DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-728 B

Base by U.S. Geological Survey, 1966

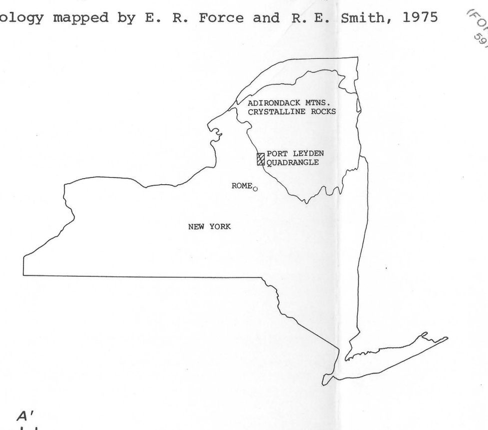
10,000-foot grid based on New York coordinate system, central zone
1000-metre Universal Transverse Mercator grid ticks, zone 18

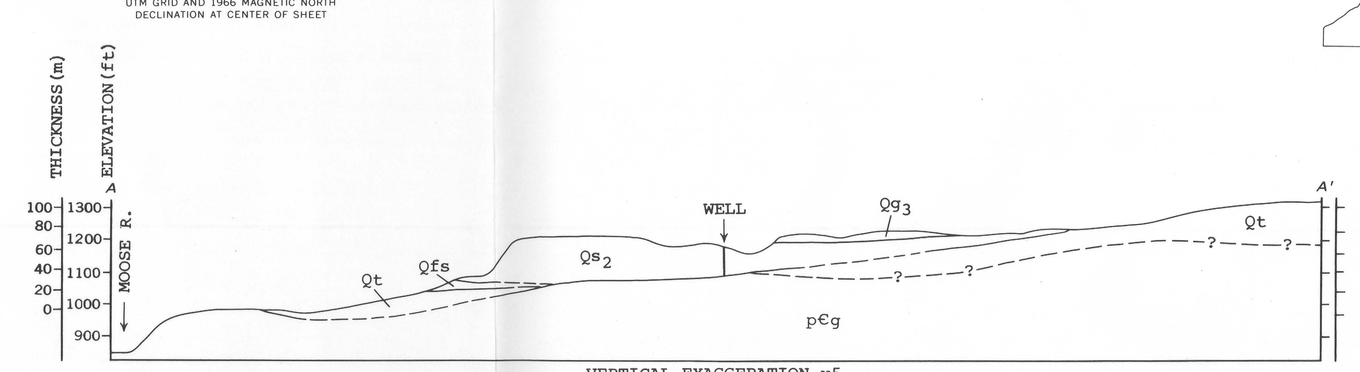
Geology mapped by E. R. Force and R. E. Smith, 1975

SCALE 1:24000

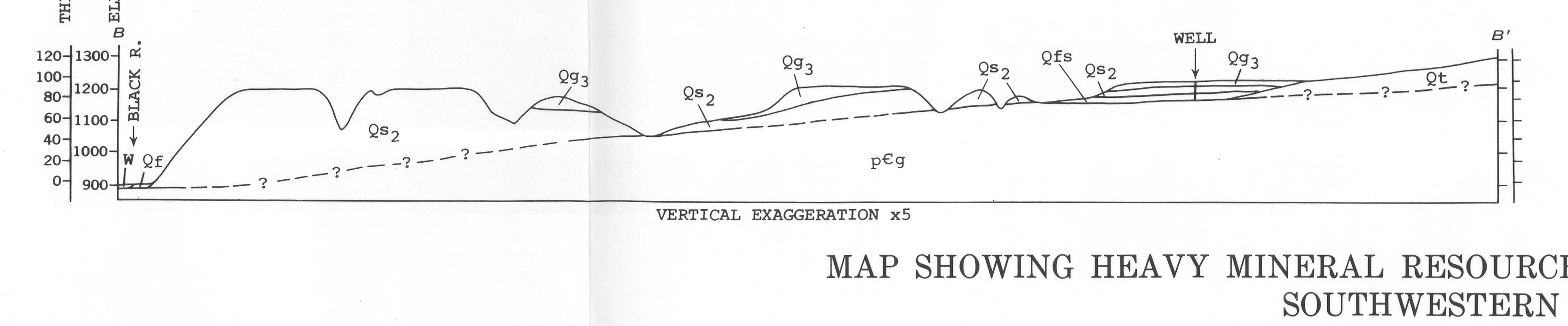
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET





VERTICAL EXAGGERATION x5



VERTICAL EXAGGERATION x5

A prominent feature of the Port Leyden area (see index map) is the flat-topped plateau rising above the east bank of the Black River. This map is the result of a resource study of sands which form much of the plateau. It is concluded that there is a large volume of sand with abundant heavy minerals but that the heavy mineral assemblage is unlike that in presently mined placer deposits.

GENERAL GEOLOGY

Past work - This paper is based on mapping by Howard University 1974 Geology Field Camp (1974) of Port Leyden quadrangle (7 1/2'). Their map shows both bedrock and surficial geology. Samples collected during their mapping and analyzed by the first author indicated a resource potential in the Pleistocene sands and led to the resampling and more detailed surficial mapping of this study.

Waller and Ayer (1975) discuss the ground water geology of an area including Port Leyden quadrangle. Their paper includes well logs, three of which are used in this study. Waller (1976) prepared a surface materials map which shows the distribution of Pleistocene sands in the Black River valley.

Older mapping by Miller (1910) and Buddington (1954) of Port Leyden quadrangle (15') includes the area of this study. Miller concentrated on sedimentary rocks and Buddington emphasized crystalline rocks, but neither subdivided surficial units.

Bedrock geology - The Port Leyden quadrangle is on the southwest flank of the Adirondack Mountains where Precambrian crystalline rocks are overlain by Paleozoic sedimentary rocks. An unconformable contact of Ordovician sedimentary rocks with Precambrian gneiss crosses the quadrangle from northwest to southeast. The gneisses include granitic biotite gneiss, granitic pyroxene and amphibole gneiss, sillimanite-garnet gneiss, calc-silicate rock, and mafic gneiss. Ordovician sedimentary rocks from oldest to youngest are the Black River Group massive limestone, Trenton Group coquinoid limestone, and Utica Shale. Of the Ordovician rocks, only the Black River Group occurs in the part of the quadrangle shown here. Readers interested in bedrock geology should consult the Howard University map.

Glacial history - Continental glaciers covered virtually all of the Adirondack Mountains area during the Pleistocene. Many geomorphic elements within the area can be attributed to discrete stages of glacial retreat (Fairchild, 1912). Deposits associated with glaciation include till, gravel, and the sand which is the topic of this paper.

The large flat-topped plateau east of the Black River is only slightly dissected by streams. Fairchild (1912) said the plateau formed as deltas in glacial lakes. We have found that the plateau is underlain by eastward-thinning wedges of sand and gravel, consistent with Fairchild's model. Many streams have cut down through these wedges to till or bedrock. Waller (1976) and the Howard University map show that both east and west of the plateau, glacial till is the most widespread surficial unit. Till over gneiss is sandy, whereas that over the Ordovician rocks is more clayey.

STRATIGRAPHY OF SURFICIAL UNITS

The upper surface of the gneiss bedrock is irregular with locally steep relief of about 20 m. The surface is glacially polished and smoothed even in the beds of the larger modern streams. Overall, mapping and well data indicate that the gneiss bedrock surface slopes at an average of about 15 m per km to the west. Thus the stratigraphy established principally on steep slopes of the plateaus should be representative.

Till (Qt) is the lowest surficial unit, but it covers only a part of the gneiss bedrock surface. Elsewhere, younger units lie directly on gneiss. The maximum thickness of till is probably 50 m, but thin veneers over bedrock are common.

Gravel occurs at four places in the stratigraphic sequence. The lower gravel (Qg_1) in some areas is partially enclosed by till but in other areas clearly overlies it. The lower gravel is as much as 30 m thick.

Sand (Qs_1) forms a cap on till in the eastern part of the quadrangle. The cap is presumably less than 10 m thick and is believed to be older than other nearby sands (Qs_2) which are at a lower elevation.

Till, the lower gravel, and the lower sand are truncated by an erosional surface with locally steep relief of up to 25 m. Higher stratigraphic units were deposited unconformably on this surface. We have not found any evidence of weathering on the surface. We believe that some erosion followed gravel deposition as the surface is too steep to be a depositional surface on gravel. The surface probably represents dissected moraines and outwash plains.

In a few areas the unit overlying the unconformity (Qfs) is very fine sand, interbedded with silt and clay in thin graded beds.

The next younger unit is fine to very coarse sand (Qs_2) up to 85 m thick. In many places this sand is common. In two places interbedded gravelly sand (Qg_2) is thick enough (10 m) to be shown on the map. In sections along Miller Brook and Moose River the sand coarsens upward from fine sand to granular or gravelly coarse sand.

Gravel (Qg_3) forms a cap in the eastern part of the plateau where it is typically less than 10 m thick. However, the relationship to the upper sand is an interfingering one where the contact is shown as steeply dipping to the east in the valley of Fall Creek. East of this interfingering contact the gravel is up to 35 m thick. In the northeastern part of the quadrangle the gravel is discontinuous and forms long linear ridges (eskers?).

North of the Moose River near Lyonsdale, gravel (Qg_4) is exposed in terraces below three erosional scarps. The terraces and scarps provide a record of the downcutting of Moose River through all the above surficial units.

SAND

Grain size and sorting - We have made no quantitative grain size study of the sands. The sand typically is very well sorted, so well sorted that fresh sand is loose or fluffy. Modal grain sizes range from fine to very coarse sand. Heavy minerals are noticeably finer than light minerals. Pebbles in amounts of less than one percent are present; some of them may have been deposited by the same agent that deposited the sand. Isolated boulders and cobbles (ice-rafted?) are locally common in the sand and are far outside the range of other particle sizes.

Sedimentary structures - Laminations of heavy minerals are characteristic of the sand. In small outcrops, especially of coarser sand, these laminations may not be present. The heavy mineral laminations appear to be roughly planar and parallel, or climbing ripple-drift cross-laminations. In larger outcrops, large low and high angle cross-beds of sand-filling channels can be seen. The latter may be trough cross-beds in three dimensions.

Thickness - The sand reaches a maximum thickness of about 85 m on the western end of the plateau where it overlies bedrock, and pinches out gradually eastward as the bedrock surface rises and as the gravel cap extends progressively down-section. The map includes isopachs of sand based on 1) surface exposures on steep plateau slopes, 2) data from two wells reported by Waller and Ayer (1975), and 3) ten wells reported to us by George Howard, well driller in Boonville, New York.

Heavy mineral contents - For this study, in which the emphasis is economic, heavy minerals were separated in methylene iodide (sp. gr. = 3.3) in order to eliminate the lighter heavy minerals from the concentrate. The amount of heavy mineral is, of course, less than would be recovered with bromoform (sp. gr. = 2.85). For example, sample 13G contains 3.7 percent material denser than methylene iodide but 7.1 percent material denser than bromoform.

Heavy mineral contents within the sand appear to be fairly uniform. Ten random grab samples which do not extend far across bedding have heavy mineral contents ranging from 1.4 to 6.8 percent, averaging 3.3 percent (table 1). The coarsest and most gravelly sands have the lowest heavy mineral contents.

Twelve vertical channel samples varying from 3 to 7.6 m in length were collected from good (or improved) exposures at various places within the sand sequence. One discontinuous sample totaling 61 m in length was also collected; R. Waller contributed discontinuous samples from a test hole 29.6 m deep, 2 km north of Port Leyden quadrangle, in similar sand (well 59-54, Waller, 1976, and Waller and Ayer, 1975). Heavy mineral contents of the channel samples range from 1.8 to 5.6 percent and average 3.7 percent (table 1).

Mineralogy - Quartz and feldspar are the most abundant constituents of the sand. Feldspar content is roughly 25 percent; much of it contains inclusions. Perthitic feldspar is common.

The major heavy mineral grains present are ilmenite, magnetite, pyroxenes, garnet, amphiboles, zircon, epidote, and pyrite. Their relative abundance is shown in table 2. These values were determined by grain counts of five weighed magnetic separates, each split into size fractions where necessary to get volume percentages. Corrections for specific gravity differences have been made where necessary to get weight percentages.

The amount of ilmenite shown in table 2 is based on opaque material in the 0.35 A magnetic fraction. X-ray diffraction of five samples shows it to be mostly ilmenite with variable amounts of hematite (table 3). Petrographic examination of grains of ilmenite from sample 3 shows it to be altered and complexly intergrown with silicate. No exsolution of magnetite or hematite was detected in this sample. Electron microprobe analyses of ilmenite show TiO_2 contents around 50 percent. Five bulk chemical analyses of 0.35 A magnetic fractions containing ilmenite, corrected for the number and composition of granular impurities, suggest that the average TiO_2 content of grains containing ilmenite is about 25 percent.

Petrographic examination shows the fraction caught on a permanent magnet (sample 3) consists mostly of magnetite with ubiquitous exsolution lamellae of ilmenite. The bimodal distribution of lamellae size (20-100 or 0.5-2.0) indicates two generations of lamellar formation. Smaller inclusions of darker spinel, possibly Fe_2TiO_4, are associated with some ilmenite exsolution bodies. Hematite is a minor exsolution product, and in most cases, it is found along cracks in the magnetite indicating that it is a later oxidation product. Electron microprobe analyses of magnetite-ilmenite intergrowths indicate that magnetite contains about 2 percent TiO_2 and 0.2 percent vanadium oxide calculated as V_2O_5; ilmenite contains about 50 percent TiO_2.

Pyroxene includes green clinopyroxene, probably diopside, brown orthopyroxene, and probably other pyroxenes. Amphiboles include hornblende and colorless amphibole. Garnet is red, pink, and colorless.

Zircon is both rounded and euhedral, and is present throughout the size range of other heavy minerals. Monazite was not identified.

Grains present in the fraction denser than bromoform but lighter than methylene iodide in sample 13G, are predominantly hornblende and aggregates which include the same heavy minerals as those discussed above.

Origin of sand - We believe that most of the sand is fluviatile, but some is probably aeolian. Evidence for fluviatile deposition includes the presence of apparently ice-rafted boulders, the change of facies eastward into gravel, the prevalence of channeling and cross-beds (possibly trough cross-beds), and the presence of climbing ripple cross-laminations. Evidence against predominantly aeolian origin (in addition to the above) is the flat surface of the plateau. Evidence against the origin of the sand as a beach deposit is its great thickness and the lack of fossils. Although the good sorting of sand would seem to be evidence of aeolian or beach origin, we believe it is a consequence of the study nature of the till from which it was derived.

In two areas the sequence is upward-coarsening. In some other areas the sequence appears to have several upward-coarsening cycles. Upward-coarsening sequences suggest a regressional origin, which is consistent with Fairchild's (1912) deltaic model.

Except at the base of the section, the lack of fine-grained facies along the western margin of the plateau argues against ponding of the sand against a glacier in the Black River valley. There may have been such a glacier, but its margin was probably not the present edge of the plateau. Alternatively, sand may have continued across the valley and been cut through by the Black River just as it has been cut by Moose River and by several creeks to the south. In either case, the steep west face of the plateau assumed its present form recently.

RESOURCES

Magnitude within the quadrangle - Planimeter measurements of the isopach map indicate that the volume of sand exposed at the surface or present within 10 m below the surface and over 10 m thick is 1.185×10^9 m^3, or roughly 2.4×10^9 tons. Based on average figures above for the heavy mineral content and for abundance of each mineral, the sand contains 3.1×10^7 tons of ilmenite, 2.3×10^6 tons of zircon, and 8.6×10^4 tons of rutile. Possibly garnet, magnetite, sulfide minerals, and (or) feldspar could also be recovered from this sand.

Extent outside of quadrangle - The plateau physiography of the sand in the Port Leyden quadrangle continues about 35 km northward. A surface materials map (Waller, 1976) and well logs (Waller and Ayer, 1975) show that plateaus to the north are indeed partly underlain by thick sand bodies. Probably sand deposits like those described here can be found at many places on the margins of the Adirondack Mountains.

Evaluation - Heavy mineral placer deposits presently mined in the U.S. are fossil beach sands containing intensely weathered material. Intense chemical weathering gives these deposits the advantage of high-TiO_2 ilmenite and a heavy mineral assemblage restricted to the more stable economic minerals.

The sands discussed in this paper are not beach deposits and are not weathered. Heavy mineral contents are as high or higher than presently mined sands, but the heavy mineral suite is not restricted to stable minerals and ilmenite is relatively low in TiO_2. The sands probably could not be mined profitably using conventional technology. However, their volume is so large that technological adaptations may eventually be warranted.

REFERENCES CITED

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EXPLANATION

CORRELATION OF MAP UNITS

Qf — Holocene
Qg4, Qg3, Qg2, Qs2, Qfs, Qs1, Qg1, Qt — Pleistocene
Ob — Ordovician
p€g — Precambrian

DESCRIPTION OF MAP UNITS

W — Water. Units shown extending across water bodies indicate extensive exposure of bedrock

Qf — Floodplain deposits, mostly silt and gravel on low flat surfaces adjacent to Black River and Moose River, and swamp deposits on the plateau

Qg4, Qg3, Qg2, Qg1 — Gravel and gravelly sand which can be gritty, pebbly, or cobbly. Sand matrix is relatively well sorted. Coarse material is as little as 10 percent. Gravel layers and heavy mineral laminations are common

Qs2, Qs1 — Fine to very coarse sand, characteristically well-sorted and containing heavy mineral laminations. It commonly contains a few isolated pebbles, cobbles or boulders, and the unit as mapped includes a few gravelly sand beds. Sand occupies broad areas on plateaus as much as 85 m high, east of Black River. The sand is described in more detail in the text

Qfs — Very fine sand, mostly graded beds of fine sand to silt- to clay-sized material, with scattered boulders and a few color-graded clay beds

Qt — Till, poorly sorted, gravelly to bouldery sand, with little clay matrix where till overlies gneiss. Bedded sand, gravelly sand, and clay interlayered with till are included. The till is exposed in isolated hills, valley bottoms, and the margins of the sand plateau

Ob — Black River Group massive limestone, includes areas where overburden thickness is less than about 2 metres

p€g — Precambrian gneiss, includes areas where overburden thickness is less than about 2 metres

—20— Isopachs of sand (Qs)--Contour interval 10 m (33 ft), dotted where concealed

Contact--Dashed where inferred

Gradational contact

× Logged well

⊙7 Sample locality. Number indicates sample in table

⊗14 Sample from well. Number indicates sample in table

Table 1 - Sample Data

Sample number	Sample type (G, grab; C, channel)	Site (O, outcrop; W, well)	Mode (C, continuous; D, discontinous)	Sample thickness (m)	Elevation range1/ (ft)	Percent (by wt) heavy mineral (sp.gr. >3.3)	Description
1	G	O	--	--	~ 830	2.5	Coarse sand
2	G	O	--	--	~1080	3.0	Coarse sand
3	G	O	--	--	~1210	6.8	Medium sand
4	G	O	--	--	~1000	3.1	Coarse sand
5	G	O	--	--	~1170	2.5	Coarse sand
6	C	O	C	4.9	~1140-1160	5.6	Medium sand with heavy mineral laminations
7	C	O	C		~920-980	3.3	Sand overlying gravelly sand
8A	C	O	D	24	~1120-1200	3.4	Medium sand and overlying gravelly sand
8B	C	O	D	37	~1000-1120	4.1	Interbedded fine and medium sand
9	C	O	C	6.5	~1080-1100	2.8	Fine sand and overlying coarse sand
10	C	O	C	3.7	~890-900	3.2	Medium sand with some heavy mineral laminations
11	G	W	--	--	~1130	3.9	At 25.0 m depth; medium sand (well 53-55, Waller, 1976)
12	C	O	C	2.7	~1000-1010	4.0	Granular medium sand
13C	C	O	C	10.3	~950-980	4.0	Medium sand with heavy mineral laminations
13G	G	O	--	--	~930	3.7	Fine sand
14	G	W	--	--	~1100	1.4	At 29.0 m depth; coarse sand (well 26-28, Waller, 1976)
15	C	O	C	7.6	~1120-1150	3.9	Medium sand and overlying gravelly sand
16C	C	O	C	4.4	~1150-1170	4.8	Medium sand with heavy mineral laminations
16G	G	O	--	--	~1160	2.8	Coarse sand
17	C	O	C	5.2	~1080-1100	5.4	Medium sand with some heavy mineral laminations; underlain by fine sand
18	C	O	D	18.3	~1000-1050	2.8	Coarse sand
19C	C	O	C	6.7	~1070-1090	3.3	Medium sand with some heavy mineral laminations
19G	G	O	--	--	~1080	3.3	Medium sand with heavy mineral laminations
20	C	O	C	4.3	~1040-1060	2.8	Medium sand with some mineral laminations
21A	C	W	D	12.8	~1190-1230	1.8	Not on map; 0-12.8 m depth; medium and coarse sand (well 59-54, Waller and Ayer, 1975)
21B	C	W	D	10.6	~1130-1170	2.1	Not on map; 19.0-29.6 m depth; fine and medium sand (well 59-54, Waller and Ayer, 1975)

1/ One foot = .3048 metre.

Table 2.--Content of heavy mineral concentrates by modal analyses
[percent, by weight; A, abundant; C, common]

Sample number	Percent ilmenite	Percent magnetite	Amphiboles	Orthopyroxene	Garnet	Diopside	Percent zircon	Epidote	Pyrite(?)	Percent rutile
1	34	28	A	A	A	A	1	C	C	>.1
3	34	39	A	A	A	A	2.5	C	C	.2
13G	36	30	A	A	A	A	3.5	C	C	.2
16G	46	24	A	A	A	A	2	C	C	>.1
19G	31	25	A	A	A	A	4.5	C	C	.1

Table 3.--Content of ilmenite magnetic fraction by X-ray diffraction
[M, major; m, minor; t, trace; nd, not detected]

Sample number	1	3	13G	16G	19G
Ilmenite	M	M	M	M	M
Hematite	M	M	m	M	m
Ulvospinel	nd	nd	m	t	nd
Other (mostly hornblende, hypersthene, and garnet; some unknowns)	M	M	M	M	M

MAP SHOWING HEAVY MINERAL RESOURCES IN PLEISTOCENE SAND OF THE PORT LEYDEN QUADRANGLE, SOUTHWESTERN ADIRONDACK MOUNTAINS, NEW YORK

By

Eric R. Force, Bruce R. Lipin, and Robert E. Smith

1976

Interior—Geological Survey, Reston, Virginia—1976

For sale by U.S. Geological Survey, price 50 cents