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DEPARTMENT OF GEOLOGY, SYRACUSE UNIVERSITY, NEW YORK
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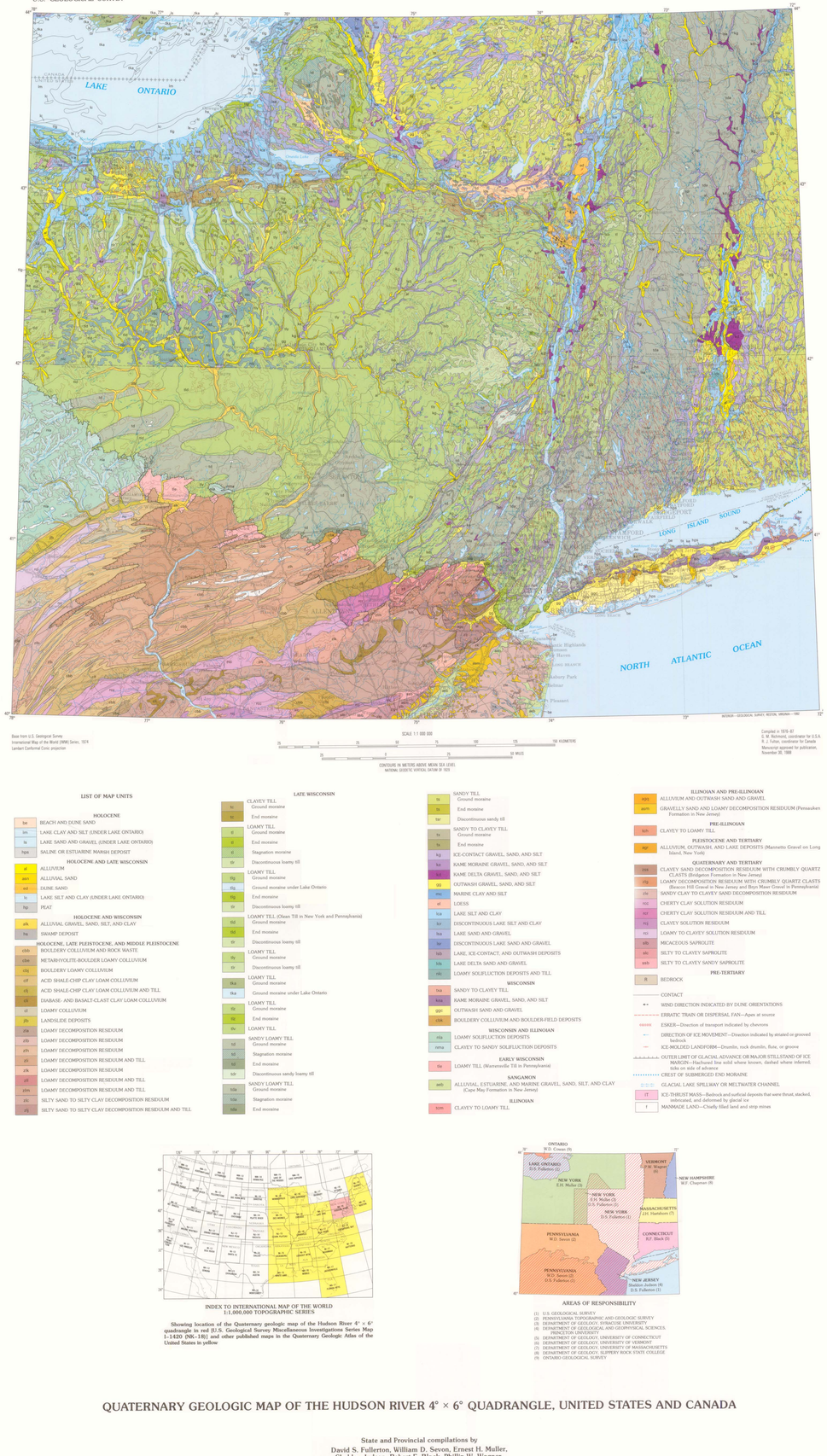
QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
HUDSON RIVER 4° × 6° QUADRANGLE
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1420 (NK–18)
Pamphlet accompanies map



LIST OF MAP UNITS

HOLOCENE
- be BEACH AND DUNE SAND
- lac LAKE CLAY AND SILT (UNDER LAKE ONTARIO)
- las LAKE SAND AND GRAVEL (UNDER LAKE ONTARIO)
- hps SALINE OR ESTUARINE MARSH DEPOSIT

HOLOCENE AND LATE WISCONSIN
- al ALLUVIUM
- asn ALLUVIAL SAND
- ed DUNE SAND
- lc LAKE SILT AND CLAY (UNDER LAKE ONTARIO)
- hp PEAT

HOLOCENE AND WISCONSIN
- afk ALLUVIAL GRAVEL, SAND, SILT, AND CLAY
- hs SWAMP DEPOSIT

HOLOCENE, LATE PLEISTOCENE, AND MIDDLE PLEISTOCENE
- cbb DISTINCT COLLUVIUM AND ROCK WASTE
- cbw METAMYOLITE-BOULDER LOAMY COLLUVIUM
- cb BOULDERY LOAMY COLLUVIUM
- cfd ACID SHALE-CHIP CLAY LOAM COLLUVIUM
- cfk ACID SHALE-CHIP CLAY LOAM COLLUVIUM AND TILL
- cmk ACID-MASAULT-BASALT CLAY LOAM COLLUVIUM
- cl LOAMY COLLUVIUM
- plb LANDSLIDE DEPOSITS
- zfw LOAMY DECOMPOSITION RESIDUUM
- zfb LOAMY DECOMPOSITION RESIDUUM
- zfn LOAMY DECOMPOSITION RESIDUUM
- zfk LOAMY DECOMPOSITION RESIDUUM
- zfd LOAMY DECOMPOSITION RESIDUUM AND TILL
- zfl LOAMY DECOMPOSITION RESIDUUM AND TILL
- zlb SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM
- zlg SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM AND TILL

LATE WISCONSIN
- CLAYEY TILL
  - tlc Ground moraine
  - tle End moraine
- LOAMY TILL
  - tl Ground moraine
  - tld End moraine
  - tlr Stagnation moraine
  - tlz Discontinuous loamy till
- LOAMY TILL (Olean Till in New York and Pennsylvania)
  - tlg Ground moraine
  - tlq End moraine
  - tlv Discontinuous loamy till
- SANDY TILL
  - tsl Ground moraine
  - tse End moraine
  - tsr Stagnation moraine
  - tsz Discontinuous sandy till
- LOAMY DECOMPOSITION RESIDUUM
  - tdl Ground moraine
  - tde End moraine
  - tdr Stagnation moraine
  - tdz Discontinuous sandy till
- SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM
  - tzl Ground moraine
  - tze End moraine
  - tzr Stagnation moraine
  - tzz End moraine
- SANDY GRAVEL TILL
  - tsgl Ground moraine
  - tsge End moraine
- LOAMY GRAVEL TILL
  - tlgl Ground moraine
  - tlge End moraine
- ICE-CONTACT GRAVEL, SAND, AND SILT
- KAME MORAINE GRAVEL, SAND, AND SILT
- KAME DELTA GRAVEL, SAND, AND SILT
- LAKE, ICE-CONTACT, AND OUTWASH GRAVEL
- MARINE CLAY AND SILT
- LOESS
- LAKE SILT AND CLAY
- DISCONTINUOUS LAKE SILT AND CLAY
- LAKE SAND AND GRAVEL
- DISCONTINUOUS LAKE SAND AND GRAVEL
- LAKE, ICE-CONTACT, AND OUTWASH DEPOSITS
- LAKE DELTA SAND AND GRAVEL
- LAKE SOLIFLUCTION DEPOSITS AND TILL

WISCONSIN
- sag SANDY TO CLAYEY SILT
- kmg KAME MORAINE GRAVEL, SAND, AND SILT
- ogv OUTWASH SAND AND GRAVEL
- ebk BOULDERY COLLUVIUM AND BOULDER-FIELD DEPOSITS

WISCONSIN AND ILLINOIAN
- ebb BOULDERY COLLUVIUM AND BOULDER-FIELD DEPOSITS
- cmg CLAYEY TO SANDY SOLIFLUCTION DEPOSITS

EARLY WISCONSIN
- tlw LOAMY TILL (Warrensville Till in Pennsylvania)

SANGAMON
- asb ALLUVIAL, ESTUARINE, AND MARINE GRAVEL, SAND, SILT, AND CLAY (Cape May Formation in New Jersey)

ILLINOIAN
- tcm CLAYEY TO LOAMY TILL

ILLINOIAN AND PRE-ILLINOIAN
- ogt ALLUVIUM AND OUTWASH SAND AND GRAVEL
- gg GRAVELLY SAND AND LOAMY DECOMPOSITION RESIDUUM (Pensauken Formation in New Jersey)

PRE-ILLINOIAN
- tcb CLAYEY TO LOAMY TILL

PLEISTOCENE AND TERTIARY
- ag ALLUVIUM, OUTWASH, AND LAKE DEPOSITS (Mannetto Gravel on Long Island, New York)

QUATERNARY AND TERTIARY
- cbg LOAMY SAND DECOMPOSITION RESIDUUM WITH CRUMBLY QUARTZ CLASTS (Beacon Hill Gravel in New Jersey and Bryn Mawr Gravel in Pennsylvania)
- sdg SANDY TO CLAYEY SAND DECOMPOSITION RESIDUUM
- ccl CHERTY CLAY SOLUTION RESIDUUM
- cl CHERTY CLAY SOLUTION RESIDUUM AND TILL
- cr CLAYEY SOLUTION RESIDUUM
- lcr LOAMY TO CLAYEY SOLUTION RESIDUUM
- kb MICACEOUS SAPROLITE
- sb SILTY SAPROLITE
- ssb SILTY TO CLAYEY SANDY SAPROLITE

PRE-TERTIARY
- R BEDROCK

- CONTACT
- WIND DIRECTION INDICATED BY DUNE ORIENTATIONS
- ERRATIC TRAIN OR DISPERSAL FAN—Apex at source
- DIRECTION OF ICE MOVEMENT—Direction indicated by striated or grooved bedrock
- ICE-MOULDED LANDFORM—Drumlin, rock drumlin, flute, or groove
- OUTER LIMIT OF GLACIAL ADVANCE OR MAJOR STILLSTAND OF ICE MARGIN—Hachured line solid where known, dashed where inferred; ticks on side of advance
- CREST OF SUBMERGED END MORAINE
- GLACIAL SPILLWAY OR MELTWATER CHANNEL
- ICE-THRUST MASS—Bedrock and surficial deposits that were thrust, stacked, imbricated, and deformed by glacial ice
- MAINMADE LAND—Chiefly filled land and strip mines

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1:1 000 000 TOPOGRAPHIC SERIES

Showing location of the Quaternary geologic map of the Hudson River 4° × 6° quadrangle in red (U.S. Geological Survey Miscellaneous Investigations Series Map I–1420 (NK–18)) and other published maps in the Quaternary Geologic Atlas of the United States in yellow

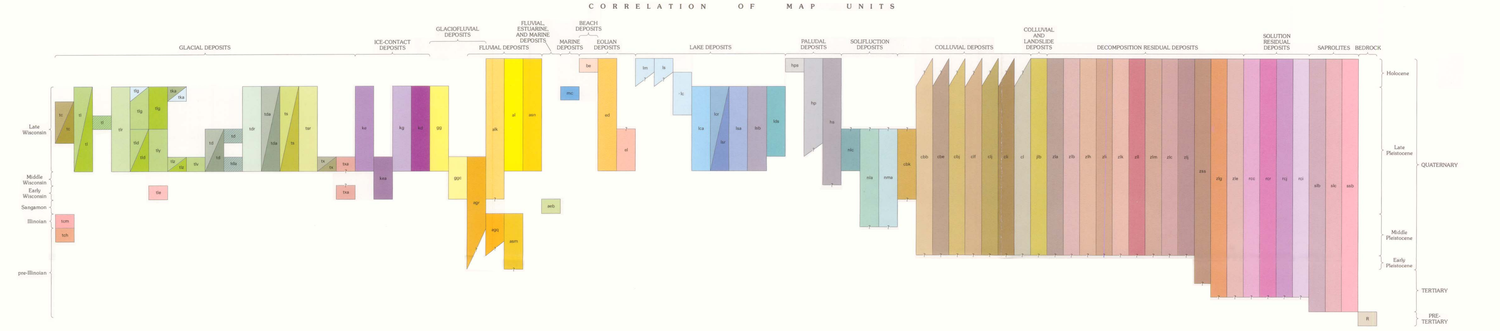
QUATERNARY GEOLOGIC MAP OF THE HUDSON RIVER 4° × 6° QUADRANGLE, UNITED STATES AND CANADA

State and Provincial compilations by
David S. Fullerton, William D. Sevon, Ernest H. Muller,
Sheldon Judson, Robert F. Black, Phillip W. Wagner,
Joseph H. Hartshorn, William E. Cummings, and William D. Cowan
Edited and integrated by
David S. Fullerton

1992

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES

C O R R E L A T I O N O F M A P U N I T S



DESCRIPTION OF MAP UNITS

HOLOCENE

be BEACH AND DUNE SAND—Brown, reddish-brown or light-gray, angular to rounded, coarse to fine sand with minor gravel, pebbles and cobbles, and scattered fragments of mollusc shells and plant debris. Locally includes concentrations of cobbles and boulders. Generally well sorted; crossbedded or laminated. Deposits of beaches, spits, tombolos, baymouth bars, and barrier islands included in map unit. Also includes sheet sand covering saline marsh deposits (hps) or freshwater swamp deposits (hs); landward from freshwater and marine deposits. Thickness 0.5–10 m

lac LAKE CLAY AND SILT (under Lake Ontario)—Brownish-gray, gray, or grayish-black calcareous clay, silty clay, and silt, generally rich in organic matter, occurring in centers of basins and silt at basin margins. Soft, fluid, compressible. Locally porous; may contain gas bubbles. Faintly laminated to massive. In places contains mollusc tests, wood chips, and disseminated plant debris. Deep-water facies of glacial Lake Iroquois and postglacial Lake Ontario. Silt, clay, and silty clay. Thickness generally 2–6 m; wave-built margins, 8–14 m in centers of basins

las LAKE SAND AND GRAVEL (under Lake Ontario)—Brown or gray, calcareous fine-sand, fine to coarse sand, and minor gravel. Poorly to well sorted; locally stratified. Mollusc tests and fragments common. Shore and nearshore facies of modern lake deposits. Generally overlies lake silt and clay (lc); till (tlw, tlg); or bedrock. Includes local accumulations of boulders and accumulations of coarse lag gravel. Where less than 1.5 km from shore, includes areas of thin till over bedrock and extensive areas of bedrock outcrop. Thickness generally 1–5 m, rarely 10 m

hps SALINE OR ESTUARINE MARSH DEPOSIT—Dark-brown, greenish-gray, brownish-gray, dark-gray, or black silty clay to clayey fine sand and carbonaceous clay interrupted and interbedded with herbaceous peat composed chiefly of *Spartina* sp. Commonly bioturbated. Tidal and estuarine marsh deposit. Thickness generally less than 3 m, locally 10 m

HOLOCENE AND LATE WISCONSIN

al ALLUVIUM—Yellowish-brown, reddish-brown, brown, olive, gray, or mottled silt, sand, and gravel. Calcareous or noncalcareous, reflecting composition of source materials. Poorly to well sorted. Poorly to well stratified; bedding commonly contorted. Includes colluvial and alluvial fans and aprons. Textures vary laterally and vertically; contrasting textures may be interbedded. Upper part commonly silt and fine sand with minor lenses of clay and organic material; lower part generally sand and gravel, rounded gravel, in places cobble or boulder gravel. Clast lithologies vary, reflecting compositions of local bedrock and other surface materials. Overbank and stream channel deposits underlies flood plains, stream terraces, and alluvial fans. Not mapped in Pennsylvania; elsewhere mapped only in largest valleys. Includes some areas of outwash and ice-contact gravel, sand, and silt (ogt, kg, ksz); lake clay, silt, sand, and gravel (lca, lsa, lsg); till, and bedrock outcrops. Locally overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of overbank and channel alluvium generally 1–4 m, rarely more than 10 m; thickness of alluvial fans may exceed 30 m

asn ALLUVIAL SAND—Pale-yellow, yellowish-brown, brown, or gray calcareous sand with scattered pebbles. Generally well sorted, well stratified. Contains thin layers and lenses of silty clay. Clast composition similar to that of outwash sand and gravel (gg, ggt); in vicinity. Chiefly redeposited outwash sand. Locally terraced. Mapped only in stuyswaps on Long Island, New York. Thickness generally 2–3 m, locally 6–9 m

ed DUNE SAND—Pale-brown or light-gray calcareous fine to medium sand. Well sorted; crossbedded. Grains subrounded or rounded; commonly frosted. Verifacts common. Locally, in coastal areas, chiefly massive ridges parallel to present shoreline; in inland areas chiefly linear or irregular crescentic ridges or parabolic and oval dunes in clusters, separated by flat areas (swales) crossed by dune ridges. Dune ridges generally 3–15 m high; in Pine Barrens, areas of lows (ef), sheet sand, and lake clay, silt, sand, and gravel (lca, lsa, lsg) between dunes. Some dune sand present in an area larger than 5,830 km²; only largest areas of dune sand shown. Most dune sand in Pine Barrens and other areas extensive on eastern Long Island, New York. Most dune stable and inactive; locally, where vegetation has been destroyed by fire, active and pre-Holocene dunes. Thickness generally 1–10 m, locally more than 20 m

lc LAKE CLAY AND SILT (under Lake Ontario)—Brown, olive-gray, reddish-brown, reddish-gray, brownish-gray, or mottled calcareous clay and silty clay. Generally well sorted. Massive to laminated, locally varved. Much more compact than silt in lake deposits of Holocene age. Includes some dropstones, coarse and deep-water facies of former glacial and postglacial lake deposits. Commonly overlain by eolian sand (ef) or peat (hp). Thickness generally 1–5 m, locally more than 20 m

hp PEAT—Black or dark-brown fibrous peat and decomposed organic residues or fibrous peat and clay and silt containing commingled plant material and organic residues. Commonly underlain by eolian sand and silt; commonly overlain by eolian sand and silt (ed, ef). Thickness generally 1–3 m, locally more than 10 m

afk ALLUVIAL GRAVEL, SAND, SILT, AND CLAY—Complex deposit of alluvium (al), outwash and ice-contact gravel, sand, and silt (ogt, kg, ksz); lake clay, silt, sand, and gravel (lca, lsa); in Pennsylvania where these deposits are not distinguished. Stratified; textures vary. Includes some of oldest glacial drift in terraced. Clast lithology generally reflects composition of local bedrock; sandstone, siltstone, and shale dominant; minor erratic crystalline igneous and metamorphic rocks. May include small areas of Holocene alluvial deposits in Pennsylvania and Vermont. Thickness generally 2–6 m, locally more than 20 m

hs SWAMP DEPOSIT—Dark-brown or black muck, mucky peat, and organic silt. Commonly contains abundant plant remains. Commonly underlain by calcareous marl, a mixture of carbonate and silt, commonly by peat. Includes some alluvial fans and fragments, or by shally gyttja, an aosenolic, pulpy, freshwater mud containing abundant aquatic material. Deposits in glacial kettles and other depressions in glacial terrain. Thickness generally 1–5 m, rarely more than 15 m

HOLOCENE, LATE PLEISTOCENE, AND MIDDLE PLEISTOCENE

cbb DISTINCT COLLUVIUM AND ROCK WASTE—Deposits of bedrock debris that accumulated on slopes by mass movement. Includes talus cones and alluvial fans; clast lithologies reflect composition of local bedrock. Clasts generally angular and poorly sorted. Commonly contains abundant fine-grained material. Thickness generally 1–5 m, locally more than 15 m

cbw METAMYOLITE-BOULDER LOAMY COLLUVIUM—Yellowish-brown, reddish-brown, brown, or olive-gray, poorly sorted, stony to very stony loam. Contains angular and subangular fragments and subrounded to rounded boulders of Precambrian metamyolite, quartzite, and minor amphibolite and gneiss. Includes some alluvium and colluvium derived from these and other gneiss and amphibolite. Thickness generally 2–5 m

cb BOULDERY LOAMY COLLUVIUM—Yellowish-brown, yellowish-brown, brown, brownish-gray, gray, or mottled noncalcareous debris ranging from angular boulders and cobbles to silty sand and clay. Contains abundant angular sandstone and shale fragments. Locally rubble. Clasts chiefly angular. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness generally 2–5 m, locally more than 20 m

cfd ACID SHALE-CHIP CLAY LOAM COLLUVIUM—Reddish-brown, orange-brown, yellowish-brown, brown, grayish-brown, olive-gray, or mottled clay loam, silty clay loam, and sandy clay loam with angular and subangular chips of acid shale. Commonly well sorted, coarsely stratified; bedded with thin beds and lenses of shale chips; subangular and subrounded fragments of sandstone and quartzite. Clasts of Triassic sandstone and quartzite rubble of plain to pseudomorphic shape; shale fragments are platy and shale-coated by clay, frequently imbricated. Colluvium commonly grades downward to bedrock through a zone of weathered rock and bedrock rubble. Colluvium unit includes some yellowish-brown clay loam residuum with decomposed shale chips and soil horizon. Commonly overlain by eolian sand and silt. Also includes solifluction deposits on moderate and gentle slopes and alluvium (al) in valleys. Thickness generally 2–6 m, locally more than 15 m

cfk ACID SHALE-CHIP CLAY LOAM COLLUVIUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to loamy decomposition residuum which is the same as unit cfl. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, vermilion, olive-gray, or mottled clay loam, silty clay loam, silty clay, and clay; locally loam. Generally acid. Nonsorted; not nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

cfl ACID SHALE-CHIP CLAY LOAM COLLUVIUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to loamy decomposition residuum which is the same as unit cfd. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, vermilion, olive-gray, or mottled clay loam, silty clay loam, silty clay, and clay; locally loam. Generally acid. Nonsorted; not nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

cmk ACID-MASAULT-BASALT CLAY LOAM COLLUVIUM—Yellowish-red, pelloweish-brown, reddish-brown, gray, or mottled, noncalcareous clay loam and silty clay loam with abundant angular, basalt, and diabase chips. Generally well sorted; bedded with thin beds and lenses of shale chips; subangular and subrounded fragments of sandstone and quartzite. Clasts of Triassic sandstone and quartzite rubble of plain to pseudomorphic shape; shale fragments are platy and shale-coated by clay, frequently imbricated. Colluvium commonly grades downward to bedrock through a zone of weathered rock and bedrock rubble. Colluvium unit includes some yellowish-brown clay loam residuum with decomposed shale chips and soil horizon. Commonly overlain by eolian sand and silt. Also includes solifluction deposits on moderate and gentle slopes and alluvium (al) in valleys. Thickness generally 2–6 m, locally more than 15 m

cl LOAMY COLLUVIUM—Yellowish-red, yellowish-brown, brown, olive-gray, or mottled silty clay loam and clay loam with abundant angular, basalt, and diabase chips. Generally well sorted; bedded with thin beds and lenses of shale chips; subangular and subrounded fragments of sandstone and quartzite. Clasts of Triassic sandstone and quartzite rubble of plain to pseudomorphic shape; shale fragments are platy and shale-coated by clay, frequently imbricated. Colluvium commonly grades downward to bedrock through a zone of weathered rock and bedrock rubble. Colluvium unit includes some yellowish-brown clay loam residuum with decomposed shale chips and soil horizon. Commonly overlain by eolian sand and silt. Also includes solifluction deposits on moderate and gentle slopes and alluvium (al) in valleys. Thickness generally 2–6 m, locally more than 15 m

plb LANDSLIDE DEPOSITS—Material same as loamy colluvium (cl); map unit distinguished on basis of topographic and geomorphic evidence of mass movement. 2–10 percent of mapped area. Landslide deposits are products of downslope movement of shale, sandstone, siltstone, and shale, commonly as a result of earthflow or slump. Thickness of colluvium commonly 1–2 m on gentle slopes, 2–4 m on foot slopes, locally more than 10 m at toes of colluvial fans and aprons. Thickness of included solifluction deposits generally 1–3 m. Thickness of included material is generally 2–6 m on gentle slopes, less than 1 m on very gentle slopes. Earthflow deposits typically are heterogeneous mixtures of clay, silt, and sand with varying amounts of angular rock fragments and organic material. Deposits are in a result of slow flow of wet, but not that were transported and deposited in a manner similar to that of alluvial fans. Angular rock fragments are commonly concentrated in the upper part. Areal extent commonly less than 0.605 km² (1 acre), although some deposits are tens of meters to a few hundred meters wide and 15–30 m long. Slump deposits typically are masses of unconsolidated materials and bedrock that have rotated and slid downslope as a unit, with little or no flow; physical properties of transported materials are not altered greatly; scarlike slopes, stratification, and bedding of slumped colluvium, solifluction deposits, residuum, and bedrock are retained; typically less than 120 m across, with spatular lengths of 2–25 m and vertical crown scarp displacements of 1–5 m. Thickness of earthflow deposits generally less than 5 m; thickness of slump deposits generally 2–20 m

zfw LOAMY DECOMPOSITION RESIDUUM—Pale-yellow, yellowish-brown, brown, or dark-brown, noncalcareous or weakly calcareous sandy loam, loam, and silt loam on ridge crests. Nonsorted; nonstratified. Chiefly residuum derived by in-place decomposition of sandstone and minor shale. Includes areas of heterogeneous, nonstratified, nonsorted rubble, locally 3–5 m thick, formed by frost action and mass movement. Includes some colluvium and alluvial fans where derived from quartzite sandstone; chemistry where derived from bedded sandstone; small sandstone and shale fragments common elsewhere. Residuum grades laterally into bouldery colluvium and rock wash (cbb) on slopes. Map unit includes extensive areas of bedrock outcrops. Thickness generally 1–2 m

zfb LOAMY DECOMPOSITION RESIDUUM—Yellowish-brown, reddish-brown, brown, or maroon, noncalcareous loam, silt loam, and clay loam with clasts of acid shale and sandstone on flat or gentle slopes. Nonsorted; nonstratified. Includes chemery colluvium 2–4 m thick on steeper foot slopes; alluvium (al) in valleys, and areas of bedrock outcrops. Thickness generally less than 1 m

zfn LOAMY DECOMPOSITION RESIDUUM—Yellowish-brown, brown, or mottled loam, silt loam, silty clay loam, and clay loam on sedimentary rocks on flat or gentle slopes. Nonsorted; nonstratified. Includes chemery colluvium where derived from composition of underlying bedrock. Generally acid; calcareous where limestone is present. Nonsorted; nonstratified. Locally consists of thin layers of disintegrated and decomposed rock fragments. Present on flat surfaces and gentle slopes. Includes colluvium on moderate to steep slopes (generally less than 6 m), locally more than 10 m thick; and debris fan deposits on foot slopes. Colluvium generally yellowish red, red, reddish yellow, brownish yellow, yellow, yellowish brown, reddish brown, brown, yellowish gray, or mottled loam, silt loam, silty clay loam, and clay loam; locally sandy loam, silty clay or clay; generally acid. Colluvium poorly sorted; generally massive; locally weakly stratified. Clasts chiefly sandstone, quartzite, sandstone, and shale; limestone or conglomerate common locally. Clasts chiefly angular and subangular pebbles and cobbles; locally very bouldery; chemery where bedrock is sandstone. Colluvium generally contains abundant fine-grained material; rocks are weathered. Colluvium generally stable; well-developed soil profiles; buried soils locally. Colluvium deposited chiefly during episodes of glaciation and glacial melt water. Map unit also includes alluvial fans and aprons in valleys and areas of bedrock outcrops. Thickness generally less than 1 m

zfk LOAMY DECOMPOSITION RESIDUUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to loamy decomposition residuum which is the same as unit zfn. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, vermilion, olive-gray, or mottled clay loam, silty clay loam, silty clay, and clay; locally loam. Generally acid. Nonsorted; not nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

zfd LOAMY DECOMPOSITION RESIDUUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to loamy decomposition residuum which is the same as unit zfl. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, vermilion, olive-gray, or mottled clay loam, silty clay loam, silty clay, and clay; locally loam. Generally acid. Nonsorted; not nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

zfl LOAMY DECOMPOSITION RESIDUUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to loamy decomposition residuum which is the same as unit zfk. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, vermilion, olive-gray, or mottled clay loam, silty clay loam, silty clay, and clay; locally loam. Generally acid. Nonsorted; not nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

zlb SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM—Pale-yellow, yellowish-brown, brown, olive-gray, or mottled silty sand, sandy loam, loam, silt loam, silty clay loam, and clay loam; locally sandy clay. Generally acid. Nonsorted; nonstratified. Chiefly residuum derived by in-place decomposition of sandstone and minor shale. Includes areas of heterogeneous, nonstratified, nonsorted rubble, locally 3–5 m thick, formed by frost action and mass movement. Includes some colluvium and alluvial fans where derived from quartzite sandstone; chemery where derived from bedded sandstone; small sandstone and shale fragments common elsewhere. Residuum grades laterally into bouldery colluvium and rock wash (cbb) on slopes. Map unit includes extensive areas of bedrock outcrops. Thickness generally 1–2 m

zlg SILTY SAND TO SILTY CLAY DECOMPOSITION RESIDUUM AND TILL—Distinguished on basis of presence of discontinuous till (Illinoian and possibly pre-Illinoian) in addition to silty sand to silty clay decomposition residuum which is the same as unit zlb. Till is yellowish-red, red, yellowish-orange, grayish-orange, reddish-yellow, reddish-brown, yellowish-brown, grayish-brown, olive-gray, or mottled silty sand, sandy loam, loam, silt loam, silty clay loam, and clay loam; locally sandy clay. Generally acid. Nonsorted; nonstratified. Very compact; much more compact than most postglacial tills; generally moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly shale and sandstone; minor amounts of siltstone, quartzite, and shale; clasts generally decomposed; erratic lithologies rare. Till intensely weathered in upper 2.5–10 m; oxidized and leached to depths of several meters. Large erratic clasts commonly rotted, with rinds 0.6–1.3 cm thick. Till commonly modified by colluviation and solifluction activity. Occurs chiefly as erosional remnants on hillops and in valley sides. Includes some colluvium derived from these and other gneiss and amphibolite. Commonly overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness of till generally less than 3 m, locally 15 m; thickness of residuum generally less than 1.5 m

ILLINOIAN AND PRE-ILLINOIAN

ogt ALLUVIUM AND OUTWASH SAND AND GRAVEL

gg GRAVELLY SAND AND LOAMY DECOMPOSITION RESIDUUM (Pensauken Formation in New Jersey)—Brown, dark-brown, gray, or mottled sand and gravel. Calcareous or noncalcareous, reflecting composition of source materials. In areas of late Wisconsin glaciation, generally pebble or cobble gravel with lenses and interbeds of sand, silt, and clay and lenses of boulders; south of the limit of late Wisconsin glaciation, chiefly sand and fine gravel with scattered cobbles and interbedded silt and clay. Poorly to well sorted. Well stratified; bedding varies from horizontal beds of well-sorted sand and gravel with local cut-and-fill structure to irregular beds of very well sorted cobble or boulder gravel. Clast lithology varies, reflecting composition of local and upstream bedrock. Cobbles and boulders abundant where derived from gneiss, basal zone and moraines or ice-contact deposits. Clasts generally subrounded to well rounded. Clasts locally intensely stained by iron oxides; gravel locally cemented by secondary calcium carbonate. Surfaces typically smooth to undulating, locally pitted with ice-block depressions. Occurs in terrace remnants, valley trains, outwash plains, fans, aprons, delta topset beds, and fills in meltwater channels. Not mapped in Pennsylvania. Includes some till, ice-contact gravel, sand, and silt (kg, ksz); lake clay, silt, sand, and gravel (lca, lsa, lsb); and alluvium (al). Locally overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). On Long Island, New York, locally overlain by thin and discontinuous till (tlr). Thickness generally 2–15 m, locally more than 60 m

ksz MARINE CLAY AND SILT—Yellowish-brown, brown, bluish-gray, dark-gray, or mottled uniform, soft, calcareous clay and fine silt containing minor fine sand lenses. Calcareous. Generally massive; locally horizontally bedded. Lithologically similar to Holocene marine clay (lc). Clay fraction is chiefly montmorillonite or saline or brackish-water mollusca. Mapped only in Champlain Valley at north edge of quadrangle. Thickness generally less than 5 m

ef LOESS—Pale-yellow, yellow, yellowish-brown, pale-gray, or mottled windblown silt and very fine sand. Grain size and thickness decrease eastward. Generally leached throughout; porous. Wall sorted. Generally nonstratified; local weak horizontal bedding and weak vertical structure. Forms discontinuous mantle over older deposits and bedrock. Mapped only in New Jersey; elsewhere extensive areas of very thin loess included in other map units. Thickness generally less than 1 m, locally 3 m

lsa LAKE SILT AND CLAY—Red, maroon, pale-yellow, yellowish-brown, reddish-brown, brown, olive, olive-gray, bluish-gray, gray, black, or mottled silt and clay; locally silt and very fine sand. Calcareous or noncalcareous, reflecting composition of source materials. Varves common in glacial lake deposits. Commonly laminated to lower part; locally varved. Ice-rafted clasts common locally. In places interbedded with sand and fine gravel or with flow till or till. Typically jointed or fractured where dry. Calcium carbonate concretions common locally. Chiefly in flat low areas formerly occupied by glacial and postglacial lakes. Not mapped in Pennsylvania. Includes many small areas of outwash and ice-contact gravel, sand, and silt (gg, kg, ksz); lake sand and gravel (lsa, lsb, lsg); alluvium (al); till, and bedrock outcrops. Locally overlain by eolian sand and silt (ed, ef); peat (hp); or swamp deposits (hs). Thickness generally 1–10 m, locally 30 m

lsb DISCONTINUOUS LAKE SILT AND CLAY—Thin and discontinuous lake silt and clay that overlie bedrock. Most of areas is sawn- or current-washed bedrock. Thickness generally less than 1 m

lsg LAKE, ICE-CONTACT, AND OUTWASH DEPOSITS—Complex deposit of lake (ls), ice-contact (kg), and outwash (ogt) gravel, sand, and silt (gg); lake clay, silt