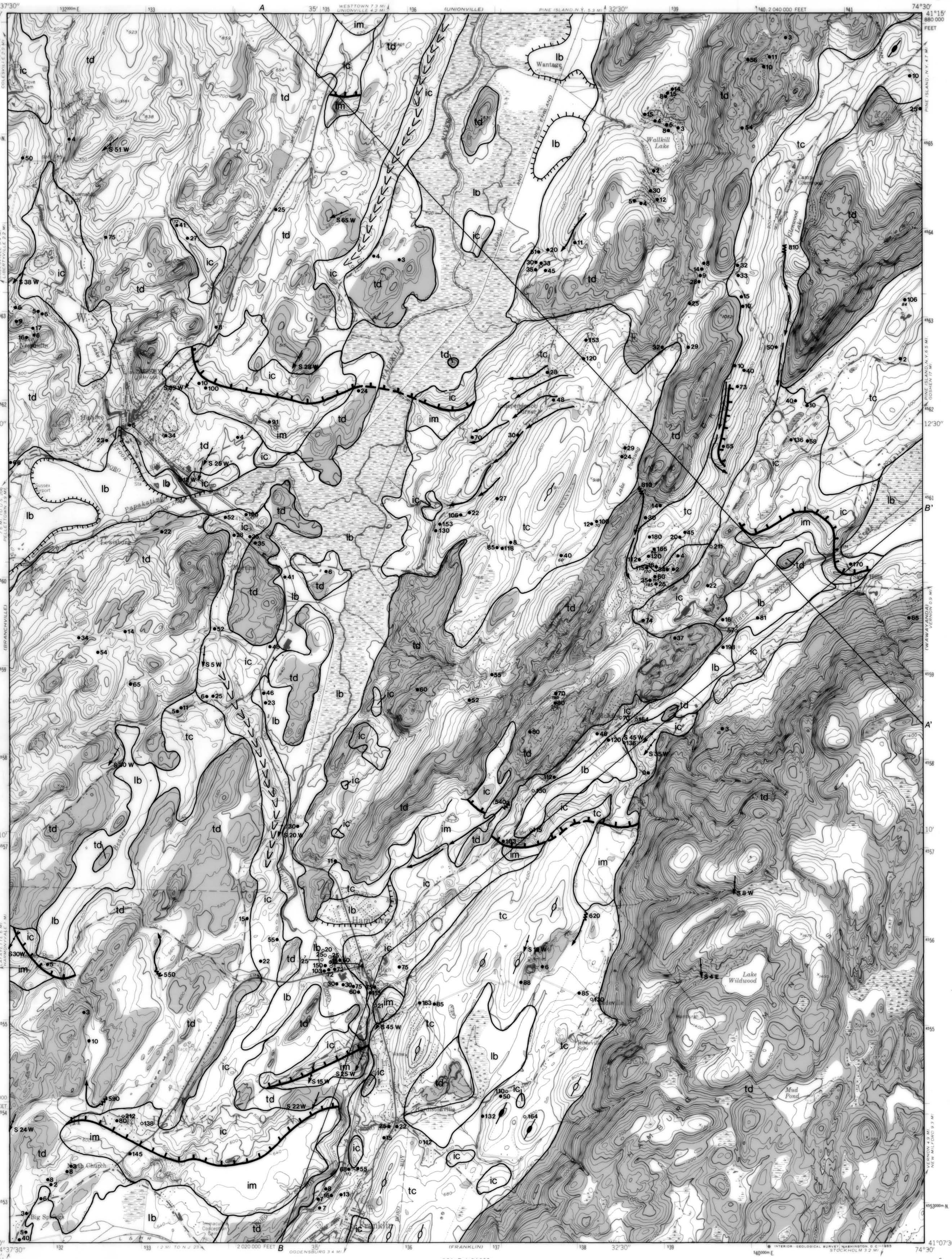
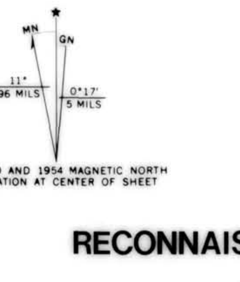
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
NEW JERSEY GEOLOGICAL SURVEY

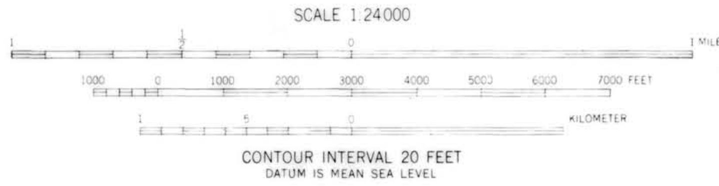


Base from U.S. Geological Survey, 1954
Photorevised as of 1971.

10,000 foot grid based on New Jersey Coordinate System.

Universal Transverse Mercator grid ticks, Zone 18, shown at 1000 meter intervals.





Geology mapped 1983. Additional information from Kummel, unpublished; Salisbury, 1902; Spencer and others, 1908; Minard and others, 1954; and Fletcher, 1975.

RECONNAISSANCE MAP OF THE GLACIAL GEOLOGY OF THE HAMBURG QUADRANGLE, NEW JERSEY

By
Scott D. Stanford and David P. Harper

1985

DESCRIPTION OF MAP UNITS

UNIT	SUBUNIT	MAP SYMBOL	MATERIAL	LANDFORM AND OCCURRENCE	GROUND WATER POTENTIAL
till	discontinuous till	td	Unstratified and unsorted boulders and gravel in a matrix of mixed sand, silt, and clay. Deposited directly from ice. Matrix is generally sandier on uplands than in valleys.	Patches of till resting directly on bedrock. Deposits are up to 100 feet thick, but thickness varies considerably within short distances. In valleys, till may be encountered in the subsurface beneath stratified sediment or lake-bottom sediment.	Deposits of till are generally poor aquifers because they are comparatively impermeable and thin. Sandy tills in valley bottoms may, in places, provide domestic water supplies.
	continuous till	tc	As above.	Continuous blanket of till covering the bedrock surface. Thickness generally is greater than ten feet and ranges up to 100 feet. In valleys, till may be encountered in the subsurface beneath stratified sediment or lake-bottom sediment.	As above.
stratified sediment	ice-marginal stratified sediment	im	Stratified sand and gravel. Sorting generally is good and stratification generally is continuous and undeformed.	Broad, flat-topped delta ridges that extend across valleys. Deposits are up to 200 feet thick, but thickness varies greatly within short distances due to irregularities of the bedrock surface.	Stratified sediment in valley bottoms is the most productive glacial aquifer because it is generally permeable, thick, continuous, and extensive. Deposits in hills, ridges, or terraces above the valley bottom are less productive because they drain rapidly, although they may act as important recharge areas for the valley-bottom deposits. Reported yields of wells in Wantage, Vernon, and Hardyston Townships tapping these deposits range from 3.5 to 45 gpm (median of 18 gpm) for 21 domestic wells and from 50 to 942 gpm (median of 213 gpm) for 10 industrial wells (Miller, 1971). Depths range from 51 to 218 feet and average 98 feet.
	ice-contact stratified sediment	ic	Chiefly stratified sand and gravel. Sorting generally is poorer than that of ice-marginal stratified sediment. Stratification is less continuous and is commonly deformed. Sediment flow deposits and till, consisting of mixed gravel, silt, and clay, are interlayered with the sand and gravel in places.	Eskers and hummocky terraces generally located within valleys. May be present in the subsurface interbedded with and underlying lake-bottom sediment. Deposits are up to 200 feet thick, but thickness varies greatly over short distances due to topographic irregularities and irregularities of the bedrock surface.	As above.
lake-bottom sediment		lb	Thinly-layered clay, silt, and fine sand. In places, lake-bottom sediment is overlain by up to 25 feet of alluvium and peat.	Flat, low-lying areas in valleys, commonly occupied by wetlands. Deposits generally are less than 50 feet thick but may be up to 150 feet thick.	Lake-bottom sediment is generally a poor aquifer because it is comparatively impermeable. However, in Vernon Valley and in the Wallkill valley near Hamburg, lake-bottom sediment is interbedded and underlain by up to 40 feet of water-producing stratified sediment.

MAP SYMBOLS

Contact, approximately located

550 Glacial lake spillway, showing direction of drainage and approximate elevation of spillway (ft.)

Meltwater channel, showing direction of flow

Glacier margin
(Ticks point toward glacier; dashed where uncertain.)

Esker

Drumlin, primarily glacial sediment
(Axis parallel to ice flow.)

Drumlin, primarily bedrock
(Axis parallel to ice flow.)

S 15 W Striation, showing direction of ice flow
(Dot marks point of observation.)

Stream-cut scarp within map unit

34 ●87 80 Water well or test boring reaching bedrock, showing depth to bedrock (ft.), thickness of overlying post-glacial sediment (ft.) in italics above dot, and thickness of underlying weathered bedrock (ft.) in italics below dot, inferred from driller's logs of variable reliability

52 ○95 Water well or test boring not reaching bedrock, showing minimum depth to bedrock (ft.) and thickness of overlying post-glacial sediment (ft.) in italics above dot, inferred from driller's logs of variable reliability

550 Glacial lake level (ft.) (Section BB' only.)

Numerous bedrock exposures

INTRODUCTION

Northern New Jersey was glaciated at least twice, and probably three times, during the Pleistocene Epoch (the past million years). The most recent glaciation, the late Wisconsinan advance, reached its maximum extent approximately 22,000 years ago. Retreat began approximately 19,000 years ago (Connally and Sirkin, 1970). At its maximum extent the glacier appears to have advanced 18 miles south of Hamburg Boro to the Terminal Moraine (Salisbury, 1902; Cotter, 1983).

Over wide areas to the north of the Terminal Moraine the ice eroded soil, sediment, and bedrock. As the glacier retreated, melting ice released large amounts of eroded sediment. In the Hamburg quadrangle most of these deposits are known to be of late Wisconsinan age, although pre-late Wisconsinan sediments may exist in the cores of drumlins or beneath late Wisconsinan deposits in valleys.

In Vernon Valley and the upper Wallkill valley some glacial deposits are productive aquifers. Because water can, at many places, move freely between surface sources, glacial deposits, and bedrock aquifers, the delineation of the surface extent and subsurface configuration of glacial deposits is essential for development and management of the ground water resources of the area. This configuration is, in large part, the result of events during northward retreat of the glacier.

As the glacier retreated lakes formed in basins between the glacier and drainage divides to the south. Such lakes occupied the north-draining valleys of the Wallkill River, Beaver Run, Papakating Creek, and Black Creek. Permeable sand and gravel were deposited at the ice margin where sediment-laden meltwater streams entered lakes. Further from the ice margin fine sand, silt, and clay settled to form less permeable lake-bottom deposits.

When the ice front was retreating steadily, sand and gravel were deposited as discontinuous layers that were, in places, covered later by less permeable lake-bottom sediment. These subsurface sand and gravel units are productive artesian aquifers in places in Vernon Valley and in the Wallkill valley near Hamburg. When the ice margin was stationary for a period of years, large sand and gravel deposits accumulated as deltas and underwater fans. These deposits commonly protrude above later-deposited, less permeable lake-bottom sediment and may be continuous with the subsurface sand and gravel units (refer to cross section BB'). These deposits today stand as ridges and hills within the valleys, and they may act as recharge areas for the artesian aquifers.

Post-glacial materials of the Hamburg quadrangle include floodplain, marsh, and hillslope deposits. They are generally thin, discontinuous and unimportant sources of ground water, and are not shown on this map. Floodplain sediments, however, may significantly influence the exchange of water between streams and aquifers.

GLACIAL HISTORY

The orientation of drumlins and striations indicate southwestward movement of ice generally along the axis of the Wallkill valley. Direction of movement ranges from S5°E to S50°W, with most measurements between S25°W and S45°W.

Retreat of the ice appears to have proceeded by intervals of steady recession separated by intervals of relative stability of the ice margin position. Major still-stands at the Augusta and Sussex Moraines of Connally and Sirkin (1973) are marked by large ice-contact deltas. Smaller deltas mark shorter still-stands between the moraines. Linear strings of individual knolls of sand and gravel are interpreted as successions of lacustrine fans deposited during briefer, possibly seasonal, still-stands.

Glacial lakes of the Wallkill valley can be grouped in four stages (Adams, 1934; Connally and Sirkin, 1967). At an initial stage, small lakes were formed in tributary valleys, in some cases at elevations well over 500 feet. At a second stage, melting of ice uncovered divides between tributaries, and the small lakes merged to form a single, large lake draining to the Paulins Kill valley through a divide at an elevation of 500 feet near Augusta in Frankford Township. At a third stage, a divide at an elevation of 400 feet at Moodna Creek, New York, had become uncovered and water drained to that level. At this and a fourth still lower stage lakes probably did not extend into the Hamburg quadrangle.

Within the Hamburg quadrangle the earliest and highest lake level was at approximately 610 feet (refer to cross section BB' for illustration of lake levels). It drained to the south through an outlet west of White Lake in Sparta Township. The lake filled the southern end of the Wallkill valley south of Franklin. A large delta near North Church was deposited in this lake.

As the ice front melted back to the north, two divides between the Wallkill and Beaver Run valleys may have been uncovered in succession: a divide at an elevation of 590 feet just north of the North Church delta, and another one mile to the north at approximately 550 feet. Uncovering of these divides would have allowed westward drainage to the Beaver Run valley. A small delta just to the northeast of the North Church delta and lacustrine fans northeast of Hamburg may have been deposited in the 590-foot lake.

Within Beaver Run valley, a lake at an elevation of 575 feet was controlled by an outlet south of Harmonyvale in Lafayette Township. A small delta at Beaver Run was deposited in this lake. As the ice retreated further, an outlet at 550 feet was uncovered north of Harmonyvale, and the lake drained westward into the Papakating valley through this outlet. The 550-foot lake eventually extended east and south to McAfee and Franklin. It persisted until ice retreated north past the divide between Papakating Creek and the Wallkill River. A delta approximately one mile southwest of McAfee, and the esker northwest of Hamburg, were deposited in this lake.

Continued retreat of the ice past the divide between Papakating Creek and the Wallkill River led to the formation of a single, large lake draining to the Paulins Kill through the previously mentioned divide at an elevation of 500 feet near Augusta. Large deltas at Sussex and Sand Hills, an esker north of the Sussex delta and a small delta along Quarryville Brook near Wantage Cemetery were deposited in this lake.

In Vernon Valley it appears that an ice block south of McAfee acted as a dam that retained a short-lived lake draining southwestward to the 500-foot lake through an outlet at 540 feet. The ice block had melted and the lake lowered to the 500-foot level by the time ice had retreated to Sand Hills. Some of the ice-contact stratified sediment within and along the sides of Vernon Valley north to a point between McAfee and Sand Hills probably was deposited in the 540-foot lake. Sand and gravel along the valley sides at elevations higher than the 540-and 500-foot lake levels probably were deposited from meltwater flowing between the valley walls and a lobe of ice in the valley. These deposits may be older than or contemporaneous with the 540-and 500-foot lake levels.

In addition to the large lakes in the major valleys, several small glacial lakes were impounded for short durations at higher elevations. The valley to the north of Glenwood Lake may have been ponded to an elevation of approximately 810 feet; the valley north of Lake Pochung was probably ponded to an elevation of approximately 810 feet; a small valley north of Rudeville was ponded to an elevation of 620 feet and completely filled with sediment; and a similar valley to the east of Franklin was ponded to 680 feet and also filled with sediment.

Deltas formed in a particular glacial lake are observed to be at progressively higher elevations as one proceeds northward. This is due to an effect known as isostatic adjustment. Under the weight of ice, the crust of the Earth was depressed and the surface became tilted down to the north. As the ice melted and its weight was removed, the crust returned to its pre-glacial configuration, and the surface rebounded to its pre-glacial level. Evidence for rebound is found in the Hamburg quadrangle and neighboring areas. Deltaic features related to the 500-foot lake level occur at about 500 feet at Frankford Plains, 1.5 miles north of the outlet; about 510 feet at the Sand Hills delta 5 miles north; and about 520 feet at the Sussex delta, 6 miles north. Post-glacial adjustment estimated on this basis increases by approximately 3 feet per mile northward.

POST-GLACIAL EVENTS

Subsequent to glaciation, the sediments and topography of the Hamburg quadrangle have been modified by stream erosion and deposition, slope processes, marsh sedimentation, human activities, and, to a minor extent, wind action.

Immediately following deglaciation, wind blowing across the unvegetated landscape eroded, transported and deposited silt. These silt deposits occur in scattered locations on flat, upland surfaces as layers up to two feet thick.

As streams re-established their courses after deglaciation they began to deposit sand, silt, and clay on floodplains. At present, major valleys are veneered with floodplain deposits up to ten feet thick. Typically, these deposits are underlain by lake-bottom sediment or by ice-contact stratified sediment. They are especially widespread in the Papakating valley and in the Wallkill valley south of route 565 (Waksman and others, 1943).

Where floodplain sedimentation is slow, accumulation of plant debris in marshes forms peat and muck. These deposits attain thicknesses of 40 feet but more commonly are less than 15 feet thick (Waksman and others, 1943). Marsh deposits cover most of the Wallkill floodplain north of route 565 and occur in Vernon Valley north of Sand Hills. They also occur in numerous small basins on Pochuck and Hamburg Mountains. In valleys the swamp deposits are commonly underlain by lake sediment; on uplands they are commonly underlain by bedrock and till.

Lastly, the bases and sides of hillslopes are covered with aprons of disaggregated rock, till, and sand and gravel that have mixed and moved downslope under the influence of gravity and water runoff. At the bases of steep slopes these deposits are up to 30 feet thick. They are typically underlain by rock, till, or ice-contact stratified sediment. Noteworthy hillslope deposits occur along the sides of Vernon Valley and in small valleys in the shale hills near Sussex.

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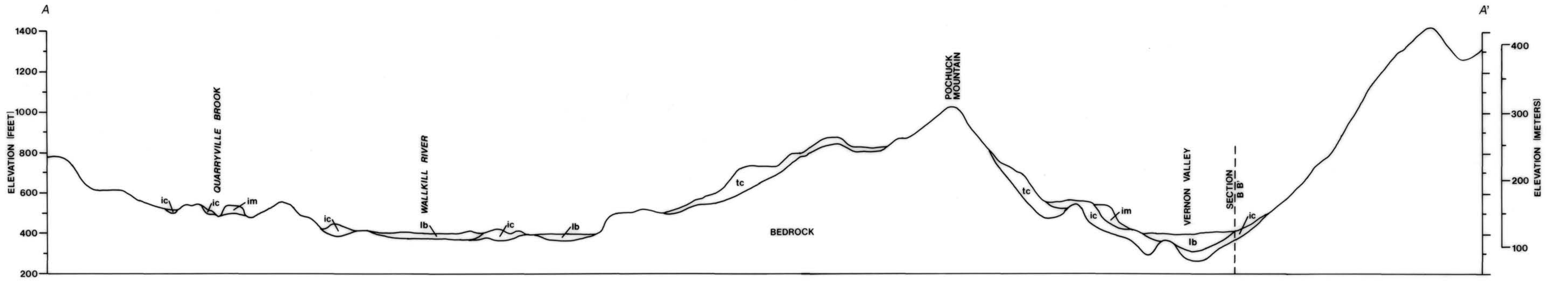

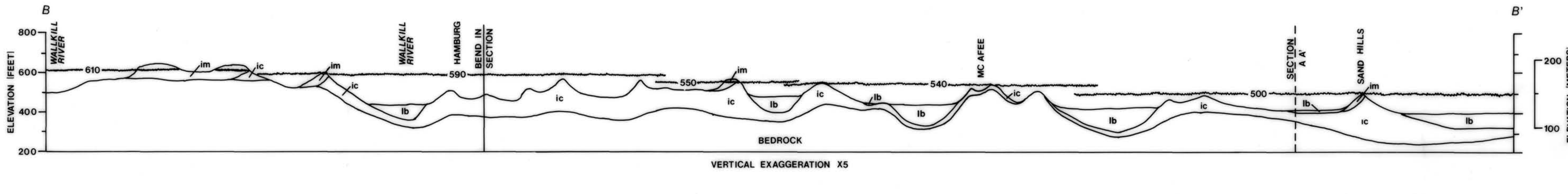

VERTICAL EXAGGERATION X5