyllitic limestone. Thin, lensatic quartzites interfinger with the phyllite in the western part of the area. These may be correlative with the Lower Paleozoic Weverton and Antietam Formations (Edwards, 1984). Metabasalt, marble, and volcanic phyllite of Late Precambrian age occur within the western Piedmont as the rootless, refolded Linganore Nappe (Edwards, 1984).

On the eastern flank of the Baltimore-Washington anticlinorium, rocks of the Baltimore Mafic Complex, which have been thrust over the Glenarm Supergroup, include massive serpentinite, metagabbro, and amphibolite as well as a layered sequence of amphibolite, talc-actinolite schist, gabbro, and serpentinite (Crowley, 1976). Felsic gneisses, schist, and amphibolite represent the metavolcanic rocks of the James Run Formation which structurally overlie the Baltimore Mafic Complex (Crowley, 1976). Emplacement of these rocks was probably coeval with the deposition and formation of the *mélange* unit as is suggested by the occurrence of mafic clasts and fragments of James Run lithologies

within the diamictites (Fisher and others, 1979). A number of such stacked thrust sheets, each overriding a *mélange* containing clasts of their own lithologies, lie stacked one on top of another along the southeastern margin of the exposed Piedmont in Harford and Cecil Counties (Higgins, in press).

Throughout the entire exposed Piedmont of Maryland the dominant trend of the structural grain, exemplified by strike of foliation, fold axes, and ductile shear zones, ranges from north-northeast at the Potomac River through northeast to east-west in northern Cecil County. This structural grain is also apparent on the aeromagnetic map of the exposed Piedmont rocks (fig. 1). Post-metamorphic brittle faults generally strike north-south to north-northwest, although a few strike northeast.

Mesozoic Rift-Basin Rocks

Exposed Mesozoic rift-basin sedimentary rocks occur in Maryland only within the western Piedmont (fig. 1). Portions of the Culpeper and Gettysburg basins are present in Carroll, Frederick, and Montgomery Counties, and belong to the Newark rift system. This is a series of separate, down-faulted basins that extend along the eastern margin of North America from Nova Scotia to Georgia and include a number of basins buried beneath the Coastal Plain. These basins or grabens have been filled with Upper Triassic (?) to Lower Jurassic (?) sedimentary and volcanic rocks of the Newark Group (Robbins, 1981). The basins that occur in Maryland are all half-grabens with near-vertical border faults along the western sides. The strata generally strike northeasterly, but, in places, particularly in the vicinity of cross-faults, strike may diverge greatly from the average. The beds have an average dip of 20° to the northwest, but locally the dips may range between 5° and 40° (Nutter, 1975, p. 7).

Sediments of the Newark Group in the Maryland basins have been broadly divided into two formations: the basal New Oxford Formation and the Gettysburg Shale. The New Oxford consists of red to gray, feldspar-rich (chiefly plagioclase) sandstone with subordinate amounts of red to maroon shale and siltstone. Beds of coarse conglomerate, locally composed either of quartz pebbles and cobbles or predominantly of carbonate rock clasts, occur sporadically at the base of the Formation. The proportion of shale and siltstone relative to sandstone increases upward in the Formation. Based upon the width of outcrop and the dip of the strata, the thickness of the New Oxford Formation may be as much as 4,500 ft in Maryland, although to date only about 1,000 ft has been confirmed by an exploratory oil test, the Sheppard-Donelson Roser No. 1, that was drilled at Keymar in Carroll County near the eastern border of the Gettysburg basin (Edwards, 1970) (fig. 1).

The New Oxford Formation grades upward into the Gettysburg Shale, composed predominantly of orange-red to light maroon shale and siltstone with sporadic layers of green to gray-tan shale. Subordinate amounts of reddish-brown, feldspar-rich sandstone are present. Along the western boundary of the basins, adjacent to the border fault, are local occurrences of a massive limestone conglomerate made up of pebble- to cobble-size clasts of Paleozoic-age carbonate rocks (Nutter, 1975, p. 7). Estimates of the thickness of the Gettysburg Shale range as high as 5,000 ft. Although fossilized plant remains have been found in both the New Oxford Formation and the Gettysburg Shale, the occurrence of coal beds has not been reported.

The Newark Group sediments as well as the surrounding crystalline rocks in the Piedmont have been intruded by a number of diabase dikes of Jurassic (?) age. These generally trend north-south to north-northeast, although a few strike to the northwest and range in thickness up to about 200 ft. One sill, which may be as much as 700 ft thick (Fisher, 1964, p. 14), has been intruded along the border of the Culpeper basin in Montgomery County at Boyds. The diabase of this sill is medium- to coarse-grained and contains two pyroxenes, augite and hypersthene. The rock of the dikes, on the other hand, typically is fine-grained and contains only one pyroxene, pigeonite (Fisher, 1964, p. 16). In northern Frederick County, the tips of two large sills intruded into the Gettysburg basin in Pennsylvania extend across the State line into Maryland. Although the thickness of these bodies is unknown, each is surrounded by a contact aureole of dark gray to black, baked and altered shale that extends outward from them for several thousand feet.

Magnetic Patterns Expressed by Exposed Piedmont Rocks

As shown on the aeromagnetic maps of Fisher and others (1979), occurrences of the Baltimore Gneiss are usually associated with nearly featureless, magnetically low anomalies (fig. 1). Crowley (1976, p. 6) suggested that the few high anomalies that occur within the gneiss areas may be due to localized abundances of magnetite. However, Muller and Chapin (1984, p. 136-137) found no evidence to support this conclusion and considered magnetite-rich phases of the gneiss to be rare.

The outcrop areas of the Setters and Cockeysville Formations are associated with the magnetically low anomalies expressed by the Baltimore Gneiss. In general, lithologies in the Setters and Cockeysville have low magnetic susceptibilities (Fisher and others, 1979), although the garnet schist member of the Setters on the Phoenix anticline is associated with anomalies as high as 1,000 gammas (Fisher and others, 1979).

"Pelitic" schists of the Wissahickon Group in general have lower magnetic intensities than the metagraywacke and diamictite units of the *mélange* to the west (fig. 1). These pelitic schists are associated with an irregular, "bird's eye" anomaly pattern that vaguely follows the structural grain and which has magnetic amplitudes in the range of 800 to 1,200 gammas. On the other hand, magnetic anomalies in the *mélange* tend to be strongly elongate or linear and trend parallel to the major structural features of the Piedmont, such as the gneiss anticlines. The occurrence of elongate magnetic anomalies that strongly parallel the regional structural grain fits the interpretation of this terrane as a *mélange* with complex interstratification or structural repetition of rock units with differing magnetic susceptibility.

West of the *mélange* terrane, the pelitic schists and phyllites of the western Piedmont show a flat, featureless magnetic pattern (fig. 1), with intensities ranging between 700 and 900 gammas (Fisher and others, 1979). High anomalies that trend across this region are associated with the Mesozoic-age diabase sills and dikes, Early Paleozoic continental-margin clastic units, or Precambrian metabasalts in the Linganore Nappe.

Rocks of the Baltimore Mafic Complex and meta-volcanic rocks of the James Run Formation which occur in thrust sheets exposed along the eastern margin of the Piedmont exhibit a considerable range in magnetic characteristics (fig. 1). This befits an assemblage of rocks that ranges in composition from felsic to ultramafic and also ranges in structure from intrusive plutonic masses to layered metovolcanics and metasediments. The more felsic rocks produce magnetically quiet areas similar to the terranes of Baltimore Gneiss. On the other hand, the mafic and ultramafic rocks tend to produce irregularly shaped, high-amplitude anomalies in the range of 1,500 to 2,000 gammas that may occur in clusters or may be expressed as raggedly defined belts. The magnetic signatures of these rocks are quite distinct from the high, severely elongated anomalies associated with the *mélange* terrane.

No distinctive magnetic expression is associated with the exposed Mesozoic rift basins. Areas occupied by Triassic(?) age sediments are indistinguishable from the generally featureless magnetic pattern of the western Piedmont region.

BURIED CRYSTALLINE ROCKS

Crystalline and rift-basin sedimentary rocks buried beneath the Coastal Plain cannot be directly correlated with the outcropping units except for the rocks which lie immediately contiguous to the Fall Zone (within 10 miles). Regional geophysical (e.g., Zietz and Gilbert, 1980) and tectonic (e.g., Williams, 1978) studies strongly infer that in the Middle Atlantic area of North America the Coastal Plain overlaps the major lithotectonic belts of the Piedmont with increasing angularity southward. As a result, these sub-Coastal Plain Piedmont-type rocks in Maryland actually may be more closely related to rocks that are exposed farther south in the Virginia Piedmont or, perhaps, even in North Carolina. However, it is also possible that beneath the more easterly parts of the Coastal Plain, the basement rocks belong to one or more lithotectonic belts or suspect terranes that are not represented in any of the exposed Piedmont.

On the "Aeromagnetic Map of Maryland" (Zietz and others, 1978; and fig. 1, this report), the Coastal Plain region exhibits three broadly defined belts characterized by differing magnetic patterns. These are here named the Inner Belt, the narrowest of the three, which lies adjacent to the exposed crystalline rocks of the Piedmont; the Middle Belt, which runs between the Potomac River in Charles County eastward to the Delaware State line; and the Outer Belt, which extends from St. Mary's County to the lower Eastern Shore south of Delaware.

Inner Belt

Geophysical data

The magnetic texture of the Inner Belt is strikingly similar to that exhibited by the rocks of the exposed eastern Piedmont. This strongly suggests that the Inner Belt consists of a continuation of the eastern Piedmont lithologies beneath the sediments of the Coastal Plain, chiefly those of the Wissahickon Group, the Baltimore Mafic Complex, and the James Run Formation. In this region, areas which have magnetic intensities greater than 2,500 gammas are juxtaposed with areas having intensities less than 500 gammas, thus producing steep-sided anomalies aligned along steep linear gradients. From the Potomac River northeast almost to Baltimore, the Inner Belt is relatively narrow, between 4 and 12 miles in width, and exhibits pronounced linear gradients and anomalies similar to those that are characteristic of the edge of the Baltimore Mafic Complex or of the *mélange* sequence in the exposed Piedmont. From Baltimore northeast to the Delaware State line, the Inner Belt widens to between 15 and 25 miles, and the magnetic

pattern changes to one of irregularly shaped anomalies including broad, magnetically quiet areas that are suggestive of felsic intrusive rocks, such as the Port Deposit Gneiss, in the exposed Piedmont. The complex pattern of irregular, steep-sided anomalies that characterizes the sub-Coastal Plain basement in Cecil and northern Kent Counties closely resembles patterns associated with rocks exposed along strike to the northeast in Delaware. There, schists of the Wissahickon Group have been complexly juxtaposed with mafic rocks of the Wilmington Complex (Ward, 1959).

In the vicinity of Washington, D.C., the Inner Belt of the buried basement rocks is characterized by an elongate gravity anomaly (+20 milligals) (fig. 3), probably related to the mafic and ultramafic rocks that crop out nearby (fig. 2). This feature extends into Virginia and, according to Johnson (1973, p. 5), may trend under the Triassic rocks of the eastern Culpeper basin. Between Baltimore and Wilmington, Del., the gravity patterns of the Inner Belt are more complex and form a terrane of irregularly shaped positive and negative anomalies (fig. 3), perhaps suggestive of the eastern margin of the contiguous Piedmont where the Baltimore Mafic Complex and metavolcanic rocks of the James Run Formation are emplaced into the *mélange* unit of the Wissahickon Formation.

Well data

Most samples of crystalline rock obtained from basement test wells drilled in this part of Maryland (fig. 1; tab. 1) are of muscovite-biotite-plagioclase-quartz gneisses and schists similar to those in the Wissahickon Group. Wissahickon-type rocks were cored at Turkey Point (CE-DC 2) and on Grove Neck (CE-EC 17) in Cecil County, and in several wells at Perryman in Harford County (Dames and Moore, 1977; Edwards and Hansen, 1979) (tab. 1). CE-DC 2 drilled about 113 ft of schistose saprolite with relict quartz veins. Relatively unweathered feldspar-quartz-muscovite-biotite schist was encountered at 898 ft. The cores exhibited steeply dipping foliation (50° to 75°), crumpled and refolded by cross-cleavage. Some joints with 45° dips were observed. CE-EC 17 cored weathered muscovite-biotite-feldspar-quartz schist from 1,028 ft to 1,107 ft. The rock is highly fractured and brecciated. It is characterized by internal shearing that has refolded the foliation planes. Streaks and veinlets of graphite and some pyrite occur along the steeply dipping shears (45° to vertical). The occurrence of sheared and mylonitized rock at the Grove Neck site is suggestive of post-metamorphic faulting (Edwards and Hansen, 1979, p. 21). At both

Cecilton (CE-EE 29) and Kennedyville (KE-BE 43) basement rock chips of apparent Wissahickon affinity were logged. CE-EE 29 bottomed in a biotite-plagioclase-muscovite-quartz schist (or gneiss) with traces of garnet. KE-BE 49 penetrated a muscovite-biotite-plagioclase-quartz gneiss. The rocks cored at Perryman are chiefly quartz-feldspar-mica schists and hornblende gneisses that Dames and Moore (1977) correlate tentatively with the pelitic rocks of the Wissahickon Group. Also at Perryman, metagabbro (HA-DE 107) and diorite-granodiorite (HA-DE 323, 324) were logged in a few of the borings. These rocks may correlate respectively with the James Run Formation and Port Deposit Gneiss, two units that are present along the eastern margin of the exposed Piedmont.

Elsewhere in the Inner Belt, mafic and ultramafic rocks have been reported as the basement rock type. At Fairlee (KE-CB 36) in Kent County, serpentinite was recovered; metabasalt, probably from the James Run Formation, was found at Spesutie Island (HA-DG 3) in Harford County; and rocks of the Baltimore Mafic Complex were encountered in the subsurface at Lazaretto Point (3S3E-36) in the City of Baltimore (tab. 1). About 21 ft of light gray-green, unstructured clayey saprolite was encountered in KE-CB 36 and relatively fresh cuttings of serpentinite and epidote-actinolite schist were recovered between 1,535 ft and 1,540 ft. The mélange sequence at the top of the Wissahickon Group as well as the mélange in the Conowingo diamictite in Cecil County (Higgins, in press) have masses of mafic and ultramafic rock associated with them. This suggests that the basement rocks at Fairlee may be of a similar mélange sequence.

The bedrock core recovered between 757 ft and 760 ft in HA-DG 3 consisted of a dark green, chloritic greenstone schist and was overlain by 45 ft of dark gray-green, dense, sticky clay saprolite. Edwards and Hansen (1979, p. 76) consider this lithology to be a metavolcanic unit in the James Run Formation. Below the greenstone schist in this same core was a coarse-grained biotite-plagioclase-quartz gneiss similar to the outcropping Port Deposit Gneiss in Harford and Cecil Counties.

Middle Belt

Geophysical data

The Middle Belt is characterized by a relatively flat magnetic pattern that contrasts sharply with the patterns and intensities exhibited by the Inner Belt (fig. 1). This belt typically displays weak gradients and ill-defined anomalies with a narrow range of magnetic intensities, largely between 900 and 1,200 gammas¹. Generally speaking, the magnetic contours strike north-

east-southwest and diminish in intensity to the southeast, perhaps in response to the thickening wedge of Coastal Plain sediments overlying the basement rocks. Although flat and relatively featureless, the magnetic intensities of the Middle Belt consistently are about twice as great as those in the magnetically quiet areas of the exposed eastern Piedmont. Intensities of the latter range around 500 gammas and are typically associated with areas of Baltimore Gneiss and with the younger felsic plutons.

The northern margin of the Middle Belt is marked by an elongate positive gravity anomaly in southern Maryland and by a series of small ellipsoidal anomalies on the upper Delmarva Peninsula (fig. 3). The central part of the Middle Belt consists of a major negative gravity anomaly which extends northward from Petersburg, Va., into southern Maryland (Johnson, 1973). This trend changes to a relatively steep gravity gradient as it crosses Chesapeake Bay to the Delmarva Peninsula.

Well data

In Maryland, most wells drilled into the region of the Middle Belt have encountered basement rocks ranging in composition from diorite to granite and in texture from granitoid to gneissic. These rocks have been reported from sites near Bowie (PG-CF 53) and Brandywine (e.g., PG-FC 17) in Prince George's County, at Kings Heights (AA-CC 78) and Herald Harbor (AA-CE 120) in Anne Arundel County, and at Cambridge (DO-CE 88) in Dorchester County (fig. 1; tab. 1). Microcline-bearing gneisses, with at least a superficial resemblance to the Baltimore Gneiss, have been found in AA-CC 78 and DO-CE 88. The former consists of oligoclase (strongly sericitized), microcline, quartz and chlorite (derived from biotite) with minor amounts of muscovite and epidote. The basement core from Cambridge is medium-grained quartz monzonite with a slightly gneissic fabric, consisting of biotite, microcline, oligoclase, and quartz. In contrast, a fine-grained tremolite-biotite-plagioclase gneiss with only a trace of quartz was cored at Waugh Chapel (AA-CC 114). Similar quartz-deficient gneisses in the exposed Piedmont have been associated with the Baltimore Mafic Complex by Crowley (1976, p. 12-18).

Magnetic data, however, indicates that the basement rocks of the Middle Belt strike southwestward across the Potomac River and appear to correlate with a belt of rocks that emerges from beneath the Coastal Plain cover south of Fredericksburg, Virginia. These exposed rocks consist largely of granitoid and gneissic units that have been assigned to the Fredericksburg Complex (Pavrides and others, 1974) or the Petersburg Granite (Conley, 1978). The relationship between the Fredericksburg Complex and the Petersburg Granite is

¹A noticeable exception to this general pattern is the pronounced anomaly immediately to the south of Annapolis.

uncertain as similar gneissic and granitoid rocks have been assigned to each of these units. According to Pavlides and others (1974), the Fredericksburg Complex consists of schists and amphibolite gneisses that have been intruded by younger felsic plutons. Two gneissic members occur: a coarse-grained, pink granitic gneiss banded with streaks of biotite and containing large crystals of microcline; and a well-foliated plagioclase-quartz-biotite-hornblende granodioritic gneiss. A gneiss from the eastern part of the Fredericksburg Complex in Virginia yielded a 606-million year lead-isotope date and is believed to be older than rocks of the Wissahickon Group, but younger than the Grenville-age basement rocks (e.g., Baltimore Gneiss). As noted by Conley (1978, p. 144), the Petersburg Granite has been mapped as a large plutonic body exposed along the edge of the Coastal Plain between Richmond and the North Carolina State line. It is typically a gray to pink, medium-grained granite, but includes porphyritic and fine-grained phases. Glover (1979, p. B-5) has suggested that these rocks were emplaced as a series of granitic plutons associated with the waning stages of the Acadian orogeny (330-260 million years). It is possible that the felsic plutons which invade the Fredericksburg Complex in the northeastern Virginia Piedmont may correlate with the "Petersburg Granite" of Glover (1979).

It should be pointed out, however, that elsewhere in the Middle Belt schistose basement rocks have been recovered that do not necessarily fit this model. For example, at Douglas Point (e.g., CH-DA 6, 7) in Charles County, garnetiferous hornblende-biotite-plagioclase schists interbedded with thin layers of amphibolite were cored (fig. 1; tab. 1). The Douglas Point site is located in a saddle connecting the two positive gravity anomalies (fig. 3) that describe the northern margin of the Middle Belt. Near Washington, D.C., this feature merges with a large positive gravity anomaly (fig. 3) that is associated with outcropping rocks of the Baltimore Mafic Complex and the Wissahickon Group (fig. 2). Correlation of the schistose rocks cored at Douglas Point remain uncertain, although association with either the Fredericksburg Complex or the Wissahickon Group seems evident. Well CH-BE 57, located about 20 miles northeast of Douglas Point, also encountered schistose basement rocks. Chloritoid-bearing chlorite-quartz-plagioclase-muscovite schist cuttings were recovered between 1,791 ft and 1,802 ft (total depth). This occurrence contrasts with the gneissic basement rocks and Triassic red beds logged in the Brandywine area wells located immediately north of CH-BE 57 (fig. 1; tab. 1).

Near the northern margin of the Middle Belt in Kent and Queen Anne's Counties, basement rock cuttings suggestive of foliated metamorphic rocks have been described (Otton and Mandle, 1984). For example, at Massey (KE-BG 33) and Kingstown (QA-BE 15) biotite-quartz-plagioclase gneisses were logged. The

gneiss chips from KE-BG 33 are calcitic and severely altered to chlorite and sericite. At Rock Hall (KE-DB 40) the basement cuttings were chiefly quartz-plagioclase gneiss chips, but quartzite fragments were also observed. The correlation of these rocks is uncertain. The wells were drilled in a magnetically quiet area (fig. 1) marked by several positive gravity anomalies (fig. 3).

Outer Belt

Geophysical data

The magnetic pattern exhibited by the Outer Belt of sub-Coastal Plain basement rocks is punctuated by a series of elongated north- to northeast-trending high anomalies (fig. 1). These range in intensity between 400 and 600 gammas and are most prominently displayed in the area of St. Mary's and Dorchester Counties. The contact between the Middle Belt and the Outer Belt is broadly defined by the abrupt change in magnetic grain. Along this boundary, the north- to northeast-trending anomalies of the Outer Belt are truncated by the weak northeast- to east-trending gradient of the Middle Belt. Toward the coast in Wicomico and Worcester Counties the magnetic pattern of the Outer Belt becomes a seemingly random display of broad, shallow anomalies, about 200 gammas in height, that are noticeably different from the planar gradients in the Middle Belt.

In northern St. Mary's County a pronounced high anomaly, that is shown both on the gravity map (fig. 3) and on the magnetic map (fig. 1), extends northward across the Potomac River from Virginia and defines the western margin of the Outer Belt of sub-Coastal Plain basement rocks. This feature is approximately 8 miles wide and exhibits gravity and magnetic amplitudes of 20 milligals and 500 gammas, respectively. It appears to be the northern terminus of a belt of dense and highly magnetic basement rocks that underlies a portion of the Virginia Coastal Plain (Zietz and Gilbert, 1980; Davison and others, 1985). The major anomalies along this 100-mile trend are approximately 4 to 12 miles in width and become less steep-sided to the south. Woollard (1940) first identified these anomalies in Virginia, and LeVan and Pharr (1963) referred to them as the Sussex-Currioman Bay magnetic trend. These authors agreed that the basement rocks along this trend must be dominated by mafic or ultramafic rocks, although the question of whether the rocks are diabase of Triassic-Jurassic (?) age and related to the period of Mesozoic rifting, or whether they are older, perhaps Early Paleozoic basic metavolcanic rocks, was unresolved.

Well data

In southern Maryland SM-DF 84 is the only well in the Outer Belt drilled deep enough to penetrate pre-

Cretaceous basement rocks (fig. 1). This well is located about 9 miles east of the Sussex-Currioman Bay magnetic trend and south of a northeasterly-trending extension of it. This extension is shown on the gravity map (fig. 3) as a thumb-like appendage, but, on the magnetic map (fig. 1), it appears to lie more *en echelon* to the main trend. The rock recovered from SM-DF 84 was an unstrained, medium-grained diabase that yielded a Middle Jurassic K-Ar date of 169 ± 8 million years (Hansen and Wilson, 1984; tab. 1). It is doubtful that this diabase is representative of the basement lithologies responsible for the Sussex-Currioman Bay magnetic trend in this area. However, two deep wells, in Charles City County, Virginia (W-3317 and W-3609), lie on or adjacent to the Sussex-Currioman Bay magnetic trend. These encountered basement rocks that respectively have been identified as "dark green metavolcanics" and "upper greenschist-facies ultramafics" (J. Gernand, 1984, pers. comm.; Johnson, 1975). A third well, located near Charles City (W-3876), cored a cataclastic-appearing rock in which shards of feldspar occur in a chloritic matrix that probably originated from the alteration of biotite or hornblende. This rock may be indicative of a shear zone in the basement.

Wells drilled to basement in the Outer Belt on the Delmarva Peninsula in Maryland have encountered a number of diverse lithologies (fig. 1; tab. 1). These include low-rank metamorphic rocks such as volcanoclastic phyllite at Crisfield (SO-DD 47) in Somerset County, and calcareous metasiltstone near Atlantic (Taylor No. 1-G), in Virginia; and higher grade metamorphic rocks such as a pegmatitic biotite gneiss near Salisbury (WI-CG 37), Wicomico County; and an epidote-amphibolite metagabbro near Berlin (WO-CE 12), Worcester County. SO-DD 47 penetrated pre-Coastal Plain basement rock from 4,225(?) ft to 5,562 ft (see tab. 1). Gleason (1979) logged the core and considered it a low-grade metamorphic rock of possible volcanoclastic origin. It is a fine-grained, massive to finely laminated rock, exhibiting graded bedding and consisting largely of quartz, plagioclase and devitrified glass plus white mica, chlorite, epidote, and titanite. The low-grade metamorphic rock drilled in the Taylor No. 1-G well has been called a calcareous metasiltstone by Robbins, Perry, and Doyle (1975) and a recrystal-

lized aphanitic limestone by D'Appolonia [1981]. It consists of alternating light, carbonate-rich layers and dark, clastic-rich layers containing biotite porphyroblasts, plagioclase, and quartz. The carbonate content ranges from 10 percent to 85 percent. The metagabbro cored at Berlin (WO-CE 12) is a medium to fine-grained, dark greenish-black mafic rock consisting of hornblende (75 percent) and quartz-oligoclase (25 percent), moderately metamorphosed to an epidote-amphibolite facies. The association of these lithologies, if broadly coeval in a tectonic sense, is suggestive of a deepwater slope or terrace setting influenced by arc-derived volcanoclastics and plutons. The felsic rock cored at Salisbury (WI-CG 37) appears to predate this sequence. It is a plagioclase-biotite-quartz gneiss cross-cut by orthoclase-rich pegmatitic veinlets, suggestive of deep crustal burial and magmatism.

Basement rocks of the Outer Belt are probably not represented by lithotectonic equivalents in the exposed Piedmont anywhere along the East Coast. Based on regional gravity and magnetic characteristics, Williams and Hatcher (1982, fig. 1) have assigned these rocks to the Brunswick Terrane which lies beneath the eastern margin of the emerged Coastal Plain north of Cape Fear, North Carolina. The nature of these rocks and the timing of their accretion to the North American continental margin are poorly understood. Nevertheless, it is possible that the sharp discontinuity in the magnetic character at the boundary between the Middle and Outer Belts in Maryland may represent a major suture zone. If so, this magnetic discontinuity could be the boundary between the crustal blocks of the North American and African Plates which were juxtaposed during the Paleozoic closing of the proto-Atlantic, or Iapetus, Ocean. The occurrence of low-grade metamorphic rocks in the Outer Belt suggests that this lithotectonic terrane may have been sutured to the North American plate subsequent to the Ordovician Taconic orogeny, when the rocks of the exposed Piedmont region were tectonically transported and metamorphosed to high-grade. The temporal and spatial relationships of the rocks of the Outer Belt, however, have yet to be deciphered and no unique interpretation is possible at this time.

BURIED RIFT-BASIN ROCKS

In Maryland, no buried rift-basin sedimentary rocks have been encountered in well samples from the Inner Belt, but wells drilled in the Middle Belt have recovered basement samples of indurated sediments which are similar to outcropping rift-basin rocks (fig. 1;

tab. 1). Well CH-CE 37, located near La Plata in Charles County, may have penetrated as much as 99 ft of weathered Triassic (?) material based on cutting returns described as "hard red clay, reddish-brown shaly clay, and red shale". Corroborating evidence is

provided by interval velocity log data which first recorded values exceeding 9,000 ft/sec at 1,934 ft depth, 10,000 ft/sec at 1,945 ft, and 11,000 ft/sec at 1,948 ft. In contrast, sediments of the Cretaceous-age Lower Potomac Group encountered at comparable depths in other wells typically have interval velocities in the range of 6,500 to 8,500 ft/sec. Similar data were obtained from well AA-CG 22 drilled at Sandy Point in Anne Arundel County, where cuttings of hematitic sandstone and siltstone were collected between 1,790 and 1,858 ft (total depth) (tab. 1). Interval velocities exceeding 10,000 ft/sec were first encountered at about 1,813 ft depth.

Five wells that were drilled in the Brandywine area of southern Prince George's County (fig. 1) encountered a distinctive sequence of sedimentary rocks below the base of the Lower Cretaceous Patuxent Formation (Ball Associates, 1959; Jacobeen, 1972); several additional wells in the area may also have encountered similar rocks, but their descriptive logs are ambiguous (Edwards, 1970; Tompkins, 1983). As much as 234 ft of strata dominated by grayish-green to reddish-brown sandstones, siltstones, and shales were cored in the Washington Gas Light Co. Mudd No. 1 well (PG-FD 61); subordinate occurrences of conglomeratic, calcareous, and coaly strata were also logged (tab. 1). These strata have been assigned to the Newark Group of Triassic (?) age. Relatively steep dips were recorded, in the range of 40° to 50°, but no diabase or basaltic volcanic rocks were encountered. Vibratory seismic survey lines run across the Brandywine area do not display coherent reflectors below the "top-of-basement" so that the extent and thickness of the rift-basin sediments remain uncertain (Jacobeen, 1972; Dames and Moore, 1973).

The Brandywine area is apparently near the northwestern boundary of a buried rift basin of indeterminate size, inasmuch as test wells to basement that have been drilled only 1 or 2 miles farther west did not encounter reddish-colored sediments, but instead bottomed in gneissic or granitic rocks of uncertain correlation. To the southwest in the exposed Piedmont of Virginia, Mesozoic rift-basin sedimentary rocks of the Richmond and Taylorsville basins (fig. 3) lie within a basement composed of the Fredericksburg Complex and Petersburg Granite. The Taylorsville basin, a small basin which strikes northeast and passes beneath the Coastal Plain sediments at its northern end, has recently been studied in detail (Weems, 1980, p. 23-38). The major boundary fault of the Taylorsville basin occurs along its northwestern side and is contiguous with the Hylas Zone, a re-activated Mid-Paleozoic (Acadian) shear zone containing cataclastic schists and gneisses (Bobyarchick and Glover, 1979). East of this boundary fault, the basin has been downfaulted and filled with about 5,000 ft of consolidated alluvial and flood-plain

deposits consisting of conglomerate, sandstone, and siltstone. These have been named the Doswell Formation (Weems, 1980, p. 24). About 800 ft above the base of the Formation is a 1,200-ft zone of flaggy sandstones, black shales, coals, and limestones that probably formed in a lacustrine environment within the basin (Weems, 1980, p. 25). The rocks in the Taylorsville basin range in color from black and dark gray to yellowish-brown and grayish-orange, but in general are much more drab than the rocks in the Culpeper and Gettysburg basins. This suggests that the Taylorsville basin was poorly drained by low-gradient streams throughout much of its history. The Richmond and Taylorsville basins, which are now separated by crystalline rocks of the Piedmont, may have been connected during Late Triassic time as both basins contain similar fish faunas. Three diabase dikes of Jurassic (?) age cut across the Taylorsville basin along a north-northwest trend (Weems, 1980, p. 27), but no sills or volcanic flows have been reported.

The occurrence within the Middle Belt of buried rift-basin sediments in the subsurface of southern Maryland suggests that similar deposits may also occur beneath the Delmarva Peninsula (Bain, 1972; Hansen, 1978). Reddish-colored, indurated sediments were logged immediately above crystalline rock in three deep oil-test wells: 5,353 – 5,498 ft in the Ohio Hammond No. 1 (WI-CG 37), near Salisbury in Wicomico County; 6,566 – 7,151 ft in the Mobil Bethards No. 1 (WO-CE 12), near Berlin in Worcester County; and 6,070 – 6,180 ft in the J & J Enterprises Taylor No. 1-G, near Atlantic in Accomack County, Virginia (Anderson, 1948; Onuschak, 1972) (fig. 1; tab. 1). A fourth well, the Exxon Maryland ESSO No. 1 (WO-BH 11), drilled in eastern Worcester County at Ocean City, bottomed (7,710 ft) in Coastal Plain sediments considered to be younger than the "red bed" strata penetrated in the other deep wells (Anderson, 1948, p. 92). However, as reviewed by Hansen (1978, p. 10-16), these deposits may be overlapped Coastal Plain beds correlative with indurated, post-rift, Lower Cretaceous or Upper Jurassic (?) units known to occur above the break-up unconformity in the offshore Baltimore Canyon Trough basin (Libby-French, 1983, p. 68). Although the presence of rift-basin sediments beneath the Delmarva Peninsula is likely (particularly within the Middle Belt), present well data do not offer conclusive proof of their occurrence.

Well SM-DF 84, located in Lexington Park, St. Mary's County, drilled into a medium-grained diabase between the depth of 2,623 ft and the bottom of the hole at 2,678 ft. This rock yielded a radiometric date of 169 ± 8 million years (Hansen and Wilson, 1984), suggesting a Middle Jurassic (American Association of Petroleum Geologists, 1983), or perhaps Late Jurassic (Palmer, 1983) intrusive event. As no other basement lithologies were encountered, it is presently not known

whether the diabase is from a sill or dike associated with the rift-basin sediments or whether it is cross-cutting the crystalline rocks. The diabase is apparently a one-pyroxene (augite) rock, which Fisher (1964, p. 14) suggests is evidence of rapid, undifferentiated crystallization in a relatively thin intrusive body, such as a dike.

The Lexington Park site is about 10 miles east of the magnetic high anomaly (Sussex-Currioman Bay trend) that separates the Middle and Outer Belts in southern Maryland (fig. 1). Because of its off-trend location, it is doubtful that the diabase cored in SM-DF 84 is representative of the dense and highly magnetic basement rocks of the Sussex-Currioman Bay anomaly. Likewise, the well site is about 10 miles west of a prominent northwest-trending, -30 milligal, low-gravity

anomaly (fig. 3) that underlies the adjacent Chesapeake Bay. Sabat (1977) speculated that the anomaly might reflect a faulted Triassic (?) basin. Although Dysart and others (1983) prefer a granitoid pluton as the source of the anomaly, they cited interval velocity data from a vibratory seismic survey as evidence for the occurrence of a 300-ft thick "indurated layer" at the base of the Coastal Plain sediments beneath the eastern Northern Neck of Virginia. However, inasmuch as indurated beds of Early Cretaceous or Jurassic (?) age are thought to occur elsewhere at the base of the post-rift Coastal Plain wedge (Hansen, 1982, 1984; Hansen and Wilson, 1984), the presence of an indurated layer by itself does not necessarily establish the existence of rift-basin sediments.

COASTAL PLAIN DEPOSITS

Post-rift deposits of Jurassic (?) to Recent age compose the Coastal Plain, an eastward-thickening clastic wedge deposited on a subsiding continental margin (Hansen, 1984, fig. 1). At the Maryland coastline the Coastal Plain wedge exceeds 7,700 ft in thickness. In the Middle Atlantic area the Coastal Plain is dominated by the Salisbury Embayment (Richards, 1948), a broad, structural depression extending from New Jersey to Virginia with its axis trending southeasterly through the Delmarva Peninsula. Relatively thick Jurassic (?) and Lower Cretaceous (Neocomian) units, which occur in the eastern portions of the embayment, are overlapped up-dip and do not outcrop.

Configuration of the South Flank of the Salisbury Embayment

In Maryland structural contours drawn on the top-of-basement rocks trend southwesterly until about latitude 38°35'N where a pronounced change of strike occurs, causing the contours to swing into a north to northwest orientation that defines the south flank of the Salisbury Embayment (fig. 2). In southern Maryland the change in strike broadly coincides with the boundary separating the Middle and Outer Belts of sub-Coastal Plain basement rocks.

The change of strike is controlled by three wells that penetrate basement, QA-EB 110 drilled on Kent Island in Queen Anne's County, PG-HF 31 drilled in southernmost Prince George's County at Chalk Point, and SM-DF 84 at Lexington Park in St. Mary's County (tab. 1). All three wells penetrate basement at about the same depth with the altitude of the top-of-basement surface varying by only about 80 ft (fig. 2). The -2,500 ft contour, which has a northeast strike between QA-EB

110 and PG-HF 31, must abruptly change strike south of Chalk Point in order to accommodate the top-of-basement altitude established at SM-DF 84. An abrupt strike change is at least suggestive of faulting (fig. 2). A suspected offset of the top-of-basement surface occurring between Chalk Point and Lexington Park was recorded on a vibratory seismic line that traversed the St. Mary's County peninsula. About 2 miles north of Hollywood along State Route 234 the top-of-basement signature on the seismic record section was apparently offset by about 250 ft with the southeast side up (Hansen, 1978, pl. 15). This basement offset is on the southeast flank of the Sussex-Currioman Bay magnetic trend near its northern terminus. The sense of the offset supports the speculation that the boundary separating the Middle and Outer Belts of basement rocks might represent a reactivated structural discontinuity with the Middle Belt subsiding relatively more than the Outer Belt. The association of the Middle Belt with Triassic (?) rift basins marks it as a structurally active terrane within which thousands of feet of sediments accumulated locally during Early Mesozoic times (Mixon and Newell, 1977; Weems, 1980). Folds and faults affecting Upper Cretaceous and Tertiary sediments, such as the Brandywine fault system of Jacobeen (1972) (Dames and Moore, 1973), suggest reoccurring adjustments within the Middle Belt during Coastal Plain deposition.

Stratigraphic Pinch-outs on the South Flank of the Salisbury Embayment

If the boundary between the Middle and Outer Belts represents a structural discontinuity, stratigraphic evidence from the overlying Coastal Plain units suggests that the last major readjustment occurred during Late

Cretaceous to Early Paleocene times. At south flank locations such as Lexington Park and Crisfield no Cretaceous units younger than Late Albian (or possibly Early Cenomanian) have been reported (Brown, Miller, and Swain, 1972; Hansen, 1978; Hansen and Wilson, 1984). If ever present on the south flank, these units were removed during an erosional event occurring near the Cretaceous-Paleocene boundary. The south flank remained a positive area at least into the Early Paleocene as evidenced by the occurrence of lignitic, oxidized,

Danian(?) -age sediments of apparent marginal marine to fluvio-deltaic origin (Hansen, 1967, p. 11; Hansen and Wilson, 1984). The sedimentary and paleogeographic patterns of younger Tertiary units, such as the Upper Paleocene Aquia Formation (Hansen, 1974) and the Lower to Middle Miocene Calvert Formation (Gibson, 1983, fig. 21), fail to reveal evidence for an active south flank that can be associated with the discontinuity separating the Middle and Outer Belts of sub-Coastal Plain basement rock.

CONCLUSIONS

A compilation of core and cuttings descriptions from Coastal Plain wells that penetrated the buried basement complex in Maryland should assist in the interpretation of regional magnetic and gravity surveys and provide additional constraints on the lithotectonic inferences made from the geophysical data. Tentative conclusions concerning the nature of the pre-Cretaceous basement rocks include:

1. Three distinct belts of crystalline rocks occur in the buried basement rock complex of Maryland. These belts strike with increasing angularity to the Fall Line from northeast to southwest.

Inner Belt: It is characterized by lithologic and geophysical patterns similar to the adjacent, exposed Piedmont and is dominated by rocks of the Wissahickon Group, the Baltimore Mafic Complex and the James Run Formation.

Middle Belt: Rocks of this belt are not exposed in Maryland. However, the Middle Belt can be projected into Virginia where it appears to correlate with outcropping rocks of the Fredericksburg Complex and Petersburg Granite. Gneissic and granitoid basement rocks are usually encountered in the Middle Belt. In Maryland the Middle Belt is generally associated with a smooth, anomaly-free, magnetic gradient.

Outer Belt: In Maryland the Outer Belt is characterized in part by a series of *en echelon* magnetic and gravity anomalies that are truncated

by the Middle Belt along a possible crustal suture. Diverse basement lithologies have been encountered in the Outer Belt, including low-rank metamorphic rocks. The occurrence of these rocks suggest that parts of the Outer Belt may have been accreted to the main North American plate subsequent to the Taconic (Ordovician) orogeny, which tectonically transported and metamorphosed the exposed rocks of the eastern Piedmont.

2. Sedimentary rocks, generally associated with Mesozoic rift basins, have been logged in several wells drilled in southern Maryland. These wells occur in the Middle Belt of the basement complex which strikes into Virginia where possibly correlative, Upper Triassic rocks of the Taylorsville basin are in outcrop. Consolidated "red beds" have also been drilled on the Delmarva Peninsula, but their association with rift basins is unclear. It is more likely that these rocks occur above the break-up unconformity and represent a basal, perhaps Jurassic (?) unit of the Coastal Plain wedge.

3. In Maryland structural contours drawn on the top-of-pre-Cretaceous basement display a pronounced change of strike near the boundary between the Middle and Outer Belts. Up-to-the south faulting on the south flank of the Salisbury Embayment can be evoked to account for this abrupt strike change. If so, the boundary (possible suture zone) separating the Middle and Outer Belts may have been structurally active during Coastal Plain deposition. The occurrence of stratigraphic pinch-outs suggests that the south flank remained a structurally positive area at least through the Early Paleocene.

REFERENCES

- American Association of Petroleum Geologists, 1983, *Atlantic Coastal Plain province correlation chart: Committee on Stratigraphic Units of North America (COSUNA)*.
- Anderson, J. L., Hammond, Bethards, and Esso Wells in Cretaceous and Tertiary subsurface geology: Maryland Dept. Geology, Mines and Water Resources, Bull. 2, p. 1-113.
- Bain, G. L., 1972, *Feasibility study of east coast Triassic basins for waste storage*: U.S. Geol. Survey Open-File Rept., 113 p.
- Ball Associates, Ltd., 1959, *The Brandywine storage field*, in *Petition to the Public Service Commission of Maryland (1966) in the Matter of the Application of Washington Gas Light Company, for an order finding the Brandywine Underground Storage Project for Natural Gas to be in the Public Interest: Exhibit E*, 16 p.
- Bennett, R. R., and Meyer, R. R., 1952, *Geology and ground-water resources of the Baltimore area*: Maryland Dept. of Geology, Mines and Water Resources, Bull. 4, 573 p.
- Benson, R. N., 1984, *Structure contour map of pre-Mesozoic basement, landward margin of Baltimore Canyon trough*: Delaware Geol. Survey, Miscellaneous Map Series No. 2, Scale 1:500,000.
- Bobyarchick, A. R., and Glover, L., 1979, *Deformation and metamorphism in the Hylas Zone and adjacent areas of Virginia*: Geol. Soc. Amer. Bull., pt. 1, Vol. 90, p. 739-752.
- Brown, P. M., Miller, J. A., and Swain, F. M., 1972, *Structural and stratigraphic framework and spatial distribution of permeability of the Atlantic Coastal Plain, North Carolina to New York*: U.S. Geol. Survey Prof. Paper 796, 79 p.
- Conley, J. F., 1978, *Geology of the Piedmont of Virginia — Interpretations and problems*, in *Contributions to Virginia geology — III: Virginia Div. Mineral Resources, Publ. 7*, p. 115-149.
- Crowley, W. P., 1976, *Geology of the crystalline rock near Baltimore and its bearing on the evolution of the eastern Maryland Piedmont*: Maryland Geol. Survey, Rept. Invest. No. 27, 40 p.
- Dames & Moore, 1973, *Geology and seismology, in Preliminary safety analysis report, Douglas Point Nuclear Generating Station Units 1 & 2*: Washington, D.C., PEPCO, p. 2.5:1-98.
- _____, 1977, *Perryman site suitability — site safety report*: Baltimore Gas & Electric Co. Limited Early Site Review, Vol. IV, figs. 2.5G1 to 2.5G-104.
- D'Appolonia, [1981], *Hot dry rock geothermal evaluation, Cris-Wall site, Eastern Shore of Maryland and Virginia: Prepared for Los Alamos Scientific Laboratory under Contract No. 4-X29-7745G-1*, p. 3-20 - 3-24.
- Davison, G. E., Nowroozi, A. A., and Venkatakrishnan, R., 1985, *Geophysical model of gravity-magnetic high, Virginia Coastal Plain (abs.)*: Amer. Assoc. Petrol. Geol., Vol. 69/2, p. 248.
- Dysart, P. S., Couch, C., and Costain, J. K., 1983, *Seismic response of major regional unconformities in Atlantic Coastal Plain sediments at Smith Point, Virginia*: Geol. Soc. Amer. Bull., Vol. 94, p. 305-311.
- Edwards, J., Jr., 1970, *Deep wells of Maryland*: Maryland Geol. Survey, Basic Data Rept. No. 5, unnumbered.
- _____, 1984, *The Linganore Fault: Key to age of Sams Creek Formation in the Piedmont of Maryland (abs.)*: Geol. Soc. Amer. Abstracts with Programs, 1984, Vol. 16, No. 3, p. 135.
- _____, and Hansen, H. J., 1977, *New data bearing on the structural significance of the upper Chesapeake Bay magnetic anomaly*: Maryland Geol. Survey, Rept. Invest. No. 30, 36 p.
- Fisher, G. W., 1964, *Triassic rocks of Montgomery County*, in *Geology of Howard and Montgomery Counties*: Maryland Geol. Survey, p. 10-17.
- _____, Higgins, M. W., and Zietz, I., 1979, *Geological interpretation of aeromagnetic maps of the crystalline rocks in the Appalachians, northern Virginia to New Jersey*: Maryland Geol. Survey, Rept. Invest. No. 32, 43 p.
- Geraghty & Miller (Consulting Ground-water Geologists), 1966, *Availability of ground water at the B. F. Goodrich property, Cecil County, Maryland*, 27 p.
- Gibson, T. G., 1983, *Stratigraphy of Miocene through Lower Pleistocene strata of the United States central Atlantic Coastal Plain*, in *Geology and Paleontology of the Lee Creek Mine, North Carolina, I: Smithsonian Contributions to Paleobiology No. 53*, p. 35-80.
- Gleason, R. J., 1979, *Description of basement rock from Crisfield deep geothermal test well*, in *Evaluation and targeting of geothermal energy resources in the southeastern United States*, ed., J. K. Costain and others: Virginia Poly. and St. Univ. Progress Report 78ET-27001-7, p. A5-6.
- Glover, L., 1979, *General geology of the East Coast with emphasis on potential geothermal energy regions: A detailed summary*, in *Evaluation and targeting of the geothermal energy resources in the southeastern United States*, ed., J. K. Costain and others: Virginia Poly. and St. Univ. Progress Report 78ET-27001-7, p. B1-B7.
- Hansen, H. J., 1967, *Hydrogeologic data from the Janes Island State Park test well (1,514 feet)*,

- Somerset County, Maryland: Maryland Geol. Survey, *Basic Data Rept. No. 3*, 24 p.
- _____, 1974, *Sedimentary facies of the Aquia Formation in the subsurface of the Maryland Coastal Plain*: Maryland Geol. Survey, *Rept. Invest. No. 21*, 47 p.
- _____, 1978, *Upper Cretaceous (Senonian) and Paleocene (Danian) pinchouts on the south flank of the Salisbury Embayment, Maryland, and their relationship to antecedent basement structures*: Maryland Geol. Survey, *Rept. Invest. No. 29*, 36 p.
- _____, 1984, *Hydrogeologic characteristics of the Waste Gate Formation, a new subsurface unit of the Potomac Group underlying the eastern Delmarva Peninsula*: Maryland Geol. Survey, *Info. Cir. No. 39*, 22 p.
- _____, and Wilson, J. M., 1984, *Summary of hydrogeologic data from a deep (2,678 ft.) well at Lexington Park, St. Mary's County, Maryland*: Maryland Geol. Survey, *Open-File Rept. No. 84-02-1*, 61 p.
- Haworth, R. T., Daniels, D. L., Williams, H., and Zietz, I., 1980, *Bouguer gravity map of the Appalachian Orogen: Map 3: Memorial Univ. of Newfoundland, scale 1:1,000,000*.
- Higgins, M. W., in press, *The crystalline rocks of Cecil County*, in *The Geology of Cecil County*: Maryland Geol. Survey, *Bull.*
- Jacobein, F. H., 1972, *Seismic evidence for high angle reverse faulting in the Coastal Plain of Prince George's and Charles Counties, Maryland*: Maryland Geol. Survey, *Info. Cir. No. 13*, 21 p.
- Johnson, S. S., 1973, *Bouguer gravity northeastern Virginia and the Eastern Shore peninsula*: Virginia Div. Mineral Resources, *Rept. Invest. No. 32*, 48 p.
- _____, 1975, *Bouguer gravity in southeastern Virginia*: Virginia Div. Mineral Resources, *Rept. Invest. No. 39*, 42 p.
- Kantrowitz, I. H., and Webb, W. E., 1971, *Geologic and hydrologic data from a test well drilled near Chestertown, Maryland*: Towson, Maryland, U.S. Geol. Survey *Open-File Rept.*, 18 p.
- LeVan, D. C., and Pharr, R. F., 1963, *A magnetic survey of the Coastal Plain in Virginia*: Virginia Div. Mineral Resources, *Rept. Invest. No. 4*, 17 p.
- Libby-French, J., 1984, *Stratigraphic framework and petroleum potential of northeastern Baltimore Canyon trough, Mid-Atlantic Outer Continental Shelf*: Amer. Assoc. Petrol. Geol., Vol. 86, No. 1, p. 50-78.
- Mack, F. K., 1983, *Preliminary analysis of geohydrologic data from test well drilled near Chester on Kent Island, Queen Anne's County, Maryland*: Maryland Geol. Survey, *Open-File Rept. No. USGS 82-854*, 35 p.
- Mixon, R. B., and Newell, W. C., 1977, *Stafford fault system: Structures documenting Cretaceous and Tertiary deformation along the Fall Line in northeastern Virginia*: Geology, Vol. 5, p. 437-440.
- Muller, P. D., and Chapin, D. A., 1984, *Tectonic evolution of the Baltimore Gneiss anticlines, Maryland*, in *The Grenville event in the Appalachians and related topics*, ed., M. J. Bartholomew: Geol. Soc. Amer. Special Paper 194, p. 127-148.
- _____, and Edwards, J., Jr., 1985, *Tectonostratigraphic relationships in the central Maryland Piedmont (abs.)*: Geol. Soc. Amer. Abstracts with Programs, 1985, Vol. 17, No. 1, p. 55.
- Nutter, L. J., 1975, *Hydrogeology of the Triassic rocks of Maryland*: Maryland Geol. Survey, *Rept. Invest. No. 26*, 37 p.
- Onuschak, E., 1972, *Deep test well in Accomack County, Virginia*: Virginia Minerals, Vol. 18, No. 1, p. 1-4.
- Otton, E. G., and Mandle, R. J., 1984, *Hydrogeology of the Upper Chesapeake Bay area, Maryland, with emphasis on aquifers in the Potomac Group*: Maryland Geol. Survey, *Rept. Invest. No. 39*, 62 p.
- Overbeck, R. M., 1948, *The physical features of Charles County*: Maryland Dept. Geology, *Mines and Water Resources*, 267 p.
- Palmer, A. R., 1983, *The decade of North American geology 1983 geologic scale*: Geology, Vol. 11, No. 9, p. 503-504.
- Pavlidis, L., Sylvester, K. A., Daniels, D. L., and Bates, R. G., 1974, *Correlation between geophysical data and rock type in the Piedmont and Coastal Plain of northeast Virginia and related areas*: U.S. Geol. Survey Jour. Research, Vol. 2, No. 5, p. 569-580.
- Richards, H. G., 1948, *Studies on the subsurface geology and paleontology of the Atlantic Coastal Plain*: Acad. Natural Sci. Philadelphia Proc., Vol. 100, p. 39-76.
- Robbins, E. I., 1981, *A preliminary account of the Newark Rift System: Lunar and Planetary Inst. Conf. on Processes of Planetary Rifting*, St. Helena, Calif., p. 107-109.
- _____, Perry, W. J., and Doyle, J. A., 1975, *Palynological and stratigraphic investigations of four deep wells in the Salisbury Embayment of the Atlantic Coastal Plain*: U.S. Geol. Survey *Open-File Rept. No. 75-307*, 120 p.
- Sabat, M. A., 1977, *Gravity anomalies associated with the Salisbury Embayment, Maryland — southern Delaware*: Geology, Vol. 5, p. 433-436.
- Tompkins, M. D., 1983, *Prince George's County ground-water information: Well records, chemical-quality data, pumpage, appropriation data, observation well records, and well logs*: Maryland Geol. Survey, *Basic Data Rept. No. 13*, 160 p.
- Trapp, H., Knobel, L. L., Meisler, H., and Leahy, P. P., 1982, *Test well DO-CE 88 at Cambridge, Dorchester County, Maryland*: U.S. Geol. Survey *Open-File Rept. 82-1015*, 81 p.
- Ward, R. F., 1959, *Petrology and metamorphism of the Wilmington Complex, Delaware*: Geol. Soc. Amer. Bull., Vol. 70, p. 1,425-1,458.

- Weems, R. E.**, 1980, *Geology of the Taylorsville Basin, Hanover County, Virginia: Virginia Div. Mineral Resources, Publ. 27, p. 23-38.*
- Williams, H. (compiler)**, 1978, *Tectonic lithofacies map of the Appalachian orogen: Map 1: Memorial Univ. of Newfoundland, scale 1:1,000,000.*
- _____, and **Hatcher, R. D.**, 1982, *Suspect terranes and accretionary history of the Appalachian orogen: Geology, Vol. 10, p. 530-536.*
- Woollard, G. P.**, 1940, *A comparison of magnetic, seismic, and gravitational profiles on three traverses across the Atlantic Coastal Plain: Amer. Geophy. Union Trans., pt. 2, p. 301-309.*
- Zietz, I., and Gilbert, F. P.**, 1980, *Aeromagnetic map of part of the northeastern United States: U.S. Geol. Survey Geophysical Invest. Map GP-936, scale 1:2,000,000.*
- _____, **Gilbert, F. P.**, and **Kirby, J. R.**, 1978, *Aeromagnetic map of Maryland: U.S. Geol. Survey Geophysical Invest. Map GP-923, scale 1:250,000.*

TABLE 1
Compilation of significant Coastal Plain Wells in Maryland
that penetrate the buried basement rock complex

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
ANNE ARUNDEL CO.									
AA-CC 78	Kings Heights	39°04'22" 76°41'15"	178	917	908	Gneiss, consisting of oligoclase (strongly sericitized), microcline, quartz and chlorite (derived from biotite). Contains minor amounts of muscovite, epidote, allanite, apatite, magnetite and hematite, and zircon. (S)	915-917 (C)	Baltimore Gneiss(?)	C. A. Hopson, (per. comm.)
AA-CC 114	Waugh Chapel	39°02'56" 76°41'31"	148	1,025	1,017	Tremolite-biotite-plagioclase gneiss; plagioclase (oligoclase), 75%; biotite, 15%; tremolite, 10%; quartz, trace. Fabric is schistose, lepidoblastic, non-porphyroblastic, and fine-grained. (S)	1,025 (C)	Associated with Baltimore Mafic Complex(?)	J. Edwards and W. Crowley, (per. comm.)
AA-CE 120	Herald Harbor	39°03'03" 76°34'43"	170	1,340	1,290	Felsic rock - "Sand consisting of biotite (a single flake of muscovite), quartz and feldspar. The high concentration of quartz suggests a meta-sedimentary rock (metagraywacke?), although the coarse grain size is more characteristic of an igneous or metaigneous rock (granite?, granite gneiss?, granodiorite?, or granodiorite gneiss?)." (M)	1,300-1,340 (D)	Not assigned	W. Crowley, (per. comm.)
AA-CG 22	Sandy Point	39°01'23" 76°24'16"	10	1,858	1,790	Sandstone and siltstone. Contains much hematite as cement or matrix. Also oxidized biotite flakes. Small grains of muscovite appear to have grown in place as a secondary mineral. (S)	1,820-1,830 (D)	Newark Group (?)	J. Edwards, (per. comm.)
BALTIMORE CITY									
1S3E-21	Highland-town	39°17'26" 76°33'52"	60	535	310	Gneiss, alternating, hard and soft. (M)	310-535 (D)	Not assigned	Bennett and Meyer (1952)
3S3E-36	Lazaretto Point	39°15'48" 76°34'13"	16	274	273	Saprolite, gray-green, clayey. (M)	273-274 (D)	Baltimore Mafic Complex	D. Drummond, (per. comm.)
BALTIMORE CO.									
BA-GF 10	Sparrows Point	39°13'56" 76°29'36"	10	711	658	Rock.	658-711	Not assigned	Bennett and Meyer (1952)
CECIL CO.									
CE-CF 48	C & D Canal near Chesapeake City	39°32'19" 75°47'54"	65	695	653	Hard streaks. Weathered bedrock. Hard bedrock.	653-657 657-673 673-695	Not assigned	Geraghty and Miller (1966)
CE-DC 2	Turkey Point	39°27'16" 76°00'30"	58	936	785	Pale yellow-orange micaceous saprolite. White to pale yellow decomposed pegmatite, with kaolinite, quartz and muscovite. Light yellow-orange micaceous saprolite. Friable decomposed light-gray mica schist. Gray feldspar-quartz-muscovite-biotite schist. Foliation dips 60° to 75° and is crumpled or refolded by cross-cleavage. A few sporadic veins of quartz. Some joints with 45° dip. Same as above but with veins of quartz and feldspar parallel with foliation.	870-879 879-880 880-890 890-898 898-909.5 909.5-913	Wissahickon Group	Edwards and Hansen (1979)

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
CECIL CO., con't.									
CE-DC 2 (Cont'd)	Turkey Point	39°27'16" 76°00'30"	58	936	785	Gray feldspar-quartz-muscovite-biotite schist as above but no quartz-feldspar veins.	913-920.5	Wissahickon Group	Edwards and Hansen (1979)
						Same as above but cross-cleavage is weak to absent.	920.5-925		
						Same as above but with a few thin veins of quartz. Foliation dips 50° to 70° and is refolded by cross-cleavage. (M)	925-936 (C)		
CE-EC 17	Grove Neck	39°24'18" 76°01'30"	8	1,107	1,028	Decomposed light gray muscovite-biotite-feldspar-quartz schist. Rock highly fractured and broken. Feldspar altered to kaolinite.	1,028-1,042	Wissahickon Group	Edwards and Hansen (1979)
						Same as above but less fractured. Foliation vertical to 70° dip.	1,042-1,051		
						Sheared gray muscovite-biotite-feldspar-quartz-schist or gneiss. Banded with feldspar-rich pegmatitic layers and mica-rich layers. Feldspar strongly altered to kaolinite. Streaks and veinlets of graphite along shears. Also some pyrite.	1,051-1,063		
						Gray muscovite-biotite-feldspar-quartz schist with some veinlets of feldspar. Feldspar strongly altered to kaolinite. Rock is broken by graphite-coated shear planes. Dip of shears vertical to 45°, average 60°. Some refolding of foliation by shear planes.	1,063-1,077		
						Partly decomposed, sheared, and brecciated graphitic mica schist, strongly broken by closely-spaced shear planes.	1,077-1,085		
						Compact, brecciated and mylonitized mica schist or gneiss composed of crushed and broken mineral grains and rock fragments. Many graphitic streaks and shears with dips vertical to 80°. Foliation dips 10° to 20°, strongly refolded.	1,085-1,097		
						Same as above but rock is broken along shears and is more decomposed.	1,097-1,102		
						Sheared chlorite-mica schist or mylonite. Many closely-spaced shears with dips vertical to 80°. (M)	1,102-1,107 (C)		
CE-EE 29	Cecilton	39°24'03" 75°52'18"	75	1,458	1,433	Saprolite: dirty white to light gray-green clay; abundant large books of muscovite; some green schist fragments, chloritic. (M)	1,433-1,444 (D)	Not assigned	Otton and Mandle (1984)
						Schist or Gneiss; biotite-plagioclase-muscovite-quartz; traces of garnet, chlorite, magnetite, zircon, and possible sillimanite. (S)	1,444-1,458		
CHARLES CO.									
CH-BB 10	Indian Head	38°35'03" 77°10'06"	32	1,200	741(?)	Rock, hard, green. Rock, red and gray.	741-923 923-1,200	Not assigned	Overbeck (1948)
CH-BE 57	Middletown (near Waldorf)	38°37'06" 76°57'56"	210	1,802	1,791	Chloritoid-bearing chlorite-quartz-plagioclase-muscovite schist. (M)	1,791-1,802 (D)	Similar to a pelitic schist of Wissahickon Group.	File Data
CH-BF 144	Pinefield (near Waldorf)	38°39'13" 76°51'02"	210	1,976	1,976(?)	Nature of basement rock undetermined; hard drilling at total depth.	-	Not assigned	File data

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
CHARLES CO., con't.									
CH-CE 37	Near LaPlata	38°32'36" 76°56'39"	185	2,014	1,915(?)	Clay, hard, red with streaks of rotten rock. Clay, brown, tough. Clay, reddish-brown. Clay, shaly, reddish-brown. Clay, shaly, reddish-brown; micaceous; whitish. Shale, red. Rock, hard. (M)	1,915-1,950 1,950-1,955 1,955-1,957 1,957-1,960 1,960-1,965 1,985-2,010 2,010-2,014(D)	Newark Group (?) Not assigned	File data
CH-DA (#101)	Douglas Point	38°26'15" 77°15'36"	28	886	882	Schist, hornblende-biotite-plagioclase; garnetiferous; interlayers of amphi- bolite; breaks created with green clay. (M)	882-886 (C)	Not assigned	Dames and Moore [1973]
CH-DA (#102)	Douglas Point	38°26'23" 77°15'15"	41	879	876	Schist, hornblende-biotite-plagioclase; garnetiferous; highly weathered at top. Schistosity dips at 40° to 50°. Core breaks along foliation planes. (M)	876-879 (C)	Not assigned	Dames and Moore [1973]
CH-DA (#104)	Douglas Point	38°27'18" 77°15'23"	28	822	822	Hornblende schist at bedrock surface. (M)	822 (C)	Not assigned	Dames and Moore [1973]
CH-DA (#110)	Douglas Point	38°27'17" 77°15'15"	54	982	876	Schist to gneiss, biotite-quartz- plagioclase; dark to light gray; occasional garnets; thin to thick (4") pegmatitic zones. Foliation ranges vertical to horizontal, but averages 30° to 60°. Occasional, thin, amphibolite layers. (M)	876-982 (C)	Not assigned	Dames and Moore [1973]
DORCHESTER CO.									
DO-CE 88	Cambridge	38°34'01" 76°03'20"	9	3,337	3,304	Gneiss. Gneiss, quartz monzonite. Holocrystal- line, hypidiomorphic-granular, non- porphyritic, medium-grained, slight gneissic fabric. Quartz, 39%; micro- cline, 18%; plagioclase (oligoclase), 34%; biotite, 10%; trace apatite, zircon, leucoxene. (S)	3,304-3,331 3,331-3,337(C)	Not assigned	Trapp and others (1982)
HARFORD CO.									
HA-DE 101	Perryman Powerplant Site	39°26'47" 76°13'08"	25	346	291	Saprolite: gray micaceous, silty, fine to coarse sand; grading to mottled gray and yellow-brown; some cementation. (M)	291-346 (C)	*	Dames and Moore (1977, fig. 2.5G)
HA-DE 102	Perryman Powerplant Site	39°26'16" 76°14'08"	20	361	305	Saprolite: white to greenish-gray, micaceous and fine to medium sand. (M)	305-361 (C)	*	Dames and Moore (1977, fig. 2.5G)
HA-DE 104	Perryman Powerplant Site	39°26'29" 76°13'18"	42	397	355	Saprolite: mottled gray, black and yellow-green, micaceous silt and fine to medium sand (thin section at 378': quartz-microcline-plagio- clase-biotite-muscovite schist).	355-379 (C)	*	Dames and Moore (1977, fig. 2.5G)

*Schistose and gneissic rocks are considered to be pelitic facies of Wissahickon Group or, less likely, James Run Formation. Diorite/granodiorite rocks may be Port Deposit Gneiss (Dames and Moore, 1977).

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	BASEMENT ROCKS			
						LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
HARFORD CO., con't.									
HA-DE 104 (Cont'd)	Perryman Powerplant Site	39°26'29" 76°13'18"	42	397	355	Gneiss: hornblende; greenish-gray to black and tan, moderately jointed and fractured; foliation at 45°; slickensides; weathered. (M, S)	379-397 (C)	*	Dames and Moore (1977, fig. 2.5G)
HA-DE 105	Perryman Powerplant Site	39°26'12" 76°13'30"	23	381	321	Saprolite: greenish-gray to brown, micaceous silt and fine to medium sand (thin section at 370': quartz-microcline-biotite-muscovite schist).	321-370 (C)	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss: hornblende; greenish-gray to black and tan; fractured and jointed; weathered. (M, S)	370-381 (C)		
HA-DE 107	Perryman Powerplant Site	39°26'13" 76°13'02"	34	365	302	Saprolite: tan to greenish-gray silt and fine sand; micaceous.	302-306 (C)	*	Dames and Moore (1977, fig. 2.5G)
						Metagabbro: greenish-gray to black; pyritic; calcite in joints and fractures. Foliation dips 30°. (thin section at 362': biotite-microcline-plagioclase-calc-silicate paragneiss). (M, S)	360-365 (C)		
HA-DE 110	Perryman Powerplant Site	39°25'43" 76°13'32"	9	448	306	Saprolite: light to dark gray and greenish-gray, micaceous silt and sand.	306-397	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss: hornblende; greenish-gray, black and tan; weathered, fractured and jointed with irregular foliation; garnet and pyrite. (thin section at 445': garnetiferous quartz-feldspar-biotite-muscovite schist). (M, S)	397-448 (C)		
HA-DE 130 (#309)	Perryman Powerplant Site	39°26'12" 76°13'32"	24	400	314	Saprolite: brown, gray, white silt and fine sand.	314-358	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss, biotite-muscovite-quartz; weathered; fractured; foliation 30°; some slickensides. (M)	358-400 (C)		
HA-DE 131 (#310)	Perryman Powerplant Site	39°26'17" 76°13'26"	32	441	331	Saprolite: blue-gray, fine sand and silt (decomposed mica-schist).	331-376	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss, quartz-feldspar, chlorite; foliation 30°-45°; quartz with serpentine on fractured surfaces; weathered.	376-425		
						Gneiss, banded dark olive green to light green; fractures and slickensides; foliation 30°. (M)	425-441 (C)		
HA-DE 132 (#321)	Perryman Powerplant Site	39°26'18" 76°13'28"	30	418	340	Saprolite, light gray silty clay with some sand; decomposed quartz-biotite gneiss; fractures; slickensides.	340-387	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss, highly fractured with pyrite and chlorite. (thin section at 388': cataclastically deformed quartz diorite). (M, S)	387-418 (C)		
HA-DE 133 (#322)	Perryman Powerplant Site	39°26'15" 76°13'29"	25	390	333	Saprolite; highly weathered blue-green quartz gneiss and biotite schist; foliated 30°; chlorite.	333-353	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss, olive-green; quartz; chlorite; breccia and slickensides; foliation 30°-45°. (M)	353-390 (C)		
HA-DE 134 (#323)	Perryman Powerplant Site	39°26'16" 76°13'23"	31	392	337	Highly weathered gray quartz gneiss.	337-364	*	Dames and Moore (1977, fig. 2.5G)
						Gneiss, olive-green, biotite; chlorite; quartz veins.	364-390		
						Diorite, coarse grained. (thin section at 393': altered granodiorite). (M, S)	390-393		

*Schistose and gneissic rocks are considered to be pelitic facies of Wissahickon Group or, less likely, James Run Formation. Diorite/granodiorite rocks may be Port Deposit Gneiss (Dames and Moore, 1977).

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
HARFORD CO., con't.									
HA-DE 135 (#324)	Perryman Powerplant Site	39°26'12" 76°13'23"	29	457	340	Saprolite, gray-green, chlorite-quartz gneiss; biotite; foliation 30°. Gneiss, light green quartz-feldspar; weathered and dark gray chlorite- biotite schist; coarse-grained diorite logged at 440' to 450'. (thin section at 450': weathered granodiorite). (thin section at 450': porphyro- blastic muscovite-quartz-feldspar- biotite schist). (M, S)	340-408 408-457 (C)	*	Dames and Moore (1977, fig. 2.5G)
HA-DG 3	Spesutie Island	39°26'43" 76°04'15"	12	777	712	Partly decomposed, chlorite schist or metabasalt. Sporadic grains of feld- spar throughout rock; many grains of quartz concentrated near top. Light pink-gray, fine-grained granite. Partly decomposed coarse-grained biotite- quartz-feldspar granite gneiss. Joints dip 60°. Same as above but with sporadic inclusions of fine-grained biotite schist. Partly decomposed coarse-grained biotite- quartz-feldspar granite gneiss. Verti- cal joints. (M)	757-760 760-763.6 763.6-767 767-767.7 767.7-777 (C)	James Run Formation Port Deposit Gneiss	Edwards and Hansen (1979)
*Schistose and gneissic rocks are considered to be pelitic facies of Wissahickon Group or, less likely, James Run Formation. Diorite/granodiorite rocks may be Port Deposit Gneiss (Dames and Moore, 1977).									
KENT CO.									
KE-AC 20	Stillpond Neck	39°20'07" 76°07'55"	7	1,151	1,128	Saprolite: clay, white to light gray, light green; books of muscovite; quartz fragments, subangular; rock fragments (schistose). (M) Gneiss, muscovite-biotite-quartz; and quartzite; traces of zircon and magnetite. (S)	1,128-1,137 1,137-1,148 (D)	Not assigned	Otton and Mandle (1984)
KE-BE 43	Kennedy- ville	39°18'23" 75°59'47"	70	1,672	1,604	Saprolite: clay, light gray-light green; micaceous, medium quartz fragments. (M) Gneiss, muscovite-biotite-plagioclase- quartz; strongly strained and altered. Also contains epidote, chlorite, and trace of hematite, magnetite, leucoxene, zircon, apatite and pyrite. (S)	1,604-1,660 1,660-1,672 (D)	Not assigned	Otton and Mandle (1984)
KE-BG 33	Massey	39°18'15" 75°47'21"	65	2,185	2,124	Saprolite: clay, light gray-green; micaceous; rock fragments, shaly or schistose, mixed with subangular quartz. (M) Gneiss, biotite-quartz-plagioclase or schist; severely altered to chlorite and sericite, calcitic. (S)	2,124-2,149 2,149-2,185 (D)	Not assigned	Otton and Mandle (1984)
KE-CB 36	Fairlee	39°14'00" 76°10'14"	40	1,540	1,514	Saprolite: clay, light gray-green; some rock and quartz fragments. (M) Serpentinite and epidote-actinolite schist; also contains some biotite and hornblende. (S)	1,514-1,535 1,535-1,540 (D)	Not assigned	Otton and Mandle (1984)
KE-DB 40	Rock Hall	39°08'37" 76°14'04"	15	1,822	1,755	Saprolite: clay, light gray to light green; micaceous. (M) Gneiss, quartz-plagioclase and quartzite. Contains traces of chlorite, magnetite and apatite. (S)	1,755-1,778 (D) 1,778-1,822	Not assigned	Otton and Mandle (1984)

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
PRINCE GEORGE'S CO.									
PG-CF 53	Bowie	38°58'16" 76°43'45"	115	1,172	1,162	Granite, weathered; drills progressively harder with depth. Cuttings contain quartz, white and light green feldspar, biotite, and other dark minerals. (M)	1,162-1,172 (D)	Not assigned	Hansen (1968)
PG-EE 49 WGL Roberts #2	Near Brandywine	38°45'49" 76°48'10"	217	1,752	1,720(?)	Siltstone, red brown; micaceous; and clay, sandy; dark gray to light gray, carbonaceous fragments. Sand, very coarse, very clayey; gray to dark gray, carbonaceous. (M)	1,720-1,745 1,745-1,752 (D)	Newark Group (?)	Edwards (1970); Hansen (1968)
PG-EE 50 WGL Butler #2	Near Brandywine	38°45'13" 76°49'59"	170	1,720	1,615(?) 1,660	Clay, variegated, light reddish-brown to yellowish-green, dull pink, white, light green, and hematite red, some mica, silt, and sand, little gravel with a few clayey gravel zones, slightly calcareous, soft, weak. Gneiss(?), quartz, feldspar, and chlorite. (M)	1,615-1,660 1,660-1,720 (D)	Newark Group (?) Not assigned	Edwards (1970); Tompkins (1983)
PG-FC 17 WGL Thorne #2	Near Brandywine	38°42'30" 76°55'56"	65	1,478	1,433	Gneiss, weathered; micaceous; friable. Gneiss, biotite-phlogopite, black (65%) and white (35%), speckled and banded (inclined about 20°), white is quartz, black is biotite-phlogopite, little hornblende, slightly pyritic, locally calcareous and very thin calcareous seams, locally rather large pinkish-buff feldspar crystals; sharp basal contact; top slightly weathered. Gneiss, hornblende, black to green (65%), and white (35%), speckled and roughly banded (inclined 20°), white is quartz, black is hornblende, some pyrite, scattered garnets, little phlogopite. (M)	1,433-1,438 1,438-1,475 1,475-1,478 (C)	Not assigned	Edwards (1970); Tompkins (1983)
PG-FD 56 WGL Dennison #3	Near Brandywine	38°44'41" 76°52'19"	239	1,743	1,707	Gneiss, yellowish-white feldspar, clear quartz; micaceous; some epidote, purple garnet (?) and quartz intermixed; probably weathered at top. (M)	1,707-1,743 (D)	Not assigned	Edwards (1970); Tompkins (1983)
PG-FD 59 WGL Moore #2	Near Brandywine	38°42'49" 76°53'43"	178	1,523	1,488(?)	Clay, cinnamon brown and greenish-gray, silty, fine to coarsely sandy, micaceous, abundant light green and brown igneous and metamorphic rock fragments. (M)	1,488-1,515 (D)	Newark Group (?)	Edwards (1970); Tompkins (1983)
PG-FD 61 WGL Mudd #3	Near Brandywine	38°43'58" 76°52'15"	124	1,725	1,491	Sandstone, graded, silty, clayey; basal 1'3" a conglomeratic clay. Siltstone, purple and green, argillaceous, very micaceous, locally sandy, few granules. Clay, grading to fine sandstone, argillaceous; some mica. Granules and pebbles; sand clay silt matrix; siltstone lense toward base; clay at base. Sand, fine to medium-grained, tight, inclined 15°, upper 1" conglomeratic. Siltstone, grayish-green, argillaceous, very micaceous, inclined 15°. Clay, variegated, silty, micaceous; locally grades to a siltstone. Siltstone, purple to grayish-green, green to gray and reddish-brown, locally mottled, argillaceous, micaceous, locally sandy, few granules; few slickensides.	1,503-1,507 1,507-1,512 1,512-1,514 1,514-1,518 1,518-1,520 1,520-1,522 1,522-1,525 1,525-1,532	Newark Group (?)	Edwards (1970); Tompkins (1983)

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
PRINCE GEORGE'S CO., con't.									
PG-FD 61 WGL Mudd #3 (Cont'd)	Near Brandywine	38°43'58" 76°52'15"	124	1,725	1,491	Conglomerate, granules and pebbles, most clear quartz; matrix sand, silty, and clay.	1,532-1,534	Newark Group (?)	Edwards (1970); Tompkins (1983)
						Siltstone, reddish-brown, some green, mottled toward top, argillaceous, micaceous, some sand, some granules and small pebbles, calcareous; occasional limestone band or patch; occasional band of sandstone; inclined 40°.	1,534-1,552		
						Interbedded sandstone and siltstone; sandstone, varicolored, fine to coarse-grained, good to poor sorting, silty, argillaceous, micaceous, slightly calcareous to calcareous, some granules; one zone grades to conglomerate; siltstone, reddish-brown and green locally mottled, argillaceous, micaceous, locally sandy.	1,552-1,577		
						Sandstone, and conglomerate, pebbles to fine sand, tight.	1,577-1,583		
						Interbedded sandstone and siltstone; sandstone, graded, few pebbles, argillaceous; siltstone argillaceous, micaceous, slightly sandy.	1,583-1,591		
						Siltstone, reddish-brown, little green mottling, argillaceous, micaceous, calcareous, little sand, some internal slickensides, inclined 40°.	1,591-1,600		
						Interbedded sandstone and siltstone, reddish-brown, little green mottling, argillaceous, micaceous, inclined 40°.	1,600-1,605		
						Interbedded sandstone and shale, reddish-brown, little green mottling, micaceous, calcareous, locally slickensided; sandstone, fine to medium-grained, argillaceous; inclined 45°.	1,605-1,616		
						Interbedded conglomerate and sandstone; conglomerate, pebbles and granules; sandstone matrix; sandstone, reddish-brown, fine grained; some coarse; inclined 50°, siltstone at top.	1,616-1,623		
						Interbedded sandstone and shale; sandstone, light green, light pink to pinkish-red and reddish-brown, locally mottled, fine to coarse grained, poor to good sorting, few granules; shale, reddish-brown, micaceous, black carbonaceous flecks; inclined 50°; very little siltstone.	1,623-1,636		
						Shale, reddish-brown, some green mottling, micaceous to very micaceous, slightly calcareous to calcareous, abundant slickensides; upper 2' more silty than lower part.	1,636-1,650		
						Siltstone, gray to green, argillaceous; internal slickensides, inclined 50°.	1,650-1,654		
						Siltstone, light and dark gray laminated, soft rock deformation, inclined 50°.	1,654-1,657		
						Sandstone, very light gray, fine grained, good sorting, cemented, silty, slightly argillaceous, few dark micaceous laminae, slightly calcareous and pyritic; quartz granules at base; bed inclined 50°, no mud infiltration.	1,657-1,667		
						Siltstone, light gray, micaceous; coal bands, black, conchoidal fracture; inclined 50°.	1,667-1,673		
						Conglomerate, granules and small pebbles; sandstone matrix; tight, lenses fine sandstone.	1,673-1,677		
						Sandstone, light gray, fine to medium grained, coal streaks, conglomeratic near base.	1,677-1,683		
						Sandstone, light gray, fine to coarse grained, slight mud infiltration, 1'4" recovered.	1,683-1,686		
						Sandstone, very light gray, fine grained, good sorting, silty, micaceous, coal fragments, few granules, slightly calcareous; inclined 50°.	1,686-1,696		

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
PRINCE GEORGE'S CO., con't.									
PG-FD 61 WGL Mudd #3 (Cont'd)	Near Brandywine	38°43'58" 76°52'15"	124	1,725	1,491	Conglomerate, granules to cobbles, quartz, quartzite and schist, rounded to sub-angular; matrix, sandstone, graded, friable to cemented; locally grades to a sandstone, inclined 50°; very slight mud infiltration. Shale, brown to reddish-brown, some green, locally mottled, slightly sandy; siltstone at top. Sandstone, reddish-brown, graded, clayey, silty, granules near base; siltstone at base. Shale, reddish-brown, gray sandy mottling top 5', below some green mottling, micaceous, slightly sandy, few calcite spots near top, few granules; in basal 1' more pebbles and granules, composed of quartz and metamorphic rocks. (M)	1,696-1,706 1,706-1,709 1,709-1,711 1,711-1,725 (C)	Newark Group (?)	Edwards (1970); Tompkins (1983)
PG-FD 62 WGL Robinson #2	Near Brandywine	38°43'12" 76°51'14"	236	1,818	1,815(?)	Mudstone, hematite, red and green mottling; internal slickensides. (M)	1,815-1,818 (D)	Newark Group (?)	Edwards (1970); Hansen (1968)
PG-GC 5 WGL Wedding #2	Near Brandywine	38°39'47" 76°55'19"	202	1,729	1,625(?)	Clay, light green, light purple, yellowish-brown, light buff, pink, red, gray, and yellow, slightly to very sandy, locally slickensided, locally waxy, plastic, non-calcareous; much core loss. Sand, medium to coarse grained, fine to coarse toward base, angular, much iron red clay. (M) (Note: top-of-basement rocks based on high electric log resistivity).	1,608-1,631 1,631-1,729 (D)	Not assigned	Edwards (1970); Tompkins (1983)
PG-HF 31	Chalk Point	38°32'50" 76°40'53"	9	2,454	2,448	Rock, hard.	2,448-2,454	Not assigned	Tompkins (1983)
QUEEN ANNE'S CO.									
QA-BE 15	Kingstown	39°12'03" 76°02'43"	25	2,009	1,953	Weathered rock, progressively harder with depth. Biotite-quartz-plagioclase gneiss. Contains traces of chlorite, sphene, magnetite, zircon, and apatite. (S)	1,953-2,009 (D)	Not assigned	Otton and Mandle (1984); Kantrowitz and Webb (1971)
QA-EB 110	Kent Island (Chester)	38°57'51" 76°17'16"	14	2,548	2,518	Weathered rock, very slow drilling; cuttings contain quartz, feldspar, biotite, chlorite, including poly-mineralic grains. (M)	2,518-2,548 (D)	Not assigned	Mack (1983)
ST. MARY'S CO.									
SM-DF 84	Lexington Park	38°15'48" 76°27'21"	108	2,678	2,623	Weathered rock. Diabase, fresh, medium-grained, greenish-black. [Core from 2,638 to 2,648 ft: Diabase, holocrystalline, intergranular, medium-grained; labradorite (59%); augite (30%); olivene (10%); magnetite (1%); serpentine (trace); anthophyllite (trace)]. (S)	2,623-2,627 2,627-2,678 (C)	Newark Group (?) K-Ar date: 169± 8 m.y.)	Hansen and Wilson (1984)

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

BASEMENT ROCKS									
WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
SOMERSET CO.									
SO-DD 47	Crisfield	38°00'57" 75°49'32"	12	5,562	4,225 or 4,467 (Gleason (1979) reported a "con- solidated sedimen- tary unit" between approx- imately 4,225 and approx- imately 4,467); Hansen (1982) considered interval weathered basement rock)	Metavolcanic, gray-green, fine-grained phyllitic rock; massive to finely laminated; graded bedding; consisting of quartz, plagioclase, and devitrified volcanic glass. Low grade metamorphic recrystallization produced assemblage of white mica (Phengite ?) + chlorite + epidote + titanite + quartz + feldspar. Cleavage 20° to 35° to bedding. Core cut by veinlets and fractures. (M, S)	4,651-4,661 5,012-5,025 5,537-5,553 (C)	Not assigned	Gleason (1979); Hansen (1982)
WICOMICO CO.									
WI-CG 37 (Ohio Hammond No. 1)	Near Salisbury	38°20'48" 75°29'13"	70	5,568	5,498	Weathered schist; mica, chlorite with small veinlets of pegmatite. Gneiss, biotite-rich with coarse pegmatite veins of weathered orthoclase and chlorite. Gneiss, biotite-rich with faint foliation cut by pegmatite veinlets. Gneiss, biotite-intruded by pegmatite containing orthoclase, pyrite, chlorite, epidote, garnet; fractured. (M, S) [A modal analysis of the gneiss is: quartz, 54%; plagioclase, 17%; orthoclase, 2%; biotite, 21%; calcite, 5%; chlorite, 0.2%; hornblende, 0.3%; titanite, 0.3%; and apatite, 0.4%]	5,490-5,506 5,529-5,537 5,537-5,542 5,542-5,547 (C)	Not assigned	Anderson and others (1948)
WORCESTER CO.									
WO-BH 11 (Standard Oil of New Jersey Maryland Esso No. 1)	Ocean City	38°24'26" 75°03'42"	8	7,710	Greater than 7,710	Sub-Coastal Plain basement rocks not penetrated.	-	-	Anderson and others (1948)
WO-CE 12 (Mobil Bethards No. 1)	Near Berlin	38°17'55" 75°17'27"	43	7,178	7,140	Gabbro, medium to fine-grained, dark greenish-black. Carbonate-filled joints at 75°. Brecciated zone at 7,168' with pyrite; serpentized in parts. About 75% amphibole (hornblende) and 25% quartz and plagioclase (oligoclase); shows moderate degree of metamorphism ("epidote amphibolite"). (M, S)	7,157-7,178 (C, D)	Not assigned	Anderson and others (1948)

Table 1.—Compilation of significant Coastal Plain wells in Maryland that penetrate the buried basement rock complex—Continued

WELL NUMBER	LOCATION	LATITUDE/ LONGITUDE	ALTI- TUDE (ft)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT ROCK (ft)	BASEMENT ROCKS			
						LITHOLOGIC DESCRIPTION (Megascopic, M; Thin-section, S)	INTERVAL (Core, C; Cuttings, D)	UNIT	REFERENCE
ACCOMACK CO., VA.									
J & J Enter- prises Taylor No. 1-G.	Near Atlantic, Accomack County, Virginia	37°53'03" 75°31'00"	53	6,272	6,186	Calcareous metasiltstone. Light carbonate-rich layers alternate with dark, micaceous and quartzose layers. Calcite, quartzite, plagioclase (andesite), muscovite in core clip (Robbins, et. al.). Recrystallized aphanatic limestone. Light carbonate layers intercalated with dark clastic-rich layers. Carbonate content ranges 10% to 85% from band to band; fine-grained biotite porphyroblasts comprise 15% to 20% of thin section. White mica comprises 5%. Remainder is quartz and feldspar. Weakly foliated with a green-schist metamorphic facies (D'Appolonia). (M, S)	Not reported (C)	Not assigned	D'Appolonia, [1981]; Onuschak (1972); Robbins, Perry and Doyle (1975)

Figure 1.—Aeromagnetic map of central and eastern Maryland showing the lithology of samples from Coastal Plain wells penetrating the buried basement rock complex.

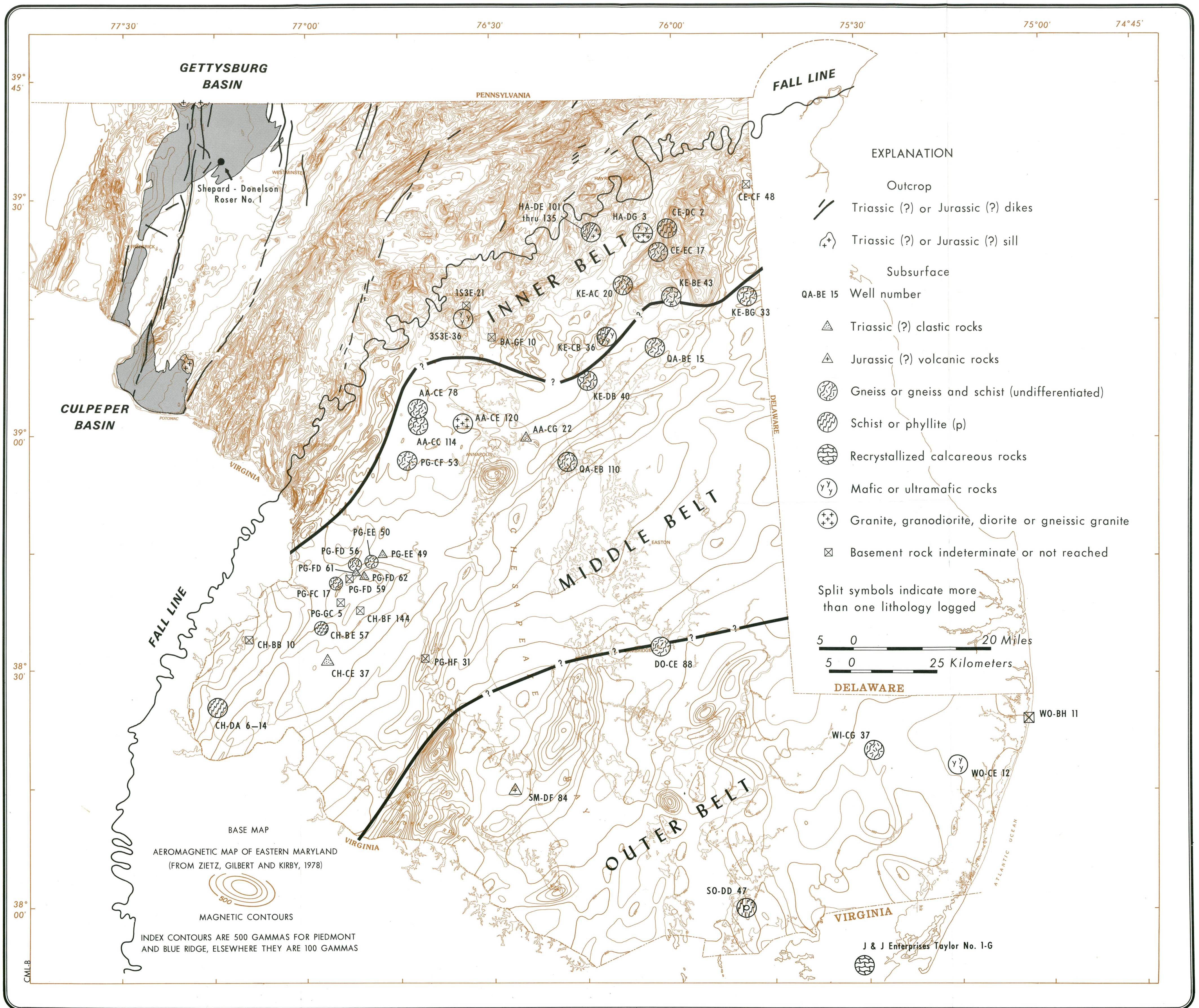


Figure 2.—Map of central and eastern Maryland showing generalized geology of the exposed Piedmont and structural contours on the top-of-pre-Cretaceous basement, with well control.

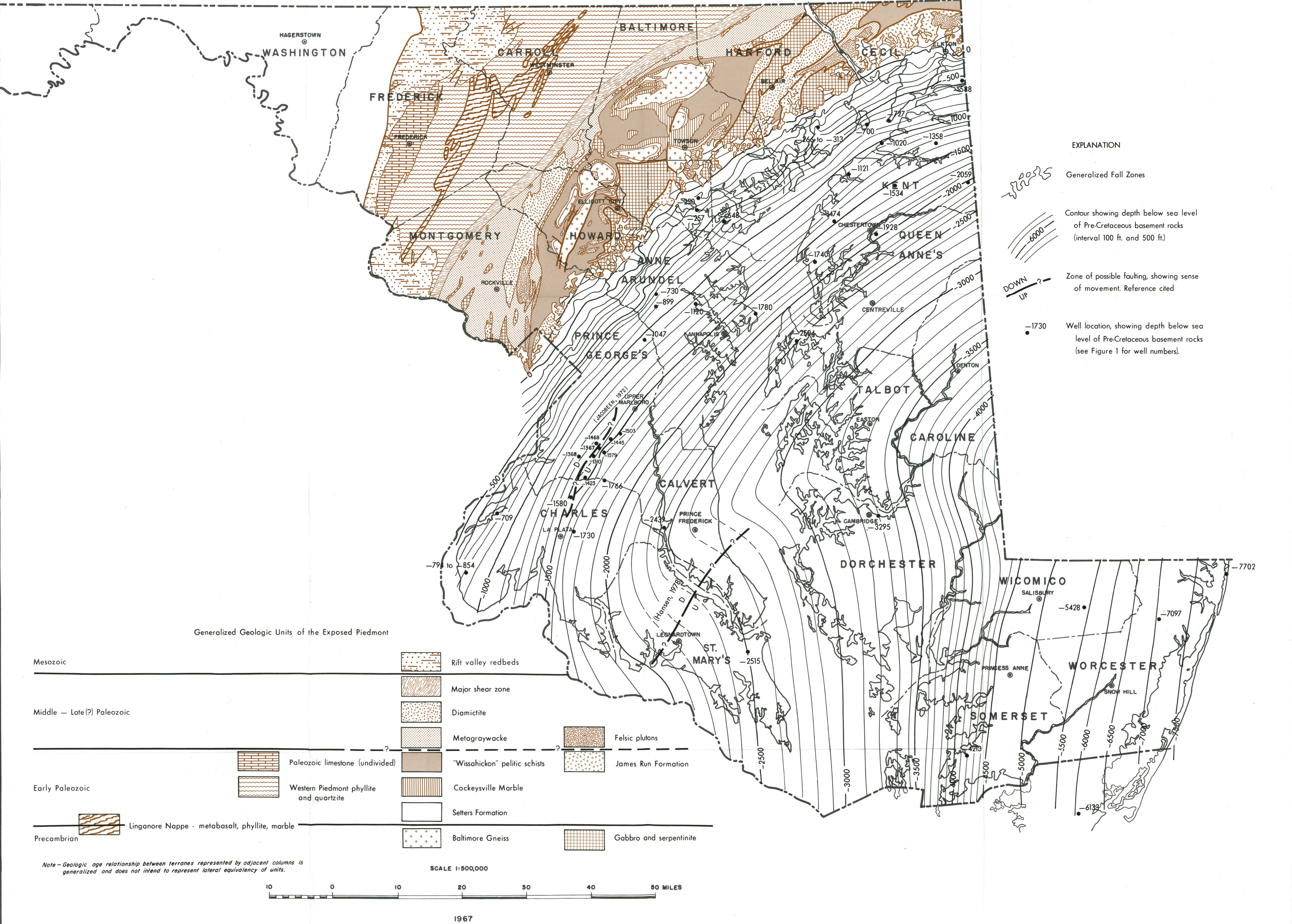
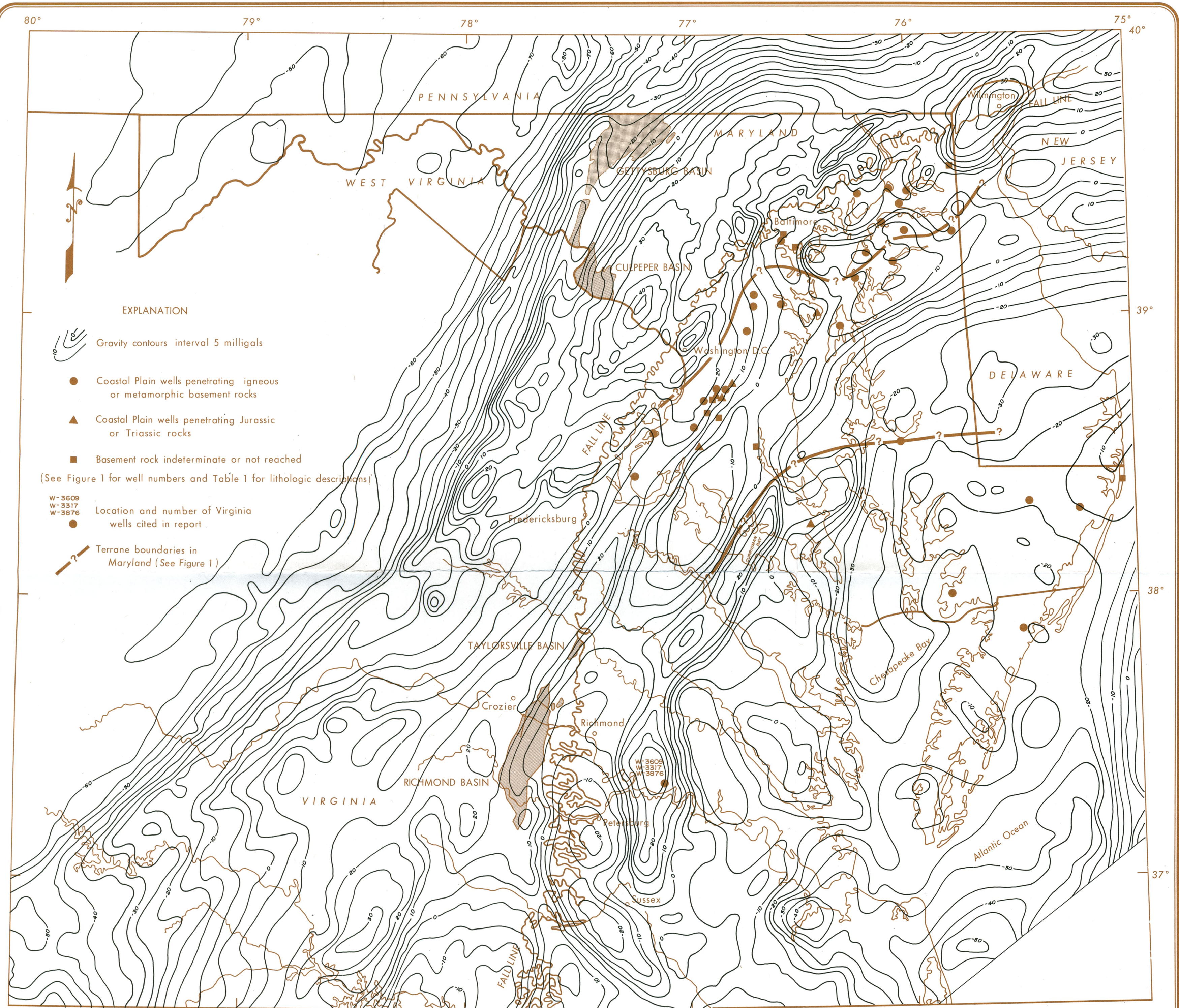
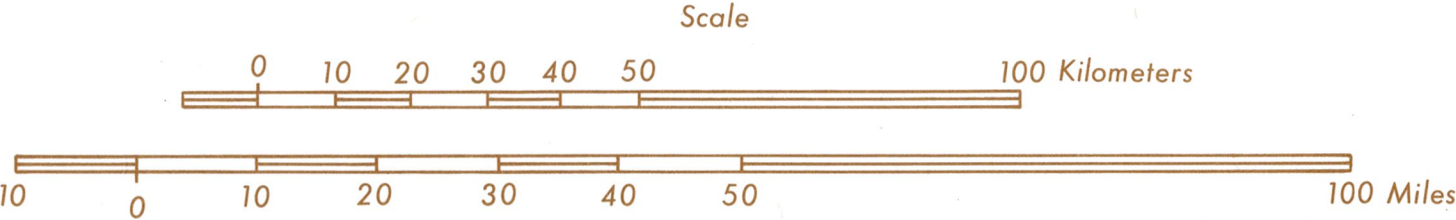


Figure 3.—Generalized Bouguer gravity map of eastern Virginia, Maryland and Delaware (modified after Haworth and others (1980); copyrighted by Memorial University of Newfoundland).



Gravity contours and base map from Haworth, Daniels, Williams and Zietz (1980). Copyright © by Memorial University of Newfoundland. Reprinted with permission.

Fall Line and Triassic Basins from Benson (1984).



MARYLAND GEOLOGICAL SURVEY
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