EXPLANATION

UNCONSOLIDATED TO SEMI-CONSOLIDATED

QUATERNARY

Alluvium

Qa *Alluvial deposits in stream valleys; thickness ranges from 0.5 meters to more than 5 meters; commonly consists of a lower gravel unit and an upper micaceous sand-silt-clay unit. Gravel unit consists of fragments of local country rock and vein quartz. Clasts locally exceed one meter in diameter. Swamp areas and bogs are common. In urbanized areas, stream deposits have been extensively disrupted. The deposits cannot be accurately shown in many areas because of channelization, suburban development, or other land modifications. Structural symbols on alluvium represent bedrock exposures in stream valleys. These are typically either along the margins of the flood plain or close to the main channel of the drainage.*

Colluvium and Alluvium

Qac *Unsorted clay to gravel-size clasts of colluvial origin; well to poorly sorted, intercalated gravel, sand, silt, and clay of fluvial origin. Drill data indicate thicknesses exceed 6 meters in places.*

CRETACEOUS

unconformity

Potomac Group
Patuxent Formation

Two lithofacies have been mapped; areas in which sand and gravel predominate are shown as Kxs; areas shown as Kxc are predominately clay and sandy clay. Iron cemented layers and lenses of sand and gravel with thicknesses ranging from less than 1 centimeter to more than 0.75 meters occur sporadically. Layers more than 0.25 meters thick are shown by a heavy dashed line (----).

Kxs *Sand and gravel facies; gray to white, some beds red, orange-brown, or yellowish brown. Characterized by abrupt horizontal and vertical changes in lithology between the sand and gravel facies and the clay facies. Maximum size of gravel clasts is 20 centimeter in longest axis, but most average less than 2 centimeters. Clasts are mainly vein quartz and quartzite, with minor quartz-feldspar gneiss and iron cemented conglomerate and sandstone. Sand beds are mainly fine to medium grained quartz. In places, the sand is very micaceous. In excavations, sediments of this lithofacies commonly show a color change from white or gray upward to orange-brown or yellowish brown, sand grains and gravel clasts are clay coated, and gravel clasts are friable. These changes are observed in the uppermost 1.5 to 2.5 meters.*

Kxc *Clay and sandy clay facies, gray to white, locally mottled brown, yellow, and maroon. Texture varies from clay, to silty, sandy, and gravelly clay. Predominant clay mineral is kaolinite; illite is less common. Characterized by abrupt horizontal and vertical variations from clay to sand and gravel.*

CRETACEOUS(?)

Potomac Group (?)

Similar in color, lithology, and sedimentological features to the Patuxent Formation in the southeastern part of the Quadrangle, but of uncertain age because of their separation from the Patuxent Formation and lack of dateable paleontological material. Where the gravel, sand and clay overlie marble, chemical weathering of the marble has apparently resulted in significant lowering of the sediments.

ps *Areas in which sand and gravel predominate.*

pc *Areas in which clay predominates*

pu *Undivided Potomac Group (?)*

INTRUSIVE ROCKS

SILURIAN(?)*

unconformity

Pegmatite

p *Massive, coarse-grained to very coarse-grained, light colored rock consisting chiefly of mica (mostly muscovite), quartz, and feldspar; contains minor garnet locally (as tiny grains about 2 mm in diameter).*

over print *Areas in which the rock formations commonly include interlayered pegmatite (identical to that described above) as concordant sills as much as several meters thick. Commonly associated with, or replaced by a finer-grained gneissic rock of the same mineralogy.*

CAMBRIAN(?)*

Gunpowder Gneiss†

gg *Fine-, medium-, and coarse-grained, very uniform plagioclase quartz-microcline gneiss, generally with both biotite and muscovite, locally with small feldspar megacrysts. (Previously designated Gunpowder Granite.)*

over print *Areas in which the mapped rock formations include interlayered Gunpowder Gneiss, identical to that described above, as concordant sills, and rarely as cross-cutting dikes, as much as ten meters thick.*

Top of Crystalline Stratigraphic Section

CAMBRIAN(?)

Perry Hall Gneiss

p *Perry Hall Gneiss. Fine- to medium-grained biotite-quartz-plagioclase gneiss with rare muscovite, and hornblende-quartz-plagioclase gneiss, commonly garnetiferous; subordinate amphibolite; all interlayered generally on a scale of meters.*

BALTIMORE MAFIC COMPLEX

Raspeburg Amphibolite

r *Raspeburg Amphibolite. Fine- to medium-grained, uniform amphibolite, locally laminated.*

um *undivided mafic-ultramafic rock.*

thrust fault

CAMBRO-ORDOVICIAN(?)

GLENARM SUPERGROUP

WISSAHICKON GROUP

Oella Formation

o *Oella Formation. Medium-grained biotite-plagioclase-muscovite quartz schist, commonly garnetiferous, locally with tourmaline, interlayered on a centimeter to decimeter scale with fine-grained biotite-plagioclase-quartz gneiss or fels (metagraywacke).*

Loch Raven Schist

l *Loch Raven Schist. Uniform, medium- to coarse-grained biotite-plagioclase-muscovite-quartz schist with lenses and pods of coarse-grained vein quartz. Locally rich in biotite and feldspar. Includes minor quartzite.*

(g) *garnet facies. Garnet common; staurolite and kyanite rare or absent.*

(g-s) *garnet-staurolite facies. Garnet and staurolite common; kyanite rare or absent.*

(g-k) *garnet-kyanite facies. Garnet and kyanite common; staurolite rare or absent.*

(g-s-k) *garnet-staurolite-kyanite facies. Garnet, staurolite, and kyanite all common.*

lh *Hydes Marble Member. Very poorly exposed, sparse outcrops of fine-, medium-, and coarse-grained calcite marble, locally phlogopitic. The Hydes Marble is either younger than Cockeysville Marble or is Cockeysville emplaced by early thrust faulting, based upon location of the Hydes astride a synclinal axis and the absence of Rush Brook in contact with the Hydes.*

lr *Rush Brook Member. Fine-grained, quartz-rich schist and gneiss with subordinate medium-grained quartzite, interlayered generally on a scale of decimeters to meters; tourmaline common in outcrops that include quartzite. Quartz pebble metaconglomerate very rare. Finely disseminated pyrite locally abundant.*

ea *epidote amphibolite. Fine-grained to coarse-grained, finely laminated to uniform amphibolite with epidote, generally accompanied by quartz, either in pods or in thin laminae; locally garnetiferous; calcite very rare.*

a *amphibolite. Similar to above but largely devoid of epidote.*

m *marble. A single lens of fine-grained, phlogopite-rich calcite marble with tremolite, at least 8 meters thick.*

Cockeysville Marble

cpl *Phlogopitic metalimestone member. Fine- to medium-grained, white to bluish-white calcite marble interlayered on a millimeter- to centimeter-scale with fine- to medium-grained, purplish, phlogopitic calcite marble or calc-schist with feldspar, scapolite, muscovite, quartz, and very minor diopside and tremolite. Locally, uniformly silicate-rich or silicate-poor.*

cmd *Massive metadolostone member. Medium-grained, white, generally massive metadolostone consisting of over 95% dolomite plus minor diopside, tremolite, phlogopite, and quartz. Includes a few occurrences of phlogopitic metalimestone and, northwest of Glen Ellen, a single occurrence of quartz-tremolite rock. Commonly weathers to dolomite sand.*

cld *Layered metadolostone member. Fine-grained, light and dark dolomite marble interlayered generally on a scale of several decimeters. Dark metadolostone contains diopside, tremolite, and phlogopite, and has quartz in thin, concordant layers (5 to 8 cm or less in thickness) and discontinuous zones of nodules; light dolomite marble is largely silicate-free.*

cml *Massive metalimestone member. Foliated to massive, medium- and coarse-grained, quite pure calcite marble, commonly blue streaked, and subordinate fine-grained, brown weathering dolomite generally bearing calcite and silicates (phlogopite, muscovite, tremolite, diopside, quartz) interlayered on a scale of several meters to more than a decameter, though locally on the order of a few decimeters. Includes rare, brown-weathering, massive quartz-tremolite-diopside rock in layers on the order of one meter thick.*

cmlc *Calc-gneiss lens. Fine-grained, bluish-gray, warty-weathering calcite marble or calc-gneiss with scapolite, diopside, tremolite, and quartz; generally pyritic; rarely phlogopitic. Locally includes layers of relatively pure calcite marble a few decimeters thick.*

Setters Formation

s *Setters Formation undivided*

sgs *Garnet schist member. Fine- to medium-grained biotite-plagioclase-muscovite-quartz schist, generally with abundant, small garnets (2-3 mm in diameter), and locally kyanite. Very subordinate quartzite in zones a few meters thick.*

sg *Gneiss member. Fine-grained microcline-quartz gneiss with biotite or biotite and muscovite and conspicuous tourmaline. Commonly thin-layered. Includes subordinate quartzite and schist in layers ranging from a few decimeters to more than a meter in thickness. Locally the basal 15 to 30 meters in the southern outcrop belt consists almost exclusively of schist, commonly tourmaline-rich, and locally garnetiferous. Gneiss of the northern outcrop belt locally has a "wormy" texture due to the break-up of thin, light-colored laminae.*

sgq *Quartzite lens. Well foliated to massive, medium-grained, unlayered muscovite-feldspar quartzite.*

sq *Quartzite member. Fine- to medium-grained, well layered, slabby weathering; varies from nearly pure quartzite to schistose quartzite rich in muscovite and microcline, commonly bearing tourmaline and locally magnetite. Layering thickness generally a few centimeters to a few decimeters. Locally the quartzite is uniform and lacks layering. Quartzite of northern outcrop belt is locally biotitic and includes schist in layers a few centimeters to a few decimeters in thickness.*

sqs *Schist lens. Medium-grained biotite-microcline-quartz-muscovite schist, locally coarse-grained and more feldspathic, rarely fine-grained and biotitic. Very subordinate muscovite-feldspar quartzite in layers a few decimeters thick.*

PRECAMBRIAN*

unconformity

Baltimore Gneiss

p€bl *Layered gneiss member. Dark and light biotite-microcline-quartz-plagioclase gneiss varying from biotite schist to massive quartzo-feldspathic granofels interlayered on a scale of centimeters to decameters. Hornblende very rare and confined to outcrops close to the contact of the augen gneiss member.*

p€bh *Hornblende gneiss member. Similar to the layered gneiss member but with hornblende-bearing dark gneiss constituting about 50% of the total outcrop area. Garnet very rare.*

p€ba *Augen gneiss member. Crops out in two belts characterized by fine- to medium-grained biotite-microcline-quartz-plagioclase gneiss containing abundant, large (1-3 cm), light-colored ovoids (augen) consisting of microcline or of microcline and quartz. Augen gneiss of the northeastern belt is pinkish and includes subordinate fine- to medium-grained, uniform biotite-quartz-feldspar gneiss, and pinkish biotite-quartz-feldspar granofels in layers generally a decimeter to a meter in thickness. Includes rare layers of Gunpowder Gneiss† in addition to the larger mass near Notch Cliff. Augen gneiss of the southwestern belt is similar to the layered gneiss member but includes augen in about half of the outcrops.*

p€bs *Streaked-augen gneiss member. Uniform, commonly pinkish, medium-grained biotite-microcline-quartz-plagioclase gneiss generally with augen that have a "stretched" or "streaked" appearance. Magnetite abundant in places; minor garnet and hornblende locally. Includes subordinate, fine-grained, dark biotite-quartz-feldspar gneiss in layers ranging from a few decimeters to a meter in thickness.*

For the crystalline rocks primary minerals are listed in order of increasing abundance. Grain size definitions are: fine = less than 1 mm; medium = 1-5 mm; course = 5 mm - 3 cm; very course = greater than 3 cm.

Contact
Generally approximate or inferred. Distribution and concentration of structural symbols indicates degree of reliability of any contact

boundary between mineral facies of the Loch Raven Schist

Normal Fault
u - upthrown side
d - downthrown side

Thrust Fault
teeth on upper plate

overturned — upright
Anticline or Dome

overturned — upright
Syncline

vertical — inclined — horizontal
Foliation or Schistosity
(everywhere virtually parallel to compositional layering)

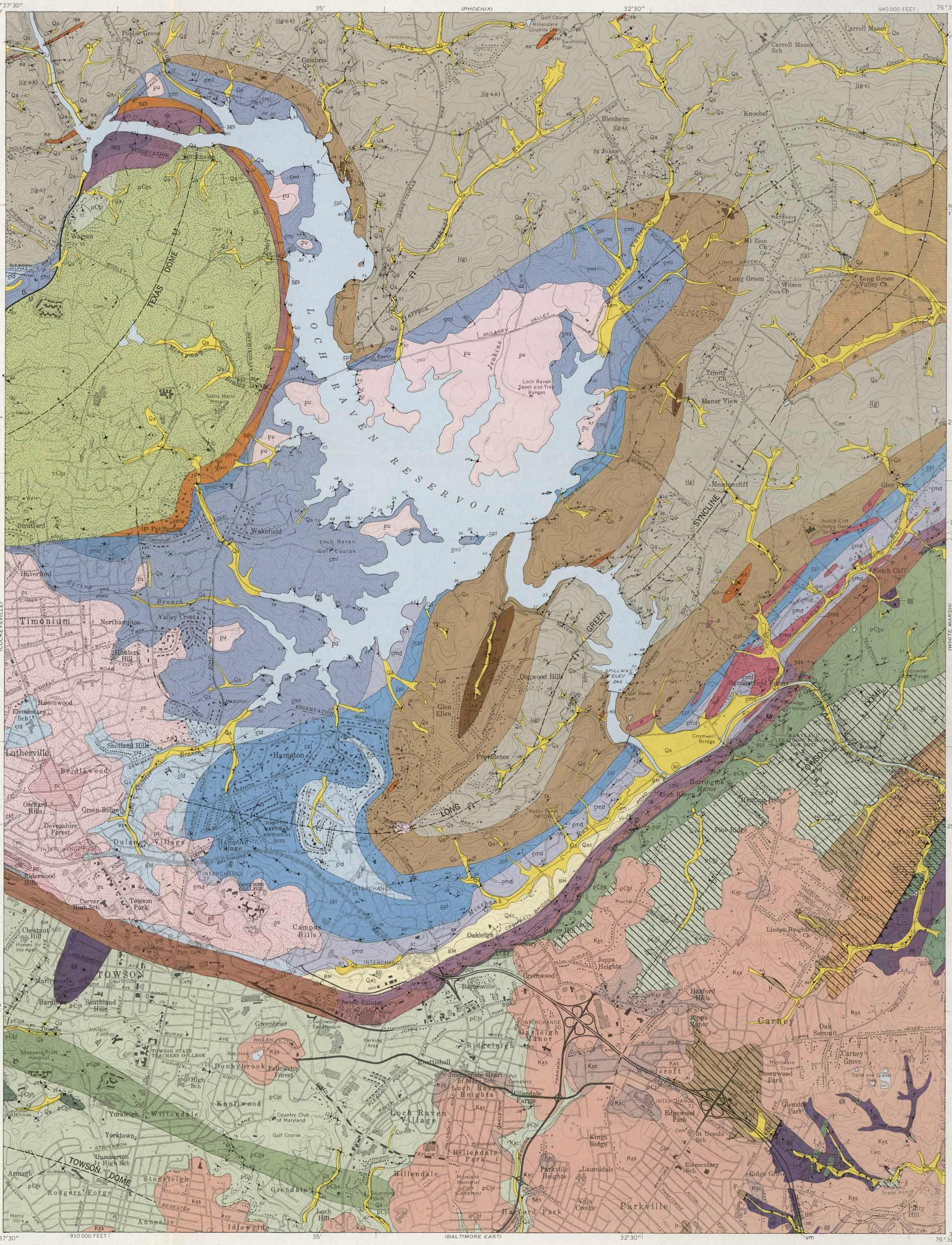
inclined
Crumpled Schistosity

inclined: symmetric — dextrally asymmetric — sinistrally asymmetric
horizontal: symmetric — asymmetric
Axis and Symmetry of Minor Fold

inclined — horizontal
Mineral Lineation

*age designations based on radiometric dates on *Geologic Map of Maryland* (1968)

†Note added in proof: The two, small, finger-shaped bodies of Gunpowder Gneiss, one at Notch Cliff, the other at Towson, are no longer considered to be Gunpowder Gneiss, but rather pre-Glenarm granitic gneiss of probable intrusive origin.



Base map from U.S. Geological Survey, 1957
Towson Quadrangle, 7½ Minute Series

Crystalline rocks mapped by William P. Crowley and sediments by Emery T. Cleaves.

Field mapping done, 1969 to 1971.

Williams & Heintz Map Corporation, Washington, D. C. 20027

MN GN 8° 142 MILS 1° 18 MILS

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GEOLOGIC MAP OF THE TOWSON QUADRANGLE, MARYLAND

By
William P. Crowley and Emery T. Cleaves
1974

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

Prepared in cooperation with the U. S. Geological Survey as part of the Baltimore-Washington Urban Area Study
Grant No. 14-08-0001-G-72

EXPLANATION

Terrain underlain by crystalline rock

Geologic factors affecting land modification in the crystalline rock portion of the Quadrangle are keyed, firstly, to the depth of the weathered material (saprolite) which mantles the rock and, secondly, to stream valleys. The parameters of five and 20 feet for overburden thickness were selected to reflect current needs for placement of on-site sewerage disposal systems that are commonly installed in subdivisions. To construct a system using a tile field, at least five feet of overburden is desirable; for a system using dry wells, 20 feet or more of overburden is desirable. As a consequence, areas with less than five feet of saprolite overlying the crystalline rock are indicated as areas of maximum constraint. Not only are such areas of shallow overburden poor sites for construction of on-site sewerage systems, but also are areas where significant rock blasting would probably be required in various contruction activities. Areas with estimated overburden between five and 20 feet present an intermediate constraint situation in comparison to areas with less than five feet of overburden and those areas with more than 20 feet. From a construction, or earth-moving, point of view, areas with estimated overburdens in excess of 20 feet present minimal geologic constraints.

Stream valleys in the crystalline rock areas are indicated as areas of maximum constraint. High water table conditions result in numerous bogs, swamps, and generally poor surface drainage conditions. Part or all of the area may be subject to flooding.

Terrain underlain by sedimentary deposits

Geologic constraints in the areas underlain by sedimentary deposits are keyed to lithology (clay, sand-gravel) rather than thickness of overburden. Where construction activities penetrate through the sediments into the underlying saprolite and crystalline rock, geologic constraints necessarily reflect the crystalline rock conditions. In the Lutherville-Timonium area, where sediments of varying thickness overlie marble, crystalline rock terrain constraints may more strongly influence man's modification of the land than sedimentary terrain constraints. Sedimentary deposits shown as unit "pu" on the geologic map are too thin to appreciably constrain terrain modification, and are not shown.

In built up areas such as the Stoneleigh, Loch Raven Village, and Parkville areas, streams have been extensively channelized or modified. As a consequence, Qal areas (Geologic Map) and Unit 1 (this map) could not be meaningfully portrayed.

Caution: The general conditions and constraints represented on this map can not replace or substitute for specific on-site investigation of specific land tracts prior to their modification.

EXPLANATION OF MAP UNITS

Terrain underlain by crystalline rock

Maximal constraint conditions

Unit	Description
1	High water table conditions. Part or all of area may be subject to flooding. Shown as Unit f on Map of Estimated Thickness of Overburden, Unit 1 on Landform Map, and Qal on Geologic Map.
2	Overburden estimated at 0-5 feet in thickness. Includes areas with slopes greater than 12°, shown as Units S2 and S3 on Landform Map. Mantle instability may occur if slope is disturbed.
3	Overburden estimated at 0-5 feet in thickness. Slope of the land generally less than 12°, and may be less than 6°.

Intermediate constraint conditions

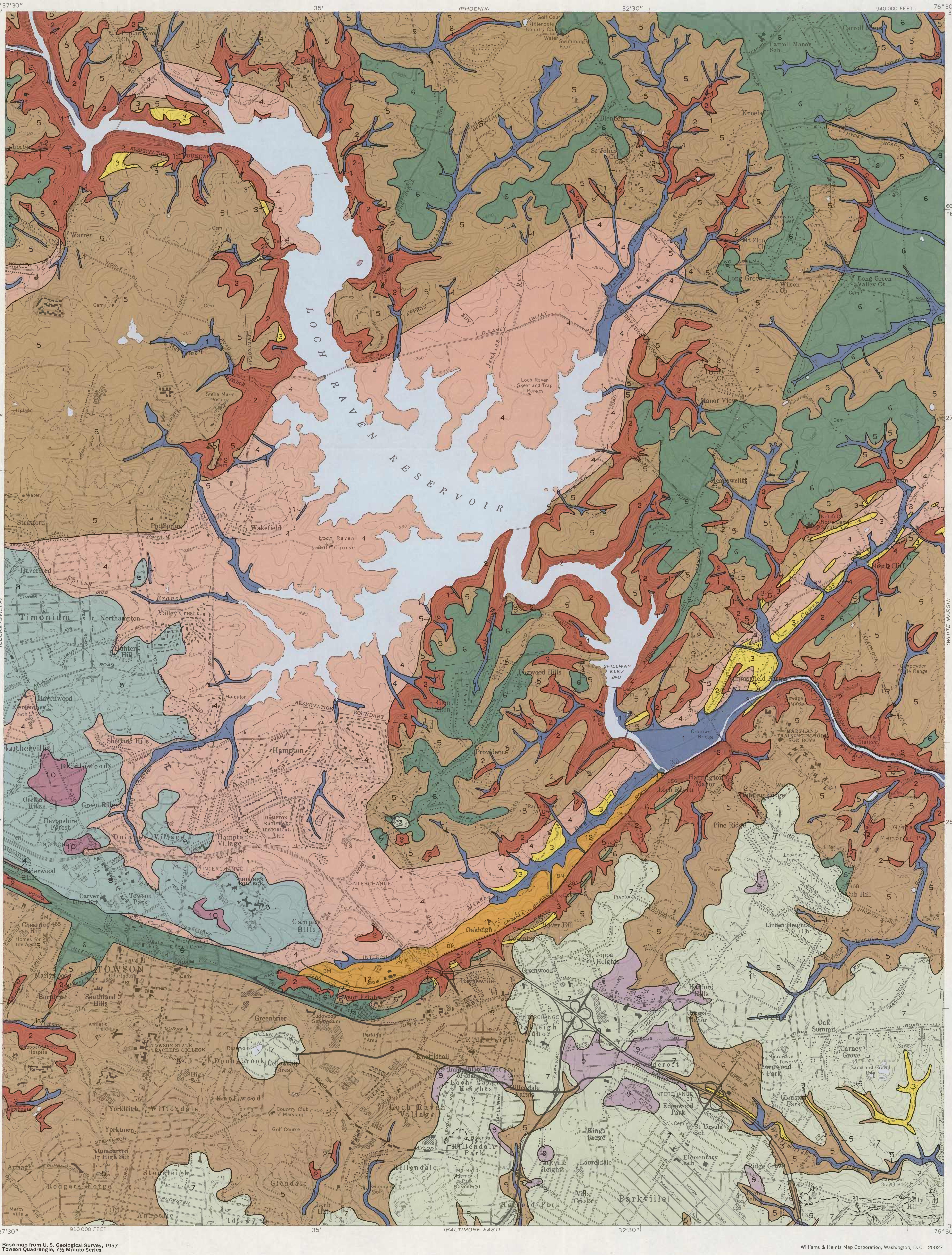
Unit	Description
4	Variable thickness of overburden. Terrain is underlain by Cockeysville Marble; abrupt local changes in overburden thickness; rock pinnacles and residual boulders commonly occur; overburden commonly is a sandy carbonate residiuum. Corresponds to Unit d on Map of Estimated Thickness of Overburden.
5	Overburden estimated at 5 to 20 feet in thickness. Saprolite comprised of quartz-clay minerals-ferric oxides and hydroxides. Rock fragments rare to common, depending upon parent material.

Minimal constraint conditions

Unit	Description
6	Depth of overburden estimated to exceed 20 feet. Slopes less than 12° and commonly less than 6°. Saprolite composed of quartz-clay minerals-ferric oxides and hydroxides, with the exception of Long Green Valley, where dolomite sand and other residiuum from weathering of marble occurs.

Terrain underlain by sedimentary deposits

Unit	Description
7	Areas in which sand and gravel predominate. Excavation characteristics and stability of cut slopes are variable due to abrupt horizontal and vertical changes in distribution of sand-gravel and clay. Groundwater seepage in predominantly sand layers results in severe slope erosion. After periods of prolonged precipitation localized perched water table conditions are common, particularly if clay seams and lenses are present. On the other hand excavations in, or cut slopes through, dry sand may result in bank failures triggered by vibration.
8	Like 7, except underlain by marble which will constrain construction activities if excavation penetrates through the sedimentary cover.
9	Areas in which clay predominates. Excavation characteristics and stability of cut slopes are variable due to abrupt horizontal and vertical changes of clay and sand-gravel. Cut slopes and vertical banks in clay may be stable over short periods of a few days. However, jointing in the clay commonly results in bank failures if cut is left open for an extended period.
10	Like 9, except underlain by marble which will constrain construction activities if excavation penetrates the overlying clay.
11	Iron cemented layers exceeding 0.25 meters in thickness. These layers may require blasting. Indicated by dashed line. Known occurrences limited to the Hillendale and Putty Hills areas.
12	Areas in which gravel, sand, and clay of fluvial origin are mixed together with poorly sorted, low density materials of colluvial origin. Bank failures may occur if land is modified by construction.



Base map from U. S. Geological Survey, 1957
Towson Quadrangle, 7½ Minute Series

Williams & Heintz Map Corporation, Washington, D.C. 20027

GEOLOGIC FACTORS AFFECTING LAND MODIFICATION, TOWSON QUADRANGLE, MARYLAND

By
Emery T. Cleaves
1974

MN GN
8° 142 MILS
1° 18 MILS
UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
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CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

Prepared in cooperation with the U. S. Geological Survey as part of the Baltimore-Washington Urban Area Study
Grant No. 14-08-0001-G-72

EXPLANATION

Mineral resources of present value, potential use, and historical interest occur in the Quadrangle. Sand and gravel are the only commodities currently being extracted. Materials that might be extracted in the future include sand and gravel, marble, quartzite, and gneiss. However, many areas in which these deposits occur have been pre-empted by other land uses. Deposits of iron ore, feldspar, and granite are of historical interest as they are no longer of economic significance.

Sand and gravel: Sand and gravel extraction is the only mineral operation currently active (1974). The material is used for fill, aggregate, and construction sand. The only active pit is located east of Carney along Joppa Road. Throughout the Quadrangle sand and gravel operations have affected 351 acres. Of these, 113 acres are developed, 176 are overgrown and have had little or no reclamation, and 62 are being worked.

Marble: Large bodies of marble east and north of Towson are coarsely crystalline with both calcite and dolomite layers. Although several small quarries were opened for local use in the past, no marble quarries are being worked at present. The marble available in the area could be used commercially for building stone, filler for paint, linoleum, or rubber, crushed stone, aggregate, and as a source of lime in cement and concrete.

Quartzite and Gneiss: Both the quartzite and gneiss of the Setters Formation have been quarried in the past, although none were being worked in 1974. Several small quarries in the quartzite and the gneiss are present along Cromwell Bridge Road east of Towson. The quartzite is hard and resists weathering. Joints and fractures yield a roughly rectangular construction block. Some quartzites cleave into neat, parallel-sided slabs, suitable for either flagstones or general building stone. The rock can also be used for crushed stone.

Economic deposits of historical interest include iron ore, feldspar, and granite. Iron ore, known as limonite or "brown ore," was mined near Towson. These old ore banks are now sites of housing developments, shopping centers or are overgrown with vegetation. Iron ore in this area generally occurs along the contacts between the Cockeysville Marble and the underlying Setters Formation and the overlying Wissahickon Group. Iron ore also occurs at the contact between the Cockeysville Marble and the overlying sediments. Iron is leached out as ground water percolates through the formation adjacent to the Marble. At the contact with the marble the iron is precipitated and pockets of limonite are formed.

Potash rich feldspar was extracted from the pegmatite dikes located near Notch Cliff. The old quarries remain, as little reclamation has been carried out. The operations were abandoned due to the difficulty in economically extracting the feldspar from the rock. The feldspar was utilized for ceramics, binding in emery and corundum wheels, poultry grit, and other uses. The pegmatite was also used for building stone.

The Gunpowder Gneiss has been quarried for crushed stone along the Gunpowder River at a location near Harford Road. A liquified propane gas underground storage facility is now located at this site.

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EXPLANATION OF MAP UNITS

Sand & gravel

Marble

Pegmatite

Gneiss

Quartzite

small inactive quarries or pits

boundary of larger quarries or pits

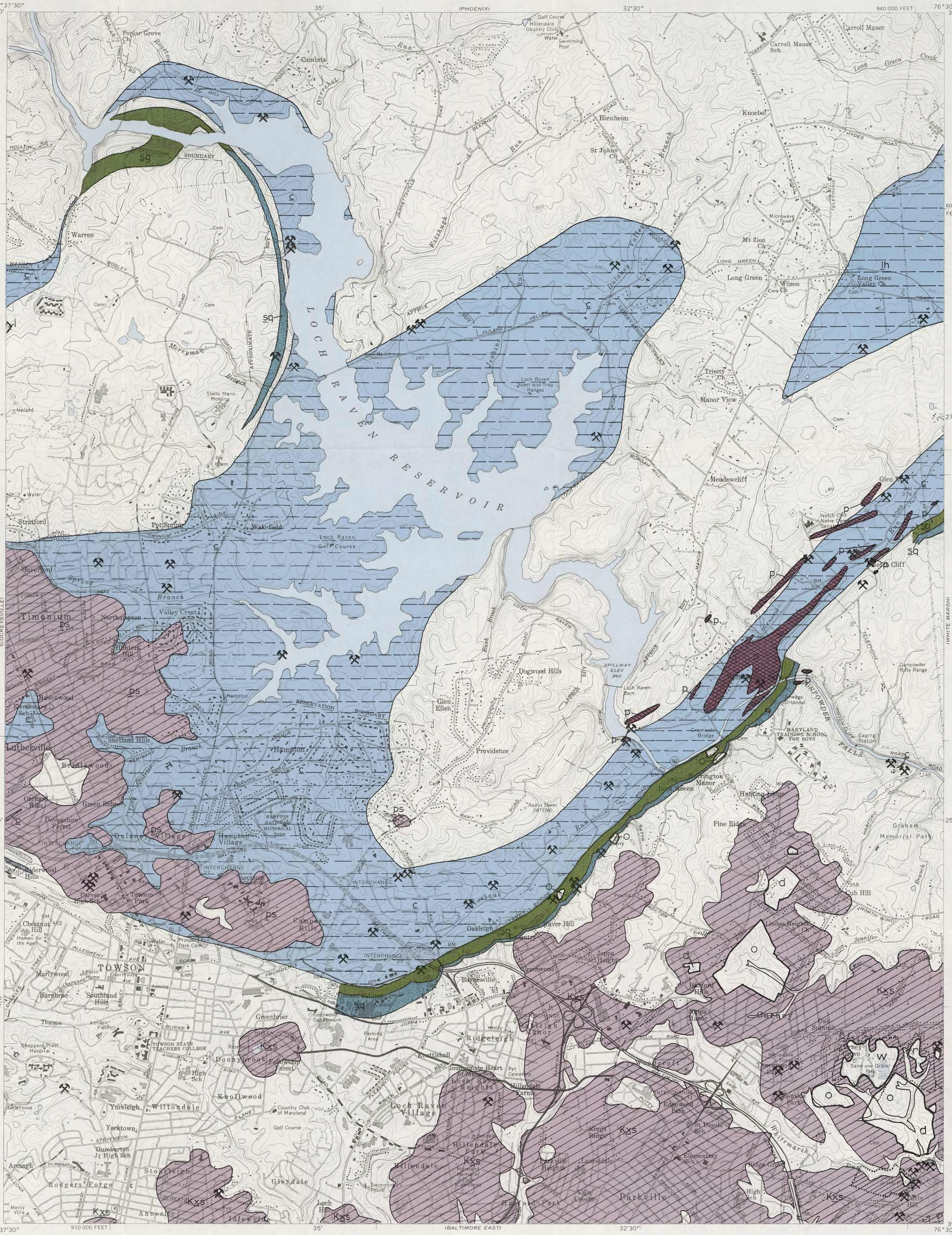
boundaries of properties owned by mineral extractors

Status of quarries or pits

- d — reclaimed, developed
- l — reclaimed, landfill
- g/p — reclaimed, planted and/or graded
- ss — abandoned, supply storage
- o — abandoned, overgrown
- r — abandoned, recent overgrown (ambiguous future)
- w — working pits

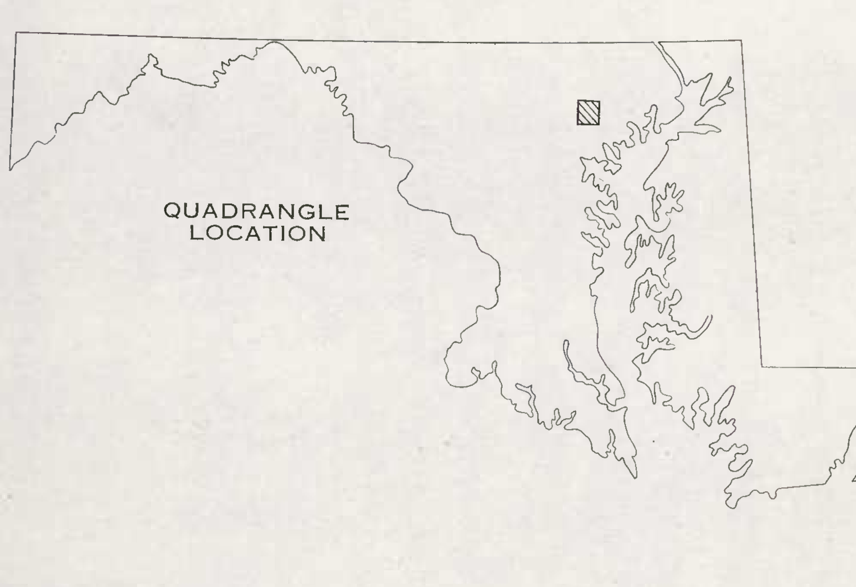
Geologic units

- Kxs — Patuxent Formation, sand and gravel
- ps — Potomac Group (?) sand and gravel
- lh — Loch Raven Schist, Hydes Marble Member
- c — Cockeysville Marble
- sq — Setters Formation, quartzite member
- sg — Setters Formation, gneiss member
- p — Pegmatite



Base map from U.S. Geological Survey, 1957
Towson Quadrangle, 7½ Minute Series

Williams & Heintz Map Corporation, Washington, D. C. 20027



MINERAL RESOURCES AND MINED LAND INVENTORY, TOWSON QUADRANGLE, MARYLAND

By
Karen R. Kuff
1974

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

Prepared in cooperation with the U. S. Geological Survey as part of the Baltimore-Washington Urban Area Study
Grant No. 14-08-0001-G-72

EXPLANATION

Most of the Towson Quadrangle lies in the eastern division of the Piedmont Province, but the southeastern part lies in the Coastal Plain Province. The terrain underlain by crystalline rocks has been subdivided into three physiographic units: Upland, Slopeland, and Lowland. In general Upland and Lowland correspond to Summit Uplands and Meadow Lowlands of Knopf (1929, p. 62, 63). Slopeland, in part, comprises the slopes that separate Upland from Lowland and, in part, the Stream Gorges of Knopf (p. 63). Each of the physiographic units has been further subdivided as defined in the explanation, and shown on the map. Upland subunits are diagrammatically portrayed in Figure 1, and some of the Slopeland and Lowland subunits in Figure 2.

The Landform Map provides the link between the "Geologic Map" and the interpretative maps "Estimated Thickness of Overburden" and "Geologic Factors Affecting Land Modification." In the course of preparation of this Atlas, landform, rock type, and thickness of overburden have been found to be interrelated. Consequently, landform is used to extrapolate thickness of overburden from known areas to unknown ones. See "Estimated Thickness of Overburden, Towson Quadrangle" Map 3 of this Atlas.

The landforms generally are related to the underlying crystalline rocks (Figure 3). The Lowland areas are usually underlain by marble (cm) upon which landforms L1, L2, and L3 are mapped. The Setters Formation (s,q) forms prominent ridges with steep slopes (S2 or S3) in areas where quartzite member is a major rock unit. Upland (U3) or Slopeland (S1, S2, S3, and S4) landforms may be found on a variety of rock types, such as the Baltimore Gneiss (ba) or Loch Raven Schist (lrs).

The Landform Map can serve as a generalized slope map. For example, L1, S1, and U1 Landforms generally slope less than 6 degrees; and S2 and S3 landforms have slopes that generally exceed 12 degrees. In the case of S2, slopes commonly exceed 20 degrees.

The Landform Map also serves as a guide to the dominant geomorphic process that affects a particular landform (Cleaves, 1973). On the Upland areas (U) underlain by non-marble crystalline rocks, chemical weathering is the significant process. Rock is altered to saprolite with loss of mass but no change in volume. On Slopeland, especially the steeper slopes (S2), underlain by non-marble rocks, mass movement is the dominant process. In valley bottoms (S1) on non-marble rocks fluvial processes are dominant.

On the Lowlands, L, both fluvial transport and chemical weathering are active. Fluvial transport is dominant on L1, and chemical weathering on L2 and L3. On marble Lowlands, however, alteration of the marble by chemical weathering generally results in loss of both mass and volume in contrast to non-marble rocks where there is loss of mass without change in volume.

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Cleaves, E. T., 1973, Chemical weathering and landforms in a portion of Baltimore County, Maryland: Ph.D. dissertation, The Johns Hopkins University, 104 p.

EXPLANATION OF MAP UNITS

Upland

- **U1** Floodplains, boggy areas, and headward extensions of channels that may carry water during heavy rains; slopes less than 6°.
- **U2** (1) Side slopes between U1 and U3; (2) divides, with less relief and more broadly spaced draws than S4 terrain; and (3) subdued hilly terrain, with draws more broadly spaced than S4 or S5, but less broadly spaced than U3. In (1) (2) and (3) slopes generally less than 12°, and usually less than 6° where U2 caps divides. Relief 40 to 120 feet.
- **U3** Gently rolling to flat upland surfaces with broadly spaced draws and streams; relief 20 to 60 feet; slopes generally less than 6°, locally between 6 and 12°.

Slopeland

- **S1** Floodplain and boggy areas usually in narrow valleys bounded by steep slopes.
- **S2** High, very steep slopes; relief up to 280 feet; slopes generally greater than 12°, commonly exceeding 20°; numerous rock outcrops, large boulders, and large rock slabs.
- **S3** Low steep slopes; relief 60 to 140 feet; slopes generally greater than 12°; rock outcrops and large boulders are common.
- **S4** Side slopes and divides of limited areal extent; moderate slopes generally 6 to 12°; relief 40 to 160 feet; locally, rock crops out.

Lowland

- **L1** Broad floodplains, boggy areas, and headward extensions of channels that carry water during heavy rains; relief 0 to 20 feet, slopes generally less than 6°.
- **L2** Bedrock terraces with short, steep slope facing stream, flat surface extending back towards valley sides.
- **L3** Low to intermediate slopes between water courses, and between water courses and adjacent SLOPELAND. Slopes generally less than 12°, commonly less than 6°; broad, open terrain; relief 20 to 100 feet.
- **sdt** Areas underlain by sedimentary deposits, exclusive of deposits shown as "pu" on geologic map. Potomac Group (?) Undivided areas included in crystalline rock terrain for purposes of landform mapping.

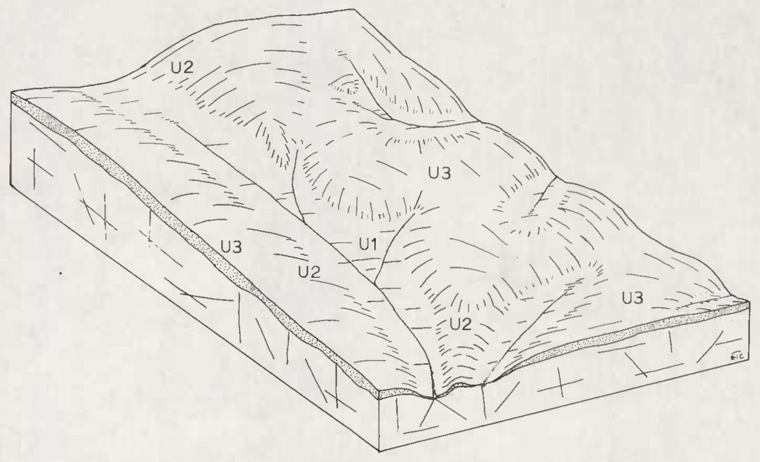


Figure 1. Block diagram illustrating landforms and overburden characteristics in the Upland.

Upland subunits underlain by Loch Raven Schist. On U3, saprolite (stipple pattern) exceeds 20 feet in thickness. On U2, saprolite exceeds 20 feet in thickness where U2 caps ridges, and is 5–20 feet thick where U2 is a subunit between U1 and U3.

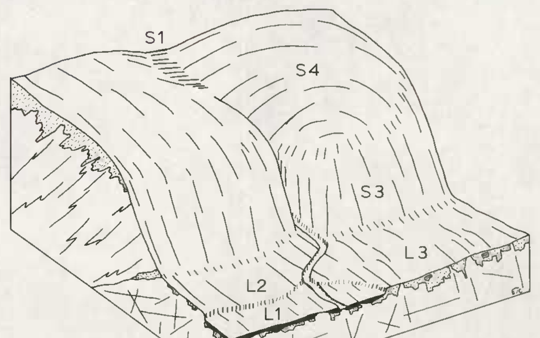


Figure 2. Block diagram illustrating landforms and overburden characteristics in Slopeland and Lowland.

Slopeland subunits S1, S3, and S4 underlain by Loch Raven Schist; Lowland subunits L1, L2, and L3 underlain by Cockeysville Marble. Alluvium shown in black, residiuum on marble and saprolite on schist shown by stipple. Residiuum on marble is thin to absent on L2; on L3 the thickness can not be estimated, but is extremely variable. On the schist, saprolite is 0–5 feet thick on S3, and 5 to 20 feet thick on S4.

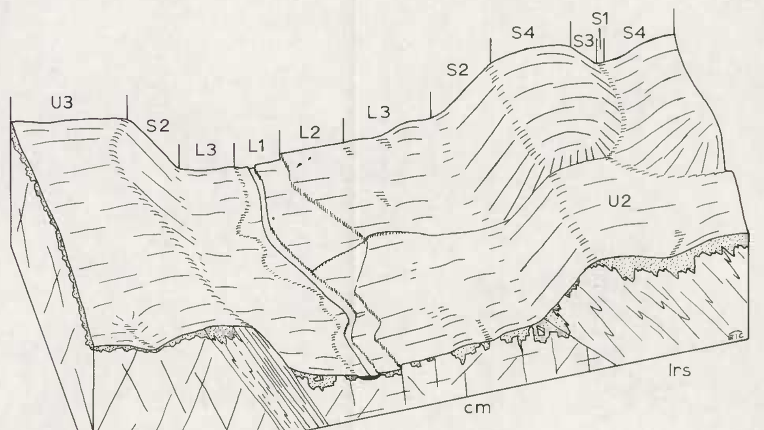
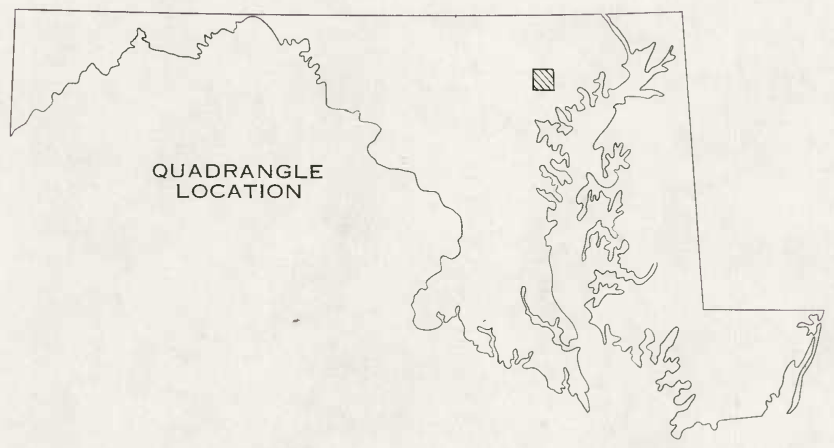
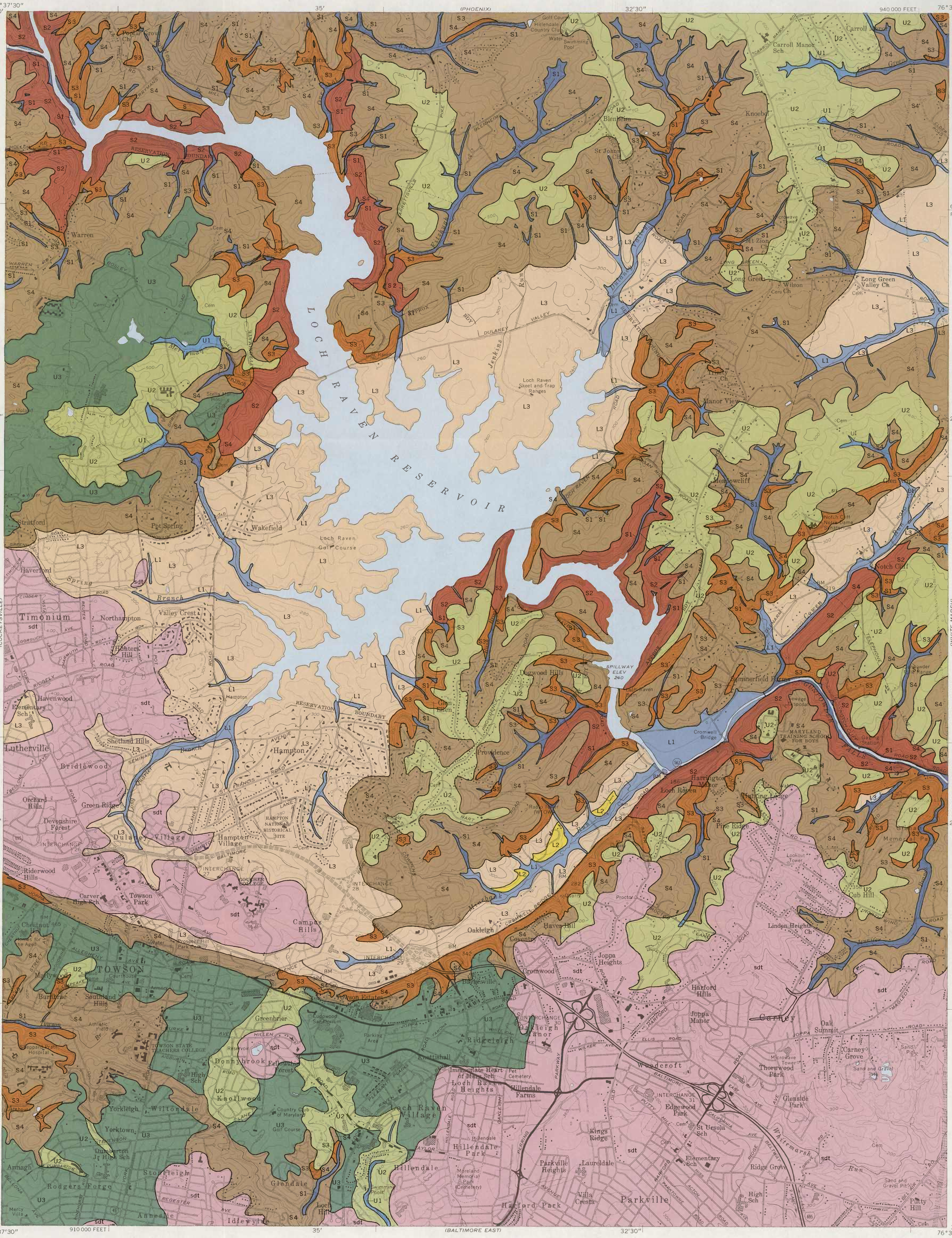


Figure 3. Block diagram illustrating landform - rock type - overburden relationships.

Landform symbles: U3, U2, S4, S3, S2, S1, L3, L2, L1. See explanation of map units. Geologic units: ba, augen gneiss member of Baltimore Gneiss; s, schist lens of Setters Formation, q, quartzite member of the Setters Formation; cm, Cockeysville Marble; lrs, Loch Raven Schist. Stipple pattern, saprolite (residiuum over marble); black, alluvium.

Upland subunits underlain by augen gneiss (ba) have shallow saprolite (5–20 feet); on upland subunits underlain by schist (s, lrs), saprolite exceeds 20 feet in thickness. S2 and S3 subunits are underlain by 0–5 feet of saprolite regardless of rock type. Marble residiuum is extremely variable in thickness beneath L1 and L3, but is thin (0–5 feet) beneath L2.





Base map from U.S. Geological Survey, 1957
Towson Quadrangle, 7½ Minute Series

Williams & Heintz Map Corporation, Washington, D. C. 20027

LANDFORM MAP, TOWSON QUADRANGLE, MARYLAND

By
Emery T. Cleaves
1974

MN GN 8° 142 MILS 1° 18 MILS
UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

Prepared in cooperation with the U. S. Geological Survey as part of the Baltimore-Washington Urban Area Study
Grant No. 14-08-0001-G-72

EXPLANATION

Overburden consists of saprolite, soil, and sediments, and overlies bedrock. A stipple pattern ("cc" and "dd" on the map) shows areas where sediments overlie rock and/or saprolite. Elsewhere, saprolite and soil mantle the crystalline rocks. The thickness of the saprolite and soil mantling the crystalline rocks has been estimated from thousands of rock and saprolite outcrops, 538 water wells, rock weathering characteristics, and rock weathering models (Cleaves, 1973; Cleaves, Godfrey, and Bricker, 1970). These data have been integrated through the "Landform Map" to provide estimates of overburden thickness (Cleaves and Godfrey, 1973, p. 148.).

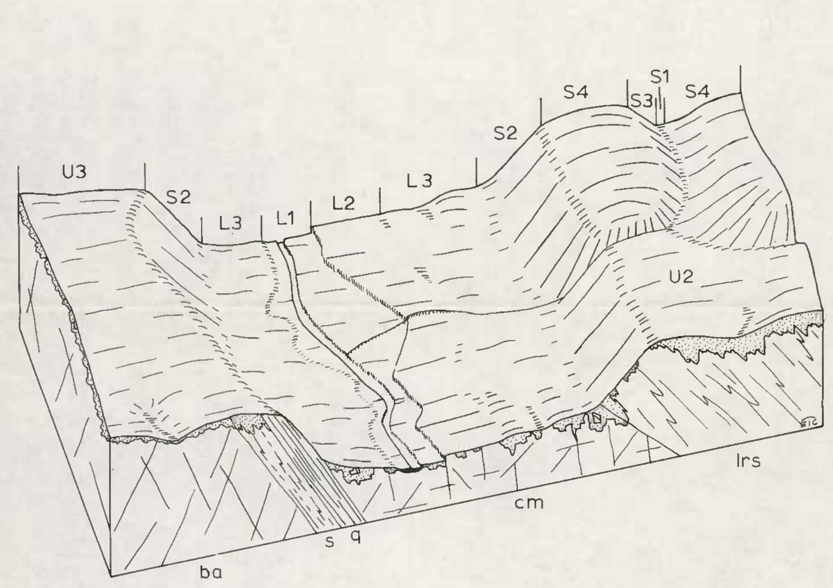
Use of the "Landform Map" permits extrapolation of saprolite-soil thicknesses from areas of sufficient data to areas where there is little or no data. For example, rock type *lrs* on landform U2 weathers in the same way and to the same thickness wherever *lrs* and U2 occur together (Figure). On the other hand, *ba* with a U3 landform has a thinner overburden as the gneiss (*ba*) has weathering characteristics which differ from the schist (*lrs*). Wherever the quartzite member (*q*) of the Setters Formation occurs, the overburden is minimal due to the very high quartz content of the rock. On the other hand, Cockeysville Marble (*cm*) weathers in unpredictable ways, except where cut by strath terraces (landform L2). Beneath an L2 surface overburden is estimated to be between 0 and 5 feet. Elsewhere on the Cockeysville Marble, landform can not be used to estimate thickness of overburden.

References cited:

Cleaves, E. T., 1973, Chemical weathering and landforms in a portion of Baltimore County, Md.: Ph.D. dissertation, Johns Hopkins University, Baltimore, Md., 104 p.

Cleaves, E. T. and Godfrey, A. E., 1973, Geologic constraint maps for planning purposes in the Piedmont of Maryland: Geol. Soc. Am., Abstracts with Programs, V. 5, No. 2, p. 148.

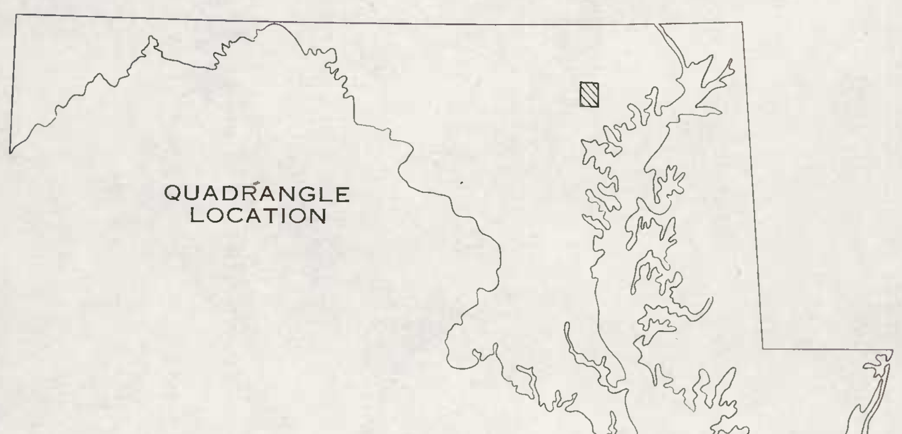
Cleaves, E. T., Godfrey, A. E., and Bricker, O. P., 1970, Geochemical balance of a small watershed and its geomorphic implications: Geol. Soc. Am. Bull., V. 81, p. 3015–3032.

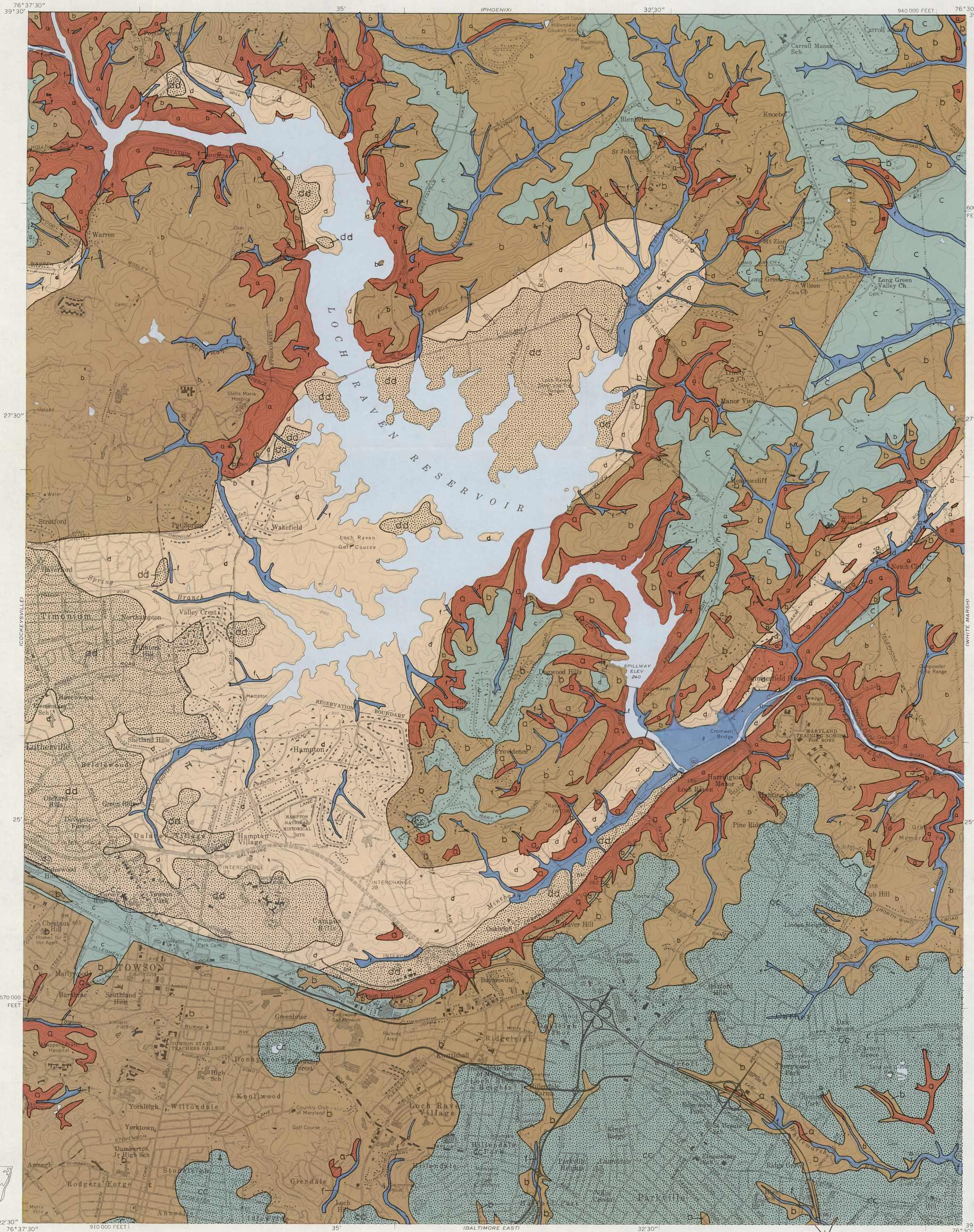


Landform symbols: U3, U2, S4, S3, S2, S1, L3, L2, L1. See Landform map for definition.

Geologic units: ba, augen gneiss member of Baltimore Gneiss; s, garnet schist member of the Setters Formation; q, quartzite member of the Setters Formation; cm, Cockeysville Marble; lrs, Loch Raven Schist; saprolite and residiuum over marble indicated by stipple pattern; black indicates alluvium.

Unit	Overburden Thickness	Comments
a	0–5 feet	Rock exposures common. Includes areas where slopes exceeds 12°, but also encompasses areas of shallow overburden where slopes are relatively flat.
b	5–20 feet	Depth may exceed 20 feet, locally. Overburden thinnest at base of slopes and thickens upward. Corestones (residual boulders) common in overburden overlying geologic units p€bs and p€bl. Rock rarely exposed at surface.
c	greater than 20 feet	Residual boulders rarely occur in upper 20 feet.
cc	greater than 20 feet	Overburden includes saprolite and sediment. Immediately adjacent to contact with Unit b, thickness may be less than 20 feet, but generally exceeds 5 feet.
d	variable	Abrupt local changes in overburden thickness. Because of weathering characteristics of Cockeysville Marble, rock pinnacles and residual boulders are common in some areas; elsewhere overburden substantially exceeds 20 feet.
dd	variable	Overburden includes sediment and residiuum on marble. Thickness can not be estimated.
f	variable	In broad valleys alluvial sediments 2 to 20 feet or more in thickness may be present. In narrow valleys (adjacent to Unit a) between steep slopes bedrock is at or near surface. In upland areas (adjacent to Unit c) bedrock may vary from 0 to 20 feet or more beneath the surface, and colluvial deposits of low density and bouldery alluvium may be present. High water table. Part or all of area may be subject to flooding.





Base map from U.S. Geological Survey, 1957
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ESTIMATED THICKNESS OF OVERBURDEN, TOWSON QUADRANGLE, MARYLAND

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TOWSON QUADRANGLE

Geologic and Environmental Atlas

By

Emery T. Cleaves, William P. Crowley and Karen R. Kuff

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