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~~FINAL REPORT~~

~~ON~~

GRAVEL AND SAND RESOURCES

OF THE

NEW ENGLAND-NEW YORK REGION

by

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L. W. Currier, U. S. Geological Survey

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Gravel and sand resources of the New England-New York region

Geologic occurrences

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Introduction

Deposits of sand and gravel are widespread in the New England-New York region and constitute one of its principal mineral resources. Most of the pits are operated intermittently to supply local needs. Because of the great number and variety of known deposits, and because they have been worked at countless points it is impracticable to describe in detail either the deposits or the individual pits. On the other hand, a broad description of the geologic modes of occurrence with relation to the regional geology will serve adequately to indicate the importance of the resource in the regional economy and development. Except for some special sands, such as "glass sand", certain molding and foundry sands, et. al., for which restrictive textural, compositional and physical properties are required, sand and gravel are used chiefly for local construction and are not commonly transported for long distances.

Sand and gravel deposits of the region fall into four principal genetic categories - e.g., glacial, alluvial, marine, and aeolian. Of these, deposits of glacial origin are by far the most widespread and important.

Glacial deposits

General statement

The entire region was transgressed several times during the Pleistocene epoch ("Ice Age") by continental ice sheets. The last ice left the region so recently (probably 10,000 to 20,000 years ago) that in general the glacial landforms have been but slightly modified by post-glacial erosion and they stand as sharply defined glacial features, giving a distinctive appearance to the landscape and a complexity of mantle materials that characterize the region everywhere. As a result of glacial deposition the area has countless lakes and swamps, extensive plain-like areas of sand and gravel, and a variety of smaller landforms composed of granular materials with a wide range in texture. Pre-glacial valleys were partly or entirely filled with rock and soil debris, and drainage systems were locally disarranged or diverted. These features present many problems related to engineering projects concerned with foundations and structures; on the other hand, the glacial deposits provide a generally abundant supply of sand and gravel that figure prominently in the resources economy of the region.

The glacial deposits may be considered under two broad groups, moraines and outwash deposits.

Morainic (till) deposits

As the ice sheet transgressed the area from the north it scraped up pre-existing soils, abraded bedrock, and plucked blocks of bedrock from projecting exposures. Some of these materials were embodied within the ice and carried long distances. Most of them probably were spread out under the ice as a general layer of unsorted and heterogeneous soil and rock debris that ranges in texture from clay to boulder sizes. Such material is called <u>till.</u> This general layer of till, for the most part covering both hills and valley floors, is called <u>ground moraine</u>, and is so designated on surficial geologic maps. In some places where the ice front remained stationary for an appreciable length of time frontal ridges of till and associated gravel were built up; these are the end-moraines as commonly designated on surficial geologic maps. In part the end-moraines mark the terminal positions, across valleys, of finger-like valley-lobes of ice; in other places they mark broader fronts of wider lobes, trending in somewhat irregular course but with impressive length and continuity across the country.

Lobal valley moraines are common, for example, in the Finger Lakes region of New York, where they formed dams behind which meltwaters were ponded. Long ridges on Cape Cod extending parallel to Buzzards Bay and the south shore of Cape Cod Bay, and others extending along Long Island, and the southwest coast of Rhode Island are examples of the end-moraines extending across both valleys and divides.

Moraines of all kinds yield relatively little sand and gravel except for local pockets or small knobs that are, for the most part, poorly sorted. The till, of which moraines are principally composed, is of variable texture, and composition, reflecting the nature of the bedrock over which the glacier rode. Much of the till of eastern and central New England, and the Adirondacks region was derived mostly from siliceous crystalline rocks and is gravelly; it is sometimes sold as gravel, for in many places it has yielded material of sufficiently coarse and loose texture to permit its use as back-fill and even for subgrade material in highway construction. The resources of such gravelly tills are large but only of very local importance and for restricted use. In places where the tills were derived from non-crystalline rocks (non-metamorphosed or slightly metamorphosed rocks) chiefly shales, slates, phyllites, limestones, and fine-grained sandstones, the till materials are finer-grained and more compact, and are rarely suitable for engineering use where granular materials of high porosity are needed. Such rocks contribute more clay minerals and rock flour to the till matrix than do the coarser crystalline rock, such as granitic rocks, gneisses, and quartzites.

Outwash sand and gravel deposits

General statement.

As the glacial ice melted, much of the rock and soil debris picked up and embodied within the ice, and some of the morainic materials deposited beneath or in front of the ice, were transported, sorted, and deposited by the meltwaters. Such deposits are included in the general term outwash; they include materials ranging in texture from clay sizes to very coarse gravels, according to the carrying and sorting power of the meltwater streams. Boulders are not uncommon in outwash deposits, where they may either be residual from reworked till deposits, or may have been dropped from ice blocks or bergs onto the outwash deposits. In some outwash deposits, particularly those in which the coarser gravels are prominent constituents, boulders are so concentrated as to make working of the deposit difficult.

Outwash deposits have various landforms, according to the loci and modes of deposition. To some degree, also, the probable general texture of the deposit may be predicted from the origin and form of the deposit. For these reasons, a detailed surficial geologic map is of great value in locating probable supplies of gravel and sand and computing the volumes of the deposits.

The principal loci of deposition of glacial outwash were the major valleys that were occupied by ice tongues, or by stagnant, residual blocks of ice during the recession of the continental ice-sheet. Here meltwater streams transported, sorted, and deposited rock debris along the floors and walls of the valleys, around and against ice blocks and tongues of ice, and in grooves, crevices, and holes in or upon the ice. In many places, also, valleys were dammed by morainal deposits, or by the receding ice front in northward draining valleys, so that lakes and ponds were formed. Deltal and lake floor deposits formed in these lakes, most of which were drained by melting of the ice dams or subsequent breaching of morainal dams by erosion.

Classification of outwash deposits.

For practical purposes outwash deposits are probably most satisfactorily classified by their landforms, for there is commonly a broad correlation between the forms of deposition, and the variability and textural range of component materials. Nevertheless, the textural range is great in many deposits, and can be ascertained only by actual pitting, sampling, and screening. Unlike many alluvial gravels of non-glacial origin even the coarse textured deposits contain a large and greatly variable percentage of sand sizes. Mapping of landforms, therefore, gives a practical key to further exploration for materials of desirable texture, but needs to be supplemented by sampling and sizing tests for engineering uses in which textural control of granular materials is important.

The following glacial landforms are ordinarily indicated on detailed surficial maps.

Kames; kame fields. Small irregular hillocks and knobs, (kames), as a class show great variability in texture and poorest degree of sorting. Boulders and large cobbles may be abundant. Kames constitute one of the chief sources of coarse granular materials. Exceptionally, kames may be composed predominantly of fairly well-graded sand, and even where large cobbles and coarse gravel sizes are prominent the sand matrix in some kames may amount to more than 50 percent.

Groups of kames are sometimes mapped as kame fields.

Ice-channel deposits (eskers; crevasse fillings). These are ridges of gravel and sand representing deposits that were formed in tunnels beneath or within the glacial ice, in channels and furrows upon the ice, or in narrow crevasses through the ice. Most of them are characteristically sinuous, narrow, and uneven-crested. Some are several miles long, though most of them are a few hundreds or thousands of feet long. They are greatly variable in texture and commonly contain boulders. Ice-channel deposits constitute one of the chief sources of coarse granular materials. In Maine eskers are particularly important sources. Like kames they have a sand matrix, which may predominate over the coarser sizes.

Kame terraces; kame plains; kame deltas. These are comparatively broad and flat-topped deposits, terrace-like in form. Kame terraces were formed between valley walls and residual ice-blocks or lobes within valleys, so that they rest against the walls, present relatively steep, "ice-contact", slopes toward the valley floor, and are perched at various elevations above the floor. In the larger valleys these terraces may be very extensive, more or less lining the valley for several miles. Isolated, mesa-like deposits of closely similar origin, representing those formed in holes within residual ice-blocks, are indicated on some maps as kame plains; where deposited in ponded waters and consequently possessing a deltal structure they have been mapped as kame deltas.

Because all these forms represent deposits by the larger streams of meltwaters that flowed for fairly long distances along valleys in which ice still remained, they are commonly composed of better-sorted granular materials than are kames and ice-channel fillings, and are major sources of medium and fine gravels, and sand; the sand content is characteristically high. The margins, being partly or entirely steep-sided ("ice-contact slopes") afford easy development. Kame terraces ordinarily rest upon floors and slopes of till, less commonly on bedrock. Boulders and large cobbles are present but less abundant, in general, than in other ice-contact forms (kames and ice-channel fillings).

Outwash plains; valley trains. Meltwaters that issued from the front of the glacier sorted and deposited extensive plains of sand and gravel, usually as coalescent fan-shaped deposits that merge into low, nearly flat, smooth plains farther from the ice-front. Known also, in part, as "sand plains", these are mapped as outwash plains and in some areas are the most abundant sources of fine-granular materials. Long, narrow outwash plains deposited along valley floors are commonly mapped as valley trains.

Outwash plains and valley trains are composed in general of well-sorted and stratified sand and fine gravel, except in parts formed near the ice-margin. The materials are progressively finer away from the margin. They have particularly broad distribution in the lower and more level parts of the region, such as central New York and southeastern New England.

Glacial lake (glacio-lacustrine) deposits. General withdrawal of the ice-sheet left many lakes in blocked valleys, or depressions in the general morainic deposits. Many of these were drained by melting away of ice-dams, or by breaching of morainal dams; others still exist, though greatly shrunken so that small lakes and ponds are now common in areas once occupied by larger and higher bodies of water. During recession of the ice, copious outwash was deposited in these lakes, both as deltas and as floor deposits; subsequent draining of the lakes has left these perched along valley walls, as deltas, or spread broadly on valley floors and plain areas, as lake clays, silts, and sands.

Of the glacial lake deposits, for most of the area the deltas are of greater importance than the floor, beach, or bar deposits. They constitute valuable sources of sand and gravel in which the sand constituent is generally predominant, but from which large supplies of medium and fine-textured gravels are obtained by screening. Notable areas for such resources are the Finger Lakes region of central New York, the valleys of the Mohawk, Hudson, Housatonic and Connecticut rivers, and the Champlain Valley. By no means, however, are important deposits of such origin restricted to these areas, for countless glacial-lake deltas are distributed broadly through the Adirondacks, the Catskills, and most of New England, especially the central and southern parts. In particular, very large deltas in the Chicopee-Springfield, and Montague-Sunderland areas of Massachusetts yield large quantities of sand and fine to medium textured gravel. It is noteworthy that the essentially horizontal top-set beds of glacial-lake deltas are composed mostly of gravel and coarse sand, whereas the underlying, inclined, fore-set beds are characteristically of finer texture, with sand as the predominant constituent.

Lake-floor deposits are composed usually of fine-textured sand, silt, and clay, with thin beds - mostly very local - of the finer gravels. Much of the flat plains area of west-central New York, for example, is underlain by extensive sand plains, beaches, sand bars, and low, thin deltas, all of which were deposited in the once very extensive glacial Lake Iroquois, now shrunken to the present Lake Ontario; lake beaches and bars mark various elevations of this lake. Many sand and gravel pits have been dug in these deposits, which, though comparatively thin, are widespread and, in unrestricted areas, are potential sources for local use. They furnish chiefly well-sorted and stratified sands and fine to medium gravels.

Quality of glacial deposits in relation to bedrock sources

Because of their derivation from various types of bedrock over which the continental glacier rode, the outwash and till commonly reflect the areal lithology.

For a large part of New England and the general Adirondack area - excepting chiefly the Champlain-Hudson, Housatonic, and Connecticut Valleys, and smaller segments of the major valleys in central and eastern Maine - the glacial debris was collected mostly from crystalline rocks and the pre-glacial soils derived therefrom. Consequently, pebbles of hard and durable granitic rock and gneisses, quartzites, and volcanics are prominent and commonly dominant constituents. Platy fragments of less durable foliated, micaceous schists, phyllites, and other slaty rocks abound in areas underlain by such bedrock formations; these are often found to be in such abundance as to limit the usefulness of the gravel and sand. Both granitic and schistose types of bedrock formations are widespread in New England and northern New York, and the proportions of these constituents in the gravels vary greatly. Consequently, although the gravels are universally suitable for ordinary "fill", they need to be examined closely for use as concrete aggregate or more specialized purposes.

It is not practicable to delimit the gravel and sand deposits geographically according to the nature of the constituent pebbles. Nevertheless, there are several general areas that reflect the bedrock lithologies prominently. Thus the glacial deposits in most of the Connecticut Valley of Massachusetts and Connecticut contain an abundance of fragments of the red sandstones, shales, and conglomerates of the Triassic formations. Gravels of eastern Massachusetts, southern Maine and New Hampshire, most of Rhode Island, and the Adirondacks highlands contain an abundance of granitic and other coarsely crystalline rocks. Schist fragments are commonly dominant in the gravels of central and western New Hampshire, eastern and central Vermont, central and western Massachusetts, and much of Connecticut. Pebbles of carbonate rocks - chiefly marbles, both calcitic and dolomitic - appear prominently in the broad valley provinces of western Vermont and Massachusetts, between the Green Mountains-Berkshire uplands on the east, and the Taconic ranges along the western borders of these states.

In New York there is great variability. Hard, quartzitic sandstone, and granitic rocks are prominent in the northeastern part of the State. Gravels and tills of the northwestern part of the State contain locally high percentages of the reddish Medina sandstone. In the central-northern part of the State boulders and pebbles of the hard quartzitic Potsdam sandstone, and of granitic and gneissic rocks are commonly abundant. In central New York, west of Schenectady, the underlying shales and argillaceous sandstones - both of which are weak and platy - are present in abundance in the glacial deposits; east of Schenectady, the older and extensive delta deposits of glacial Lake Albany had their source in the soft sedimentary rocks of the Mohawk basin, but later deposits in the same area were coarser-grained and more quartzose, owing to derivation from the Adirondacks areas as it was uncovered by the retreating ice. Sands and gravels of the Hudson Valley, in general, contain a relatively high percentage of fragments from the soft and platy Hudson River shale, and slate. Shale and limestone beds contributed abundantly to the glacial deposits of central and western New York.

Alluvial deposits

Much of the load picked up, transported, and deposited by present-day rivers is derived from glacial deposits, both outwash and till. Some of this load, which ranges in texture from clay sizes to cobbles, is deposited as flood-plains; the finer materials for the most part find their way to the sea or the larger lakes.

Locally, small deltas are being formed in the larger lakes, but, unlike the earlier deltas formed by streams of glacial meltwaters, these are of inconsiderable importance.

Because of the partly submerged, or "drowned", nature of the coast, rivers emptying into the sea are not forming significant deltas, though sediments - chiefly of sand, silt, and clay sizes - are contributed as bottom deposits to the embayments and shallow coastal areas, where they are in part reworked by shore and wave currents into beaches, bars, and sand spits together with materials derived from glacial deposits being attacked and redistributed by these currents.

Large quantities of gravel and sand were formerly dredged from the Niagara River in the vicinity of Buffalo, but this production is reported to have been s topped by Government restrictions. Recent alluvial deposits are, in general, better sized than those of glacio-fluvial origin and, in particular, river gravels - though commonly occurring as thin beds - are apt to be of much more uniform texture. In areas underlain chiefly by shale and thinly-bedded sandstone, such as in much of central and western New York, the alluvial sediments are usually of poor quality and have little economic value.

Flood-plains of the Connecticut River in parts of Massachusetts and Connecticut can yield large supplies of the finer textured sands; these deposits are of considerable thickness in a few places, but are generally thin.

Marine and lake deposits

Sand and shingle beaches abound along the New England coast south of southwestern Maine. Beach sands have been exploited in a few places, but at present there is little or no production from such sources because of restrictions as residential and recreational areas.

In New York bottom and bar sands and gravels of Lake Ontario have been dredged extensively. Such deposits, though relatively thin, yield well-sorted sands and fine gravels. Dredging from Lake Erie, as formerly reported by Nevin (1929), have been prohibited by State law.

Beach and bar deposits of the area have been derived almost entirely from materials of glacial origin. Generally, they have been reworked many times by currents and waves and are consequently well-sized and uniform. Pebbles in them are well-rounded.

Aeolian (wind-blown) deposits

Wherever strong winds with a prevailing direction blow across sand plains and beaches that have scant vegetation they pick up and transport the fine sand, silt and dust. These materials are then deposited in favorable places where obstructions retard the winds. Fine sand and silt sizes commonly blanket large areas. Such aeolian deposits are widespread in the region and furnish an appreciable amount of the thin soil cover in many areas, ranging ordinarily from a few inches to a few feet in thickness. They do not appear, however, to have economic value in the region.

On the other hand, along broad beaches and on bare sand plains bordering major rivers dunes have formed locally, and in places have furnished well-graded foundry, filter and asphalt sands. For foundry purposes they generally require additions of some bonding material. High dunes just east of Provincetown, on Cape Cod, have been successfully worked for several years (see report on Silica). The resources are very large. Dunes occur at many places elsewhere along the coastal belt of Cape Cod, but have not been exploited. For the most part they lie in restricted areas, a possible exception being parts of Scorton Neck and Sandy Neck, in Sandwich and Barnstable.

In the Connecticut Valley many dunes occur on the broad terraces bordering the Connecticut River flood plains of Massachusetts, and to a much less extent in northern Connecticut. They are almost entirely confined to the terraces east of the river. Although most of these dunes are but a few feet high, some dunes have heights up to approximately 50 feet. High dunes appear to be particularly abundant in Massachusetts south of Springfield, and are valuable potential sources of very uniformly graded sand. Indeed, much of this area has a general blanket of aeolian sand, which includes the large, well-formed dunes.

In New York, according to Nevin (1929), "On the old sand plains at Albany, Forestport, and Rome ideal conditions must have prevailed for dune formation, since today we find in these districts many ancient sand dunes which have been anchored by vegetation and are no longer active. Their commercial value is limited to the fine grades of core and filter sands and in some cases asphalt sand." Nevin further reports that "at Selkirk on the eastern shore of Lake Ontario, an excellent sand dune deposit is now being formed. The sand is highly siliceous, white in color and is blown from the beach by prevailing westerly winds. In many respects this deposit is similar to the famous Michigan City core sands."

Geographic distribution of principal types of deposits

Correlation of subregions with physiographic provinces

The following summary presents the general geographic distribution of the principal types of sand and gravel deposits by physiographic provinces, sections, and subregions. It does not imply, however, exclusion of other types of deposits, as described in this report, from the individual areas.

The physiographic provinces are those outlined on the map entitled "Physical Divisions of the United States", as prepared by N. M. Fenneman in cooperation with the Physiographic Committee of the Geological Survey. A correlation of these provinces with subregions is made as follows:

Province	Section	Subregion
New England	Seaboard Lowland	Coastal belts of A and B from easternmost Maine to south-central Rhode Island.
	New England Upland	A and B, except coastal belt from eastern Maine to south-central Rhode Island, White, Green, and Taconic Mts., sections.

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Major Division	Province	Section
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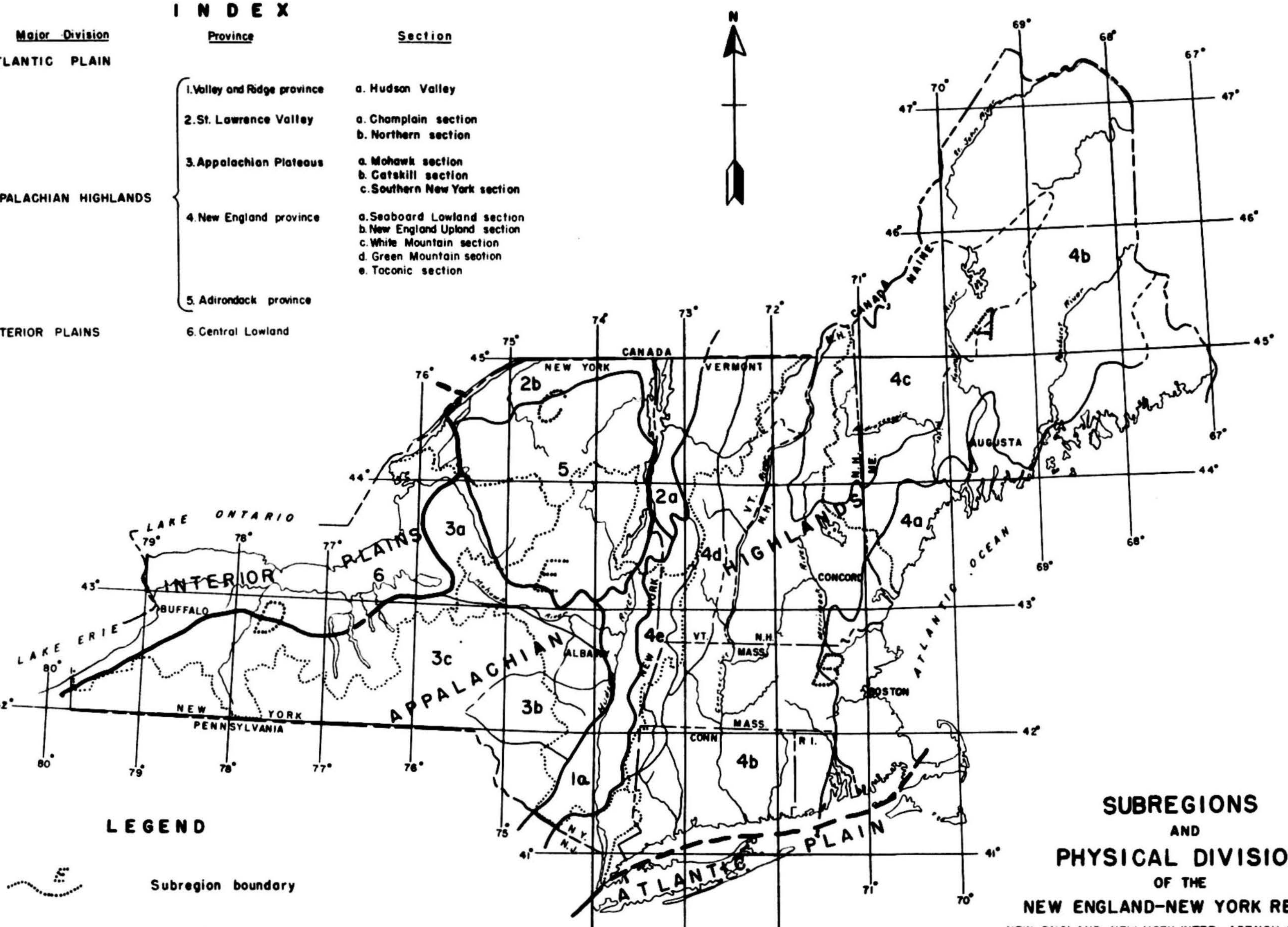
	2. St. Lawrence Valley	a. Champlain section
		b. Northern section
	3. Appalachian Plateaus	a. Mohawk section
		b. Catskill section
		c. Southern New York section
	4. New England province	a. Seaboard Lowland section
		b. New England Upland section
		c. White Mountain section
		d. Green Mountain section
		e. Taconic section
	5. Adirondack province	
INTERIOR PLAINS	6. Central Lowland	



SUBREGIONS AND PHYSICAL DIVISIONS OF THE NEW ENGLAND–NEW YORK REGION

NEW ENGLAND–NEW YORK INTER-AGENCY COMMITTEE

OCTOBER 1954

SCALE IN MILES

25 0 25 50 75 100

LEGEND

Subregion boundary

Major physical division

Physiographic province

Physiographic section

Note: Broken line indicates boundaries much generalized or poorly known.

Province	Section	Subregion
New England	White Mountains	Chiefly in A, small part in B; north-central and northern New Hampshire, north-central and western Maine.
	Green Mountains	Chiefly in western part of B; north-south belt through west-central Vermont into northwestern Massachusetts.
	Taconic	Small parts of C and E. A short narrow belt extending south from Rutland into northwestern Connecticut and including parts of the Champlain-Hudson, Otter Creek, Hoosic, and Housatonic Valley.
Valley and Ridge	Hudson Valley	Part of E. Narrow valley area Lake George south to Newburg.
St. Lawrence Valley	Champlain	In eastern part of C. Champlain basin.
	Northern	In northern part of C. Low plains north of Adirondack section and west of Champlain section.
Adirondack		Adjacent parts of C, D, and E. Northern New York highlands.
Central lowlands	Eastern Lake	Entirely within D. Low lake plains bordering Lake Ontario and Erie.
Appalachian Plateaus	Mohawk	In eastern part of D and western and central parts of E. Chiefly the Mohawk Basins, extending southeast and east from Rome, N. Y. to Schenectady, N. Y., but includes a narrow belt from Rome to a point just east of Watertown.
	Catskill	Eastern part in south-central part of E.
	Southern New York	Southern parts of D and E.

Principal types of deposits by areas

New England Province.

Seaboard Lowland section. In this coastal belt strip of low altitudes and relief, ranging up to 60 miles in width are included the coastal basins of Maine, New Hampshire, Massachusetts, and eastern Rhode Island, and the coastal segments of other major basins within the belt.

Principal deposits: outwash sands and gravels abundant, but greatest from southwestern Maine to southern Rhode Island. Marine and glacial clays and silts are prominent in several areas. Beach and dune sands especially abundant along Massachusetts coast south of Scituate and particularly on Cape Cod, but most areas restricted; production current near Provincetown.

New England Upland section. This is a dissected plateau province that includes central, eastern, and northern Maine, central and southern New Hampshire, eastern Vermont, central Massachusetts, and Connecticut.

Principal deposits: outwash sands and gravels within all major valleys, the amount generally increasing to the south and particularly extensive in the Connecticut, Merrimack, Housatonic, Farmington, and upper Thames valleys and their principal tributaries. Clays chiefly of glacial origin are associated in the Connecticut, Quinnipiac, and Quinebaug valleys. Many beaches with small dunes along Connecticut coastal belt, but mostly restricted.

White Mountains section. A mountainous region in northern, western Maine (includes chiefly the upper parts of Kennebec and Androscoggin basins), northern New Hampshire, and northeastern Vermont; includes headwater sections of Connecticut River basin.

Principal deposits: data for this area are scant but probably comparatively small deposits of outwash gravel and sand, in part as terraces, considerably dispersed along valley walls.

Green Mountains section. A north-south belt through west-central Vermont and a few miles into northwestern Massachusetts; an area of long, north-south trending, mountain ridges and valleys. Includes central and upper parts of Mississquoi, Lamoille, Winooski, White, and Deerfield basins.

Principal deposits: numerous outwash deposits of sand and gravel chiefly as kame terraces and deltaic deposits along walls of major valleys. Great variability in quality; in many places the gravels are poor where they contain an abundance of leached and oxidized pebbles from the siliceous limestone beds of the Waits River formation, and thin platy fissile fragments of the associated beds of phyllite and slate, and various schists of adjacent formations. Specific data on deposits are very scant for this area, and practically no surficial geologic maps are available.

Taconic section. A short, narrow belt extending south from the vicinity of Rutland into northwestern Connecticut, and including parts of the Champlain-Hudson, Otter Creek, Hoosic, and Housatonic basins. It is an area of old, dissected mountains and adjacent broad valleys, underlain chiefly by highly folded beds of schist, slate, and marble.

Principal deposits: scant data are available, but deposits appear to consist chiefly of many relatively small and dispersed glacial outwash terraces (kame terraces), kames, deltas, and outwash plains.

Valley and Ridge Province.

Hudson Valley section. A narrow valley area in a glaciated peneplain, extending southward from Lake George area to vicinity of Newburgh.

Principal deposits: extensive deltal deposits of glacial derivation, composed of beds of clay, silt, and sand, with subordinate gravel; from Schenectady to Albany it is covered by broad outwash sand and gravel deposits. Locally, kame terraces of sand and gravel.

St. Lawrence Valley Province.

Champlain section. This is a rolling lowland area lying between the Adirondack section and the Green Mountains, largely occupied by the Lake Champlain basin.

Principal deposits: numerous scattered, generally small outwash deposits, and some large deltas composed chiefly of sand.

Northern section. This section is a generally low, smooth, glaciated plain with a covering of marine sediments.

Principal deposits: sand plains; alluvial (dredging) gravels from St. Lawrence River.

Adirondack Province.

A much dissected, glaciated, mountainous area underlain by crystalline metamorphic and igneous rocks including much marble.

Principal deposits: local and widely dispersed deposits of outwash gravel and sand, chiefly as small kame terraces, kames, and glacial lake deltas in the lower parts of the valleys.

Central Lowland Province.

Eastern Lake section. Predominantly nearly flat lake plains with low beach and morainic ridges. Essentially the shore and shallow water areas of the former glacial Lake Iroquois, antecedent of present Lake Ontario.

Principal deposits: abundant sand deposits, much of it suitable for concrete and molding; subordinate gravel in numerous relatively small, local, deltal, terrace, and esker deposits in most of which the sand fraction is comparatively high; beach and bar deposits of sand and gravel in Lake Ontario. Dredging of gravels from Lake Erie, formerly an important source, have been prohibited by State law.

Appalachian Plateaus Province.

Mohawk section. A maturely dissected plateau area of marked relief. The Mohawk Valley was a major drainage channel for glacial meltwaters and glacial Lake Iroquois.

Principal deposits: glacial outwash deposits numerous and widespread as kames, kame terraces, and deltas, particularly in upper part of valley. Thick outwash plains are prominent in the central and lower parts of the valley.

Catskill section. Maturely and deeply dissected plateau area of mountainous relief; many glaciated valleys.

Principal deposits: numerous and widespread glacial outwash deposits in the prominent valleys, as kames, kame terraces, deltas, and valley trains.

Southern New York section. A large part of this section within the New England-New York region consists of a broadly bevelled escarpment of the Appalachian Plateau Province that is deeply notched by prominent valleys; some of the larger of these valleys contain the so-called "Finger Lakes".

Principal deposits: numerous glacial outwash deposits, including kames, kame terraces, glacial lake deltas, and outwash plains. Many of the gravel deposits contain a high percentage of shale and limestone fragments.

Mapping of sand and gravel deposits

Sand and gravel deposits are shown on surficial geologic maps. The region as a whole is very deficient in such maps (see report on Status of topographic and geologic mapping). References to principal reports and maps relating to sand and gravel deposits are given in the appended Selected Bibliography.

For the greater part of the area surficial geologic maps should be made on a scale not smaller than 1:31,680 and contour interval of 10 feet if maximum value of the mapping is to be realized in the delineation of resources of sand and gravel. The 7½-minute quadrangle surficial geologic maps now being made for Massachusetts and Rhode Island may well be taken as a standard of such mapping. Besides these States, Connecticut, much of New York (chiefly the central and western parts), the southern parts of New Hampshire and Vermont, and elsewhere the major valleys, are appropriate areas for mapping at this scale. Principal exceptions are the Adirondacks, northern and central Maine, and the higher mountainous parts of New Hampshire and Vermont, where a smaller scale, but not smaller than 1:62,500, could be used to practical advantage.

It is to be noted that, according to the report on the status of topographic mapping, probably 50 percent of the appropriate area will be provided with suitable topographic base maps for the larger-scale mapping when present projects and plans for topographic mapping are completed, and the rest of the region will be provided with base maps on a scale of 1:62,500.

Current and continuing mapping programs are directed to the complete surficial geologic mapping of Massachusetts and Rhode Island by 7½-minute quadrangles, on a scale of 1:31,680 (2 inches to a mile). In addition, an earlier surficial map (Alden, 1924) on a scale of 1:125,000 covers 8 15-minute quadrangles of central Massachusetts. (For indexes see report on status of geologic mapping).

In New York, surficial mapping, completed or in progress, has been repported for 6 15-minute quadrangles in the St. Lawrence Lowland, and 7 quadrangles in the area from Alexandria Bay to Sackett's Harbor.

A State map of Connecticut, entitled "Map showing the glacial geology of Connecticut" (Flint, 1947), was published on a scale of 1:125,000, in 1930, by the State Geological and Natural History Survey. This map shows the generalized sand and gravel areas, and locations of many of the pits.

A map entitled "Surficial geology of New Hampshire", on a scale of 1:250,000, was published in 1950 by the New Hampshire State Planning and Development Commission (see selected bibliography). This map indicates the generalized distribution of principal glacial deposits. It was based on large part on an earlier file report on sand and gravel deposits made for the State Highway Commission.

A map entitled "Glacial deposits, State of Maine" on a scale of 1:250,000 was published in 1934 as a supplement to Volume II of Maine Technology Experiment Station Bulletin 30, "A Survey of Road Materials and Glacial Geology of Maine." (See selected bibliography). The geologic data are very much generalized, and except for the valleys of the St. Johns and Aroostook Rivers, and the lower reaches of the Allagash and Fish Rivers in northern Maine, they are limited to the southern half and eastern part of the State. Particularly noteworthy on this map are the abundant and exceptionally long ice-channel fillings (mapped as eskers). The text of the bulletin describes in considerable detail the known gravel pits of importance.

Little data are available concerning sand and gravel deposits in Vermont. Like other parts of New England the larger valleys contain an abundance of glacial outwash deposits, and terrace sands, in large part of marine origin, are abundant in the Champlain Valley. Brief descriptions appear in scattered reports and papers (see selected bibliography) but no specific program of surficial geologic mapping has yet been carried on in the State. However, it is reported that it is planned to begin such a program in 1955.

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Essex County, areas contiguous to route 1
Granville 15-minute quadrangle
Hingham
Gravel and sand resources of Northfield, Millers Falls, and Bernardston quadrangles
Area around Norwood Pond, Beverly
Gravel and sand deposits adjacent to relocation route 2, West Concord to Ayer
Gravel and sand deposits adjacent to relocation route 3, North Lexington to Chelmsford
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