FIFTH ANNUAL MEETING

FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

in the

PHILADELPHIA AREA

of

SOUTHEASTERN PENNSYLVANIA

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Headquarters: Academy of Natural Sciences of Philadelphia
Nineteenth Street and the Parkway.

All trips leave headquarters at the hours listed below.

Local Committee:

Edward H. Watson, Bryn Mawr College, Chairman
Samuel Gordon, Academy of Natural Sciences, Secretary
Benj. L. Miller, Lehigh University
Frederick Ehrenfeld, University of Pennsylvania
S. Herbert Hamilton, Atlantic Refining Company

Guides and Contributors to the Excursions:

Leaders: Trip A - May 31, 2 P.M. - L. Dryden, Bryn Mawr College
Trip B - May 31, 2 P. M. - S. Gordon, Academy of Natural Sciences
Trip C - June 1, 8 A. M. - E. Watson, Bryn Mawr College
Trip D - June 2, 8 A. M. - B.L.Miller, Lehigh University

Contributors:

F. Bascom, U. S. Geological Survey
J. L. Gillson, Dupont de Nemours and Co.
D. Wyckoff, Bryn Mawr College
E. T. Wherry, University of Pennsylvania
E. J. Armstrong, Bryn Mawr College
A. Dowse, Bryn Mawr College
R. Johnson, Bryn Mawr College

For the Coastal Plain Excursion in New Jersey
(Trip E - June 3, 9 A. M. - guidebook bound separately)

F. Ehrenfeld, University of Pennsylvania
P. J. Storm, University of Pennsylvania
H. B. Kümmel, New Jersey Geological Survey

- CONTENTS -

INTRODUCTION

E. Watson

The area herein referred to is covered by the following publications of the United States Geologiwal Survey: Philadelphia Folio (#162) (Norristown, Germantown, Chester and Philadelphia quadrangles); Coatesville- West Chester Folio (# 223); Trenton Folio (# 167); and the McCalls Ferry-Quarryville Quadrangles (Bull. 799)

Three major geologic and physiographic provinces are in close juxtaposition in the Philadelphia region of southeastern Pennsylvania: (See Fig. 1) (1) the Triassic Lowland to the north, (2) the Piedmont Upland in the center, occupying the greater part of the area under discussion, and (3) the Coastal Plain to the southeast.

GENERAL PHYSIOGRAPHY

L. Dryden

Three belts topographically distinct run across southeastern Pennsylvania in an ENE-WSW direction. From south to north they are: the Coastal Plain, the Piedmont (containing, as a subdivision, the Chester-Whitemarsh valley), and the Triassic Lowland. The last gives way along part of its southern margin to a belt of higher ground, the Mine Ridge Uplift complex.

The Coastal Plain is underlain by unconsolidated rocks of Cretaceous to Pleistocene age. It offers few elevations of more than 200 ft., unless outliers of sands and gravels on the Piedmont region to the northwest be included. The margin of the Coastal Plain just touches Pennsylvania in the Delaware River Valley, so that this province, to be seen well, must be visited in other states.

The Piedmont is a dissected upland, ranging in elevation from near sea-level to some 600-700 ft. Large, more or less flat, areas reach to about 400-500 ft. In general the region shows a rolling topography with gentle, open valleys, but the larger streams, and even the smaller ones near the Fall Line, have cut steep-sided, youthful valleys into the upland, leaving flat-topped divides where the rejuvenated streams have not yet extended their headwaters.

The Chester-Whitemarsh valley is a long, straight lowland floored with limestone. It stands out as a conspicuous feature because it is bordered on the south by the more resistant schists of the Piedmont and on the north by the sharp Cambrian quartzite ridge or older, crystalline rocks. Relief within the valley is very low.

Toward its eastern end the valley is bordered by the Triassic Lowland, and here there is no topographic distinction between these two divisions. The Triassic shales and sandstones are here little more resistant than limestone, and yield open valleys and extensive flat areas. To the west, however, the Triassic gives way to an uplift showing ancient rocks in its core. This Mine Ridge uplift shows rather flat surfaces, at about 900 ft. These have been regarded as peneplain remnants.

GENERAL GEOLOGY

E. Watson

The Crystalline Rocks

The Piedmont Plateau, in the Philadelphia region of southeastern Pennsylvania, may be divided into three parts: (1) the largest part, bounded on the north by Chester Valley and on the south by the Coastal Plain, is made of old, crystalline rocks, highly metamorphosed and abundantly intruded by igneous rocks; (2) the long, narrow trough of Chester Valley, underlain by Paleozoic limestone, and bouded on the north by Cambrian quartzite; and (3) the Mine Ridge Uplift, underlain again by old, crystalline rocks of Pre-Cambrian age. This section is concerned only with the first of the above subdivisions.

The oldest geologic unit of the area is the Baltimore gneiss, a generally acidic rock, highly altered and contorted, and at places extensively injected by pegmatite. Both a sedimentary and an igneous facies of the gneiss are recognized, the former being interpreted as derived from the latter. The gneiss is exposed in a belt of variable width for sixty miles, from the Delaware River at Trenton on the northeast to the neighborhood of Avondale and West Grove on the southwest. It crosses the Schuylkill River just south of Conshohocken.

At a few places (near Chadds Ford and at Vanartsdalen's quarry) the Baltimore gneiss contains lenses of graphitic marble, which are correlated with the Franklin limestone of New Jersey.

Now intrepreted by the United States Geological Survey as unconformably overlying the Baltimore gneiss, and also of pre-Cambrian age, is the Glenarm series of sedimentary rocks. This begins with the Setters quartzite at the base, overlain in turn by the Cockeysville marble and the Wissahickon schist. The most important member in this area is the Wissahickon schist which underlies a broad belt of country generally to the southeast of the Baltimore gneiss block, including the larger part of the city of Philadelphia. It is a mica-rich schist or gneiss with intercalated arkosic gneiss and igneous injections.

Beginning at Conshohocken on the Schuylkill River and extending southwest is a belt of less metamorphosed phyllitic schist. It underlies the South Valley Hills, bounding the Chester Valley on the south, and separates the Paleozoic limestones on the north from the Baltimore gneiss and Wissahickon schist to the south. Farther southwest, in the vicinity of Quarryville, it broadens to underlie a wide belt of country extending into Maryland. This phyllite is called the Octoraro schist in the Philadelphia Folio, and because of its apparently conformable relations to the limestone in the eastern part of the Chester Valley, is therein considered of Ordovician age, and regarded as separated from the older gneiss or schist by faults or unconformitites. Later work in the McCalls Ferry-Quarryville district (Bull. 799) has caused the United States Geological Survey to interpret the Octoraro schist as the retrogressive metamorphic equivalent (diaphthorite) of the Wissahickon schist; its position is explained as the result of overthrusting on the younger Paleozoic rocks (the Martic Overthrust). Two facies of the Wissahickon are thus recognized: (1) the oligoclase-muscovite schist facies (the older Wissahickon), and (2) the Albite-chlorite schist facies (the Octoraro). Still a third view is the contention of some workers that the whole of the Wissahickon schist, as well as the Octoraro, is of Paleozoic age.

About thirty miles southwest of Philadelphia, in the vicinity of Avondale and Doe Run, the Setters quartzite and Cockeysville marble crop out in isolated areas and are apparent-conformably overlain by the Wissahickon schist. Those who consider the Wissahickon pre-Cambrian correlate the quartzite and marble with the Glenarm series near Baltimore; whereas others, because of the general similarity in lithologic sequence and proximity to the rocks of Chester Valley, consider the succession at Avondale to be the base of the Paleozoic, here more metamorphosed. The Setters quartzite varies from a flaggy, arkosic quartzite to a biotite gneiss and is reported to have a maximum thickness of 1000 ft. The Cockeysville is a coarse-grained saccharoidal marble of white or light blue-grey color, characteristically carrying phlogopite. Its thickness is said not to exceed 500 ft. The 1935 Conference will see the Cockeysville marble at the "Poor House quarry", west of West Chester.

Extensive intrusions of igneous rocks occur in the more highly metamorphosed sediments of the Piedmont province. Since they are so abundant here and are not present in rocks of demonstrable Paleozoic age nearby, it has been the general contention that the intrusive rocks are of pre-Cambrian age. Obviously any future work affecting the age of the schists of the Piedmont will also bear on that of the igneous rocks. It is of interest to note that in this region the intrusions are absent from the Octoraro schist (or albite-chlorite facies of the Wissahickon). It should be remembered that these remarks do not refer to the minor intrusions of Triassic diabase which occur throughout the region.

The eruptive sequence and detailed relations of the igneous rocks near Philadelphia are very imperfectly known. In general, in the Piedmont of the Middle Atlantic States, metamorphism and the quantity of igneous intrusions increase toward the east until overlapped by the Coastal Plain cover. Near Philadelphia gabbro is the most abundant eruptive and the greater part of it is restricted to two main areas: (1) a series of irregular bodies, some of large size, within the Baltimore gneiss block, extending from a point near the Schuylkill River 25 miles southwest beyond West Chester; and (2) one large mass, south of the above, intrusive into the Wissahickon schist, extending from near Media southwest beyond Wilmington in Delaware. A great number of gabbroic types are present in these masses, and more than one intrusive epoch occurred. Among the commoner types are: normal gabbro, hypersthene gabbro and norite, quartz gabbros, hornblende gabbros, olivine gabbro and garnetiferous gabbro.

The gabbro of the northern area, within the Baltimore gneiss, has suffered extensive alteration over broad areas. Part of it was originally unusual in that it carries abundant garnet (often 20%) in apparent equilibrium with the other magmatic minerals. This rock was then altered by widespread acidic injections or solutions: some highly quartzose, others of granitic or pegmatitic character. These have produced a series of mixed rocks or migmatites over wide areas. Following this another surgence of the garnetiferous gabbro occurred as fine-grained diabase dikes with chilled borders.

Probably related to the gabbro is a series of ultra-basic intrusions of irregular lenticular shape, often showing a tendency to occur peripherally with respect to the gabbro masses. These are of pyroxenite and peridotite and are usually serpentinized. Following serpentinization at many places acidic solutions have produced rocks rich in anthophyllite, talc, chlorite and other minerals.

Granitic rocks are common throughout the area as smaller intrusions, but only one large mass occurs. This is in the form of a large lens, intrusive into the Wissahickon schist, 15 miles long from northeast to southwest, extending from the Schuylkill river near Manayunk, including the western corner of Philadelphia, and passing under the Coastal Plain cover at the Delaware River between Philadelphia and Chester. At least two and probably three granites are present in the region, but their relations are still obscure. Biotite granites are the most common, of which a coarse porphyritic type, an even-grained type, and an aplitic type are known. Near Lima, west of Media, a cataclastically deformed augite granite is intrusive into serpentine. In general all the granites have exceptionally well-developed flow structures which become pronounced toward the borders of the masses.

The eruptive sequence near Philadelphia is not yet determined. Some of the granites are certainly younger than the gabbro because: (1) extensive "granitization" of the gabbro has occurred at places; and (2) granite cuts serpentine near Lima, and the serpentine is probably related to the gabbro. On the other hand more than one intrusion of gabbro occurred and basic dikes are found at places in the granites.

The Paleozoic Rocks

D. Wyckoff

The Paleozoic rocks of this region from the Chester-Whitemarsh Valley with its enclosing hills (in part).

The Lower Cambrian is represented by the Chickies quartzite with the Hellam conglomerate at its base. The latter is rather variable, including arkosic and schistose layers; its most conspicuous feature, where well exposed, is the abundance of small quartz pebbles, many of them of a peculiar "blue" quartz, undoubtedly derived from the pegmatites of the pre-Cambrian rocks. The Chickies formation is also rather variable, comprising thin-bedded vitreous quartzites and sericitic schists; the latter commonly show "stretched" tourmalines on the bedding planes. The fossil worm-boring, Scolithus linearis, is abundant at some localities. Farther west, on the Mine Ridge anticline, the Chickies is succeeded by the Harpers phyllite and the Antietam quartzite; neither of these has been recognized at the eastern end of the Valley.

The Upper Cambrian and Ordovician sediments are dolomites and limestones, now metamorphosed to marbles. In the Coatesville-West Chester Folio (#223) the following formations are distinguished: the Cambrian formations overlying the quartzites are, in order, the Vintage dolomite, the Kinzers formation (a very thin band of impure micaceous limestone), the Ledger dolomite, and the Elbrook dolomite (including some limestone). East of Downingtown the Elbrook is succeeded by the Conococheague limestone.

Still farther east, the Beekmantown limestone, of Lower Ordovician age, overlies the Conococheague and is exposed in the valley: fossils (Raphistoma - 2 species - Maclurea, Lituites, Cyrtoceras) were formerly collected at a quarry near Henderson Station, about 2½ miles south of Norristown.

Overlying the Beekmantown is the Conestoga limestone: this overlaps to the southeast upon all the other formations from the Conococheague to the Harpers phyllite, and thus in places occupies the full width of the valley. It is a very impure limestone, of variable character. Many of the basal beds are conglomeratic, with large pebbles of white or grey marble in a finer-grained, darker-colored matrix. These are overlain by blue limestones of a shaley or sandy character.

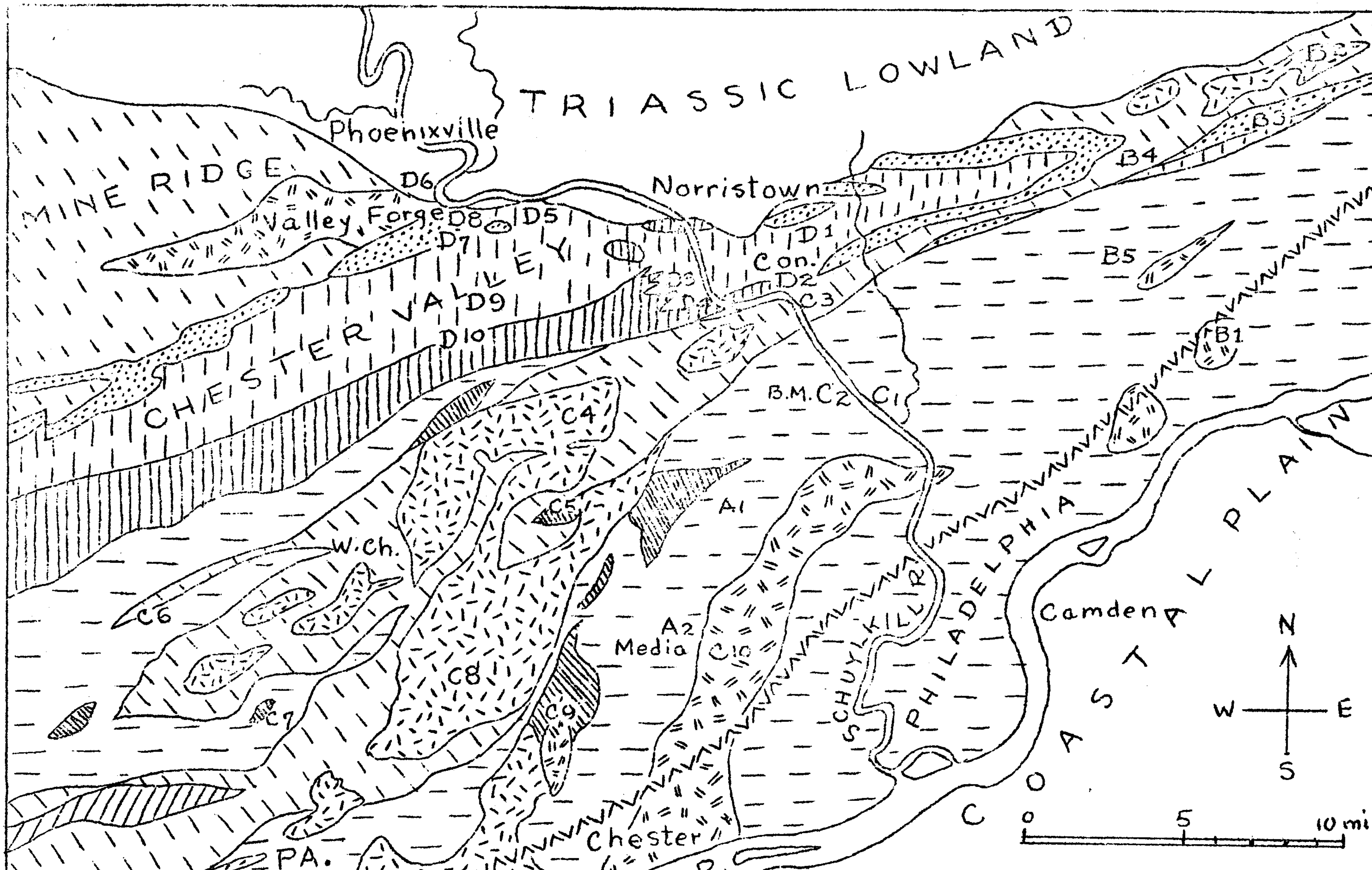


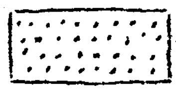
Fig. 1 - Geologic Map of The Piedmont.

D. Wyckoff.

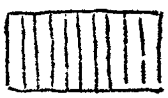
LEGEND (Fig. 1 - Geologic Map of the Piedmont)

Approximate boundary of unconsolidated sediments, mostly sands and gravels, forming a thin cover on the crystalline rocks of the Piedmont. Isolated patches of unconsolidated material are found farther north and west, as shown on map, Fig. 2.

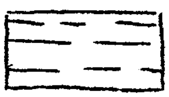
Cambrian and Ordovician limestones and dolomites



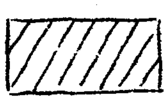
Cambrian quartzites



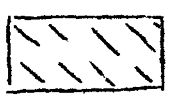
Chlorite-albite schist or phyllite of doubtful age: it may be Ordovician, overlying the limestone, or it may be a diaphthoritic facies of the pre-Cambrian Wissahickon gneiss



Wissahickon gneiss - pre-Cambrian (?)
(Many small intrusive bodies of gabbro and serpentine are not shown)

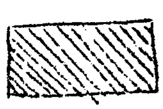


Glenarm series - pre-Cambrian (?)
(Setters quartzite and Cockeysville marble)

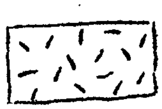


Baltimore gneiss - pre-Cambrian
(Many minor intrusive bodies of gabbro, serpentine and granite, and large areas of intense injection and alteration by igneous magmas, are not separately mapped)

Granite



Pyroxenite and serpentine



Gabbro

Only the larger intrusive bodies are shown, and many different types are lumped together

The structure of the valley, at the extreme northeastern end, is a syncline pitching to the southwest, with the quartzite ridge surrounding it; it is overturned, the quartzite dipping steeply south on both limbs. There is, however, close folding within the syncline, and the limestone is highly contorted. West of the Schuylkill River, the southward dip of the quartzite forming the North Valley Hills persists; but the quartzite disappears from the south side of the valley, replaced by a low line of hills composed of a chlorite-albite phyllite. This formation was considered, in the Philadelphia Folio (#162) to be a series of Ordovician shales, overlying the limestone, and in places (e. g., south of Norristown) closely folded with it. An alternative interpretation is that this phyllite is the diaphthoritic albite-chlorite facies of the pre-Cambrian Wissahickon gneiss, which is here overthrust upon the Paleozoic rocks.

The Triassic Rocks

D. Wyckoff

The Triassic beds in this region are similar to those found in other Triassic basins in the eastern United States. They are nearly horizontal, with a very gentle dip (15°-20°) to the north, and have been repeatedly displaced by small normal faults. The three formations, the Stockton, Lockatong and Brunswick all crop out in bands running southwest-northeast across the Norristown, Germantown, Quakertown and Doylestown sheets, extensive sills of diabase forming distinct ridges in the two latter quadrangles.

The only portion of the Triassic to be visited by the Field Conference is the Stockton (oldest), which is seen near Valley Forge. This is a series of red sandstones and shales, with light colored arkosic or conglomeratic beds near the base. The Stockton seems to overlap upon the older formations of the Piedmont - a contact which is strikingly different from that seen along the northern border of the Triassic, where extensive fanglomerates testify to an active fault-scarp in Triassic times.

Small dikes of diabase are found in many places, cutting not only the Triassic beds but also many of the older formations farther south (none of these are shown on the map, Fig. 1.)

The Coastal Plain Deposits

L. Dryden

The southeastern border of Pennsylvania lies practically at the Fall Line, so that the Coastal Plain is poorly represented in the state. To the east, in New Jersey, there is found a series of unconsolidated sediments, ranging in age from Lower Cretaceous to Miocene, capped by "Pleistocene" sands and gravel. The whole series lies on an erosion surface on ancient rocks. The base of the lowest bed dips some 75 ft. per mile to the east; dips decrease upward in the series, implying more or less continuous tilting during deposition. The oldest beds are found in general farthest west, and the younger lap over them as do shingles on a gently sloping roof.

The Cretaceous, especially Upper Cretaceous, sediments are the best developed. Generally they are glauconitic sands and clays, and show a characteristic green color. This type of sedimentation continued into the Eocene. The Miocene, not widespread or well exposed, is usually finer and without significant amounts of glauconite.

Outliers of the New Jersey sediments have been reported from west of Philadelphia, in Chester Valley and at Media. A consideration of these beds will be taken up on the trips, under stops C-1 and A-2 respectively.

Trip A: 2-6 P. M. Friday, May 31.

Physiographic trip southwest of Philadelphia

Leader: L.Dryden
Assisted by: F.Bascom, A.Dowse, R.Johnson

INTRODUCTION

PENEPLAINS, PARTIAL PENEPLAINS, and BERMS OF THE BLUE RIDGE AND PIEDMONT PROVINCES OF PENNSYLVANIA

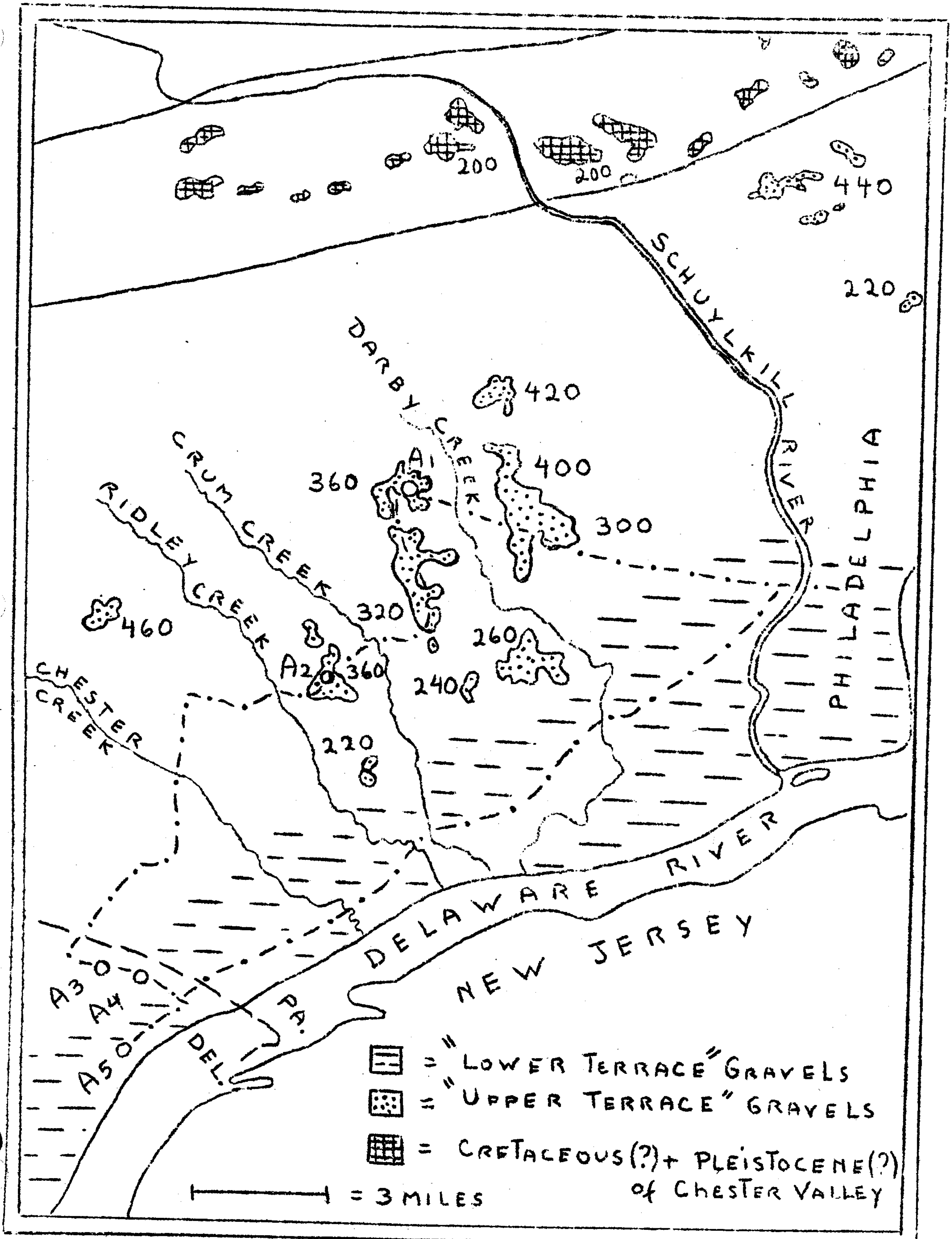
F.Bascom

Fall Zone peneplain	obliterated or conealed	Jurassic and Lower Cretaceous
Kittatinny-Schooley peneplain	1800-1000	Upper Cretaceous
Honeybrook part.penep.	800-740	Tertiary
Chambersburg par.penep.	780-600	Tertiary (Miocene)
Bryn Mawr part.penep.	600-300	Pliocene
Brandywine berm	300-200	Pleistocene
Sunderland berm	180-100	Pleistocene
Wicomico berm	90-60	Pleistocene
Talbot berm	40-20	Pleistocene

In Pennsylvania it is thought that traces may be seen of two peneplains, three partial peneplains and four berms.

The oldest post-Triassic surface is still preserved only where it is buried beneath a comer of Cretaceous, Tertiary, and Quaternary sediments on the coastal plain. This pre-Cretaceous surface emerges along the Fall Zone at an angle which takes it "up in the air" and has either suffered complete obliteration or has undergone strong warping along the entire length of the Fall Line, being represented, in that case, by remnants of the peneplain known as the Kittatinny-Schooley. There seems to have been time enough for the development and obliteration of a pre-Kittatinny-Schooley peneplain and so localized and steep a warping of such linear extent seems more reasonably explained as the intersection of two peneplains.

The Fall Zone peneplain, if it existed, began in Jurassic time, was developing further in Lower Cretaceous time, while the ocean was advancing on the planed crystallines. The Kittatinny-Schooley peneplain, dating, perhaps, from the uplift that closed Lower Cretaceous time, was developing during the remainder of Cretaceous time. Toward the close of Cretaceous time an uplift



SCHUYLKILL RIVER
DARBY CREEK
CRUM CREEK
RIDLEY CREEK
CHESTER CREEK
PHILADELPHIA
DELAWARE RIVER
NEW JERSEY
PA.
DEL.
200
200
440
220
420
400
360
A1
300
320
260
460
A2
360
240
220
A3
A4
A5
= "LOWER TERRACE" GRAVELS
= "UPPER TERRACE" GRAVELS
= CRETACEOUS (?) + PLEISTOCENE (?) of CHESTER VALLEY
= 3 MILES

arched the Kittatinny-Schooley peneplain and erosion was again accelerated and a partial peneplain,the Honeybrook,was developed.

At the beginning of Tertiary time an uplift inaugerated the erosion of the Chambersburg (Harrisburg) peneplain.A considerable remnant of this peneplain is ideally preserved just west of Chambersburg and does not appear at Harrisburg.North and South Chester Valley Hills show remnants of this peneplain.

Immediately east and west of Harrisburg and northwest along the Susquehanna River the interstream areas reach a level of 500 to 520 feet.This is the Bryn Mawr peneplain,a partial peneplain with a thin and sporadic deposit of gravel with sand in pockets and characterized in some places by an ironstone conglomerate.Carvel Lewis named the gravel from a deposit in the Railway cut just south of Bryn Mawr station,and the peneplain takes its name from the gravel.

The next four berms or terraces in Pennsylvania are presumably not of marine origin but were cut in Pleistocene time by the Delaware River.They are narrow and of low altitude and are not limited,as at first sight theyappear to be,to the Pennsylvania side of the river.A difference in material favorable to the preservation of these berms on the west rather than the east side of the river has been a factor in their more conspicuous development of the Pennsylvania side.

PENEPLAINS AND TERRACES OF MARYLAND AND PENNSYLVANIA

L.Dryden

Alternate or conflicting interpretations of peneplains and other erosion surfaces of Maryland and Pennsylvania have been presented by other authors.The conflict is a general one,involving the number of such features,their names,elevations,character, and geologic age.In the following table there is given the classification of Piedmont terraces proposed by Knopf for Baltimore County,Md.,together with that of Cooke for the Coastal Plain terraces.Suggested ages have been added on authority of the person named.An asterisk indicates a name used by Bascom in the table above.

(table on page 10)

The correlation of these features with those found in eastern Pennsylvania is a task which has proved impossible so far.A comparison of the two tables will show that even where the same names are used,different elevations may be given to the same peneplain.It may be,of course,that the same surface has these different elevations,but surely no one would deny the possibility that different erosion surfaces are being included under the same name,further that some of these surfaces are parts of the same peneplain,or even the possibility that some of them should not have the rank of penepalin or terrace.

	Kittatinny* (not recognized)			Miocene (Ashley)	Tertiary (Johnson)
	Manchester (Schooley*)	1020		Cretaceous (Bascom)	Cretaceous (Stose)
	Hampstead (Mine Ridge)	900			
	Arcadia	820			
	Reisterstown (Honeybrook*)	720			
Piedmont	Sweetair (Chambersburg*)	640-600		Miocene (Campbell)	
	Catonsville (Bryn Mawr*)	520-500		Pliocene (Campbell)	
	Howard Park	400			
	Hamilton	300			
	Brandywine*	270		pre-Nebraskan warm period	Pliocene (Wentworth)
	Coharie	215		Aftonian	
Coastal Plain	Sunderland*	170		Yarmouth	Pleistocene (Wentworth)
	Wicomico*	100	Cooke	Sangamon	
	Penholoway	70		Peorian	
	Talbot*	42		1st.Wisc.intgl.	
	Pamlico	25		2nd.Wisc.intgl.	
	Princess Anne	12			

Note: In the Delaware Valley of S.E.Pa.the Pensauken of Campbell and Basoom is reported found from sea-level to 180 ft.and its age is given as pre,or early Pleistocene. Therefore,<u>in elevation</u> (<u>not in age</u>) the Pensauken of these authors is equal to Princess Anne to Sunderland of the above table.

In theory it would seem much easier to correlate the Coastal Plain terraces,especially if one follow Cooke in believing them to be eustatic benches.Cooke,however,has restricted his studies to the region south of Pennsylvania,and has not attempted to find the high-water levels given in the table,in New Jersey.Correlation of the lower terraces is impossible if Campbell and Bascom have correctly described the Pensauken formation of the Delaware Valley.They believe that the gravels were laid down in the flood plain of a large river (immediately removing them from the eustatic class),and that the formation has been subsequently warped,so that the edges of the elongate deposit stand above the the down-warped axis.The highest point on the edge is about 160ft.,and the lowest in the center is below sea-level.On this scheme,all "terraces" in the Philadelphia region below 160ft. are part of the same formation (Pensauken) and owe their exostence to the wandering of the River and cutting of rock terraces on the Pennsylvania side of the valley.(Just what the warping did to them is not plain.Perhaps it caused nothing more than a slightly increased tilt toward the present Delaware valley). Roughly,then,elevation is a criterion of age,but in no such perfedt and progressive way as in the arrangment of Cooke.

DETAILED ITINERARY

L.Dryden

0.0 — Academy of Natural Sciences: turn right (south) 19th on ~~18th~~.St. Go 4 blocks to end of street and turn right on Walnut St.(one way traffic).Go 45 blocks to end of Walnut St.at 63 St.

4.9 (4.9) — Turn right (north) on 63rd.St. Go three bdocks and turn left (west) on Market St.(at elevated)

You are now on route 5. Keep straight through on this route for 6.2 miles more to Broomall. Disregard signs of U.S.13 and U.S.1

9.1 (4.2) — Gravel at elevation of about 310 ft.showing along road

11.1 (2.0) — STOP A-1

BROOMALL? pit in Bryn Mawr gravel. (cars will be seen parked on right side of road just at sign "Intersection route 320".) Stop about 25 minutes.

1/ sand and gravel capping flat surface,top about 360 ft. 2/ composition and structure: a/thickness (past or present) not known,nor contacts at this place; b/ bedded with some current-bedding and perhaps imbridation of pebbles; c/ types,roughly in order of abundance: vein quartz,metamorphic vein quartz,pinkish quartz,quartzite,reddish sandstone (Triassic?),fine-grained sandstone,weathered serpentine (honeycomb rock), Paleozoic chert pebbles (fossiliferous),smoky quartz, Wissihickon (?) schist,decayed quartz-feldspar rock, coarse quartz-mica rock,sugary vein quartz; 3/ size: max.about $1\frac{1}{2}$ ft.; avg.max.about 4-6 inches; avg.about 2-3 inches for pebbles and cobbles; sand where pure shows excellent sorting,with 75% on 1/4 mm.sieve and 21% on the 1/8. 4/ heavy mineral analysis shows a very small suite with about 50% zircon,20% tourmaline, 20% staurolite,and scattered grains of sillimanite, rutile,kyanite.Almost nothing else is present; 5/points that are to be considered in discussion are: relation to other gravels of Philadelphia area;relation of gravel to flat area it covers;origin of gravel and sources of lithologic types;direction of currents; comparison with Cretaceous (?),Triassic,Pleistocene.

Leaving pit,turn immediately left from route 5 onto route 320; continue on this route for 3.2 miles.

11.1 to 14.3 (0.0 to 3.2) For 3.2 miles from Broomall travel will be along a gravel-capped flat spur running toward the Delaware River.Elevation of gravel declines from 360 ft.at Broomall to 320 ft. where route 320 is left.

14.3 (3.2) turn sharp right,then immediately right at "Y" from route 320 onto route 927.Begin descent into valley of Crum Creek,one of three large creeks we shall cross,flowing into Delaware River with almost due south course.

15.0 (017) SLOW - quarry in Wissahickon schist to left of road- note bedding,which is well shown here

15.2 (0.2) STOP STREET : go right.Just beyond is Crum Creek, which is dammed below

16.8 (1.6) junction route 252: go hard left

17.0 (0.2) STOP A-2

MEDIA, pit in Bryn Mawr gravel (?)

1/ elevation top about 330 ft.,distance 4 miles SSW of Broomall; 2/section exposed is a/indurated ledge holding up flat (graveyard) about 1ft.or so thick, b/semi-indurated material with small pebbles, 6-8 ft., c/pure yellowish and brownish sand,few ft. exposed; 3/ironstone contains about 60% ordinary vein quartz (mostly semi-translucent),30% sugary but firm vein quartz,and smaller amounts of rose quartz,friable vein quartz,and fine-grained sandstone (?).Little else is present. 4/ mechanical analysis of sand below shows good sorting, 23% on 1/4 mml.sieve,72% on 1/8 mm.,3% on 1/12 mm.sieve; 5/ heavy mineral analysis shows a small suite with about 60% zircon,10% tourmaline,17% staurolite,7% hornblende,and a few grains of chlorite and rutile. Almost nothing else is present except for 1 grain of epidote.Difference from Broomall suite is in proportions and presence of small amount of hornblende; otherwise suites quite similar. 6/ the origin and relationships of this material will be considered.

Leaving pit continue on in same direction

17.7 (0.7) Traffic light,junction U.S.1; turn right into U.S.1 and continue on this route for 3.3 miles

20.6 (2.9) SLOW- Lima granite quarry at right side of road.Is in small granite mass intruded into serpentine of this area

21.0 (0.4) Lima cross-roads.Turn left (south) off U.S.1 onto route 452. Just after turning,in left distance views of Delaware River valley and N.J.

21.6 (0.6) turn off route 452 onto macadam road,sign "Lenni 1"

22.3 (0.7) turn sharp left,down toward mills

22.5 (0.2) double "Y"- go right and then immediately left,crossing left of two bridges and on up steep hill.

From now until last exposure to be visited the bed-rock will be gabbro and at several places boulders are to be seen in the fields

23.2 (0.7) SLOW - look back to see sharp character of stream valley just crossed. Upland is flat-topped and stream valley "V" shaped.

Just beyond view of Delaware valley to left

23.8 (0.6) turn right past Catholic school

24.3 (0.5) SLOW - view to left shows three surfaces: a/ that on which you are traveling,at about 320 ft.,b/ wide surface from about 180 ft.to 100 ft., c/ surface on which plants in distance are situated,at about 40 to 20 ft. Rather sharp descent,or scarp,in fore-ground

24.4 (0.1) STOP STREET - go straight through on route 61

25.6 (1.2) go left onto route 261

28.1 (2.5) STOP STREET - junction route 491 - keep straight through on route 261

28.7 (0.6) Delaware State line - gabbro in road-cuts

29.2 (0.5) traffic light,-go left off route 261 onto unmarked concrete road. Gabbro near surface in fields just beyond

30.3 to 30.5 (1.1 to 1.3) From flat area descent is made over what seem to be two narrow rock benches.Bed rock can be seen in fields nearby

30.9 (0.4) <u>STOP A-3</u> -view of terraces in Delaware valley (stop for 15 minutes)

Sharp descent is made in foreground from about 240 ft.to flat at about 180 or 160 ft. (small stream valley accentuates the sharpness of descent at this place.) There is gradual descent from 180 ft.to about 100 or 80 ft.,where there is another "scarp",which descends to about 60-40 ft.Factories and refineries in distance are on this lowest sruface

31.5 (0.6) STOP A-4 - gravel overlying gabbro - 25 mins.

1/ at Carpenter station,B.& O.R.R.gravel mapped as Pensauken lies on gabbro at an elevation of about 150 ft.This is the western edge of the gravel cover,and the rock character of the terrace is shown clearly; 2/ weathering of the gabbro has suggested that the gravel was laid down after long exposure of gabbro; shape of contact surface is not known for any distance; appears to decline to north along track 3/ gravel contains considerable variety of types: vein quartz,angular gabbro,sugary frim vein quartz,fine-grained sandstone,rounded gabbro, rose quartz,shale fragments (brown),metamorphic vein quartz,red sugary firm vein quartz, fine-grained dense schistose rock,chert pebbles with crinoid stem joints; 4/ relations of this gravel will be discussed,both in connection with those seen,and with several depsoits not visited.(Good example of exfoliation of gabbro, and coarse character of latter seen in cut.)

Continue on toward Delaware River

32.4 (0.9) gravel on left side of road.Is last of patch seen,here at elevation of about 100 ft.

33.1 (0.7) STOP STREET - junction U.S.13 -GO RIGHT

35.3 (2.2) STOP A-5 -lower scarp and character of lower gravel - stop 20 minutes - Holly Oak,Del.

1/ elevation of gravel about 80 ft.where exposed in road,and is lying on gabbro,as can be seen in stream bed just to south 2/sharp descent to about 40 ft.plainly shown near road.If any agreement with Cooke's scheme,would be with Talbot,42 ft. 3/ types: vein quartz,metamorphic vein quartz,fine-grained sandstone,fine-grained quartzite,"Chickies" type quartzite,chert pebbles, some black,some fossiliferous,ironstone cgl., (like that at Media or coarser),reddish shales with banded color,small amounts of hornblende schist,gabbro,coarse quartz-mica rock,pegmatite.

The lithologic types at Holly Oak differ from those at Broomall in following: 1/not at Broomall: a/black chert,"Media type" cgl.,gabbro,reddish shale; 2/not at Holly Oak: serpentine,quartz-feldspar rock,Wissahickon schist,pink quartz.

To return to Philadelphia turn around and go north on U.S.13

37.5 (2.2) turn left off U.S.13 around beacon

37.7 (0.2) turn right at beacon onto route 891 (not marked just here) For several miles north from here one runs along the base of the same scarp as that seen at Holly Oak (A-5), and occasionally runs up over the scarp onto the next higher level.

In Chester route 891 merges with U.S.13. FOLLOW U.S.13 back to Philadelphia

51.0 (13.3) (approx.) DO NOT TAKE U.S.13 BY-PASS TO LEFT- TURN SHARP RIGHT INTO Main St., thence into Woodland Ave, and on into Philadelphia. Use route map to return to Academy of Natural Sciences.

58.0 (7.0) (approx.) Academy of Natural Sciences

Trip B: 2-6 P. M. Friday, May 31.

Mineralogic and Petrologic Localities north of Philadelphia

Leader: S. Gordon
Assisted by: E. Watson, E. Armstrong

0.0 Academy of Natural Sciences: go eastward on Race Street.
0.4 Left on Broad Street
5.0 Turn R on U.S. 1 (Roosevelt Boulevard)
12.0 Turn R on Rhawn Street
13.3 Turn L at Crispin Street
13.6 STOP B-1

HOLMESBURG. Granite Quarry (S. Gordon)

An elleptically mapped mass of granite, a half mile long, intrusive in Wissahickon gneiss, and partially mantled with Pensauken (Pleistocene) sands and gravels. The granite in thin-section shows quartz, microcline, albite and biotite, with some garnet. The parallel arrangement of flakes of biotite (perhaps a flow structure) produces a foliated appearance trending N 35 E and dipping 45 with respect to the sheeting. An easily effected breakage across the grain has a direction of N 60 W. There are a few vertical joints (a system normal to the flow structure), and these pass soon into quite massive granite. A pegmatite vein with pink microcline, white albite, quartz, and a few garnet crystals, measuring 2" wide, is exposed in the floor of the quarry, striking S 30 E. The age of the granite has not been definitely determined: absence of structural features evincing great age suggests late Ordovician or even a Carboniferous designation as possible.

13.6 Proceed westward on Welsh Road
14.5 (0.9) Turn R just beyond circle
15.3 (0.8) Road turns sharply L
15.8 (0.5) Cross Roosevelt Blvd., continue on Penna. 532
22.0 (6.2) Leave Philadelphia at Somerton
23.4 (1.4) Feasterville, take extreme R hand road, Penna. 213

25.6 (2.2) Lane leads into quarry
STOP B-2

VANARTSDALEN'S QUARRY (S. Gordon)

Opened more than a century ago, but idle for the last 50 years, this quarry is one of the best known nearby mineral localities. The limestone, estimated by Bascom to cover 10 acres and correlated with the pre-Cambrian limestone at Franklin (70 miles to the northeast), was regarded by Kemp as a block caught up in the intrusive gabbro which surrounds it. Kemp found the norite south of the quarry to be quite fresh, and composed of hypersthene, a light green monoclinic pyroxene, yellow-brown hornblende, plagioclase, and magnetite; the rock resembling a dark gneiss. A large mass of gabbro lies at the entrance to the quarry, and there are inclusions of gabbro in the limestone !

The mineralogical interest is due to the extraordinary development of contact minerals in the crystalline calcite: abundant plates of graphite; masses of blue quartz (color has been thought due to inclusions of graphite, rutile, or a solid solution of some titanium compound); blue feldspar (mostly microcline, some oligoclase); wernerite (large greyish masses, and as small crystals in calcite); wollastonite; pyroxene (green grains of coccolite, and cleavable diopside); plates of phlogopite; and grains of pyrrhotite; brown tabular crystals of titanite; occasionally zircon.

25.6 Regress on Penna. 213
27.8 (2.2) Feasterville, continue on Penna. 532
29.3 (1.5) Somerton

STOP B-3

Quarry in Chickies Quartzite (S. Gordon)

The Chickies (Cambrian) formation is here represented by thin-bedded sericite-quartz schists, in which bedding and schistosity coincide. The beds stand on end (dip is to the southeast), and show pronounced creep at the surface. The quartz schist contains orthoclase, and the "stretched" tourmalines so characteristic of this formation. Joints at right angles to the beds produce rhomb-shaped blocks.

29.3 Continue on Penna. 532
29.6 (0.3) Turn R onto Penna. 163

For four miles the road follows a valley mapped as limestone on the basis of several old records. Cambrian quartzite is exposed on the hill to the north (right), and Wissahickon schist to the south of the valley.

32.8 (3.2) Bethayres. Continue on Penna. 63
33.3 (0.5) STOP B-4

Quarry in Baltimore gneiss (E. Armstrong)

The Baltimore gneiss as it appears here is of a number of different types: grey, finely banded; dark, finely banded; light and dark, uniformly banded; and light and dark, irregularly banded; with all intermediate gradations. The banding throughout the greater part of the quarry is more or less uniformly oriented, striking approximately N 65 E and dipping 80 S.

A thin-section from the grey finely-banded gneiss, which is conspicuously exposed in the center of the quarry, shows abundant sericitized feldspar (orthoclase, albite and oligoclase), with granulated borders and bent twinning lamellae. Quartz and mica (both biotite and muscovite) occur in irregular undulating bands between the feldspars. Abundant epidote is associated with the mica bands, as well as apatite, and zircon, with minor amounts of garnet, titanite, magnetite and calcite. Microcline and microcline-perthite are associated with some of the quartz, suggesting secondary origin.

A thin-section from the dark finely-banded rock from near the southern end of the quarry shows the dark mineral to be chiefly hornblende, with considerable amounts of biotite (in part altered to chlorite), and some magnetite. There are subordinate amounts of sodic plagioclase, most of which is thickly filled with small epidote prisms. Epidote also occurs as inclusions in the granulated quartz which makes up the remainder of the slide.

33.3 Regress on Penna. 63
33.8 (0.5) Turn R onto Penna. 163
36.3 (2.5) STOP B-5 Rockledge.

Quarry in Wissahickon Gneiss (S. Gordon)

The Thorough injection of granite into Wissahickon schist may be seen here, and the resulting crumpling and plication, with isolation of feldspar crystals into augen produced by rolling them into mica plates.

36.3 Continue on Penna. 163
37.4 (1.1) Turn R onto Church Road
39.4 (2.0) Turn L onto New Second Street
41.4 (2.0) Turn R onto Godfrey Street (6200 North)
42.4 (1.0) Turn L onto Broad Street into center of city.

Trip C: 8 A.M.-6 P.M. Saturday, June 1.

Crystalline Rocks of the Piedmont, north and west of Philadelphia

Leader: E.Watson
Assisted by: F.Bascom, J.Gillson, D.Wycoff, S.Gordon, E.Armstrong

ITINERARY

0.0 (0.0) Academy of Natural Sciences. Go around Logan Circle and northwest out Fairmount Parkway

0.8 (0.8) Art Museum on left

1.2 (0.4) Schuylkill River on left

1.4 (0.2) Wissahickon schist on right. From here on for 4 miles drive is along east bank of Schuylkill River and almost continuous exposures of Wissahickon schist are seen

3.1 (1.7) Amphibolite exposure (in Wissa.schist)

5.7 (2.6) left on Ridge Ave (422). Cross Wissahickon Creek and 100 ft.beyond regress to left thru cinder track opposite gas station and park (15 minutes)

STOP C-1

WISSAHICKON SCHIST AT WISSAHICKON CREEK (F.Bascom)

Wissahickon Creek, which provides the best section through the gneiss, has also provided a name for the formation, which was formerly Rogers' First and Second Gneiss Belts, and later the Chestnut Hill, Manayunk and Philadelphia mica schist and gneiss of the Second Pennsylvania Geological Survey. The name Wissahickon mica gneiss was first applied in 1909 (U.S. Gologic Folio 162); and still more recently this formation name has been extended to include not only the original Wissahickon mica gneiss (now designated as the oligoclase-mica schist facies) but also the formation previously called the Octoraro schist (now designated as the albite-chlorite schist facies). (U.S.G.S.Bull.799)

The Wissahickon mica gneiss or Wissahickon oligoclase-mica schist extends from the southeastern flanks of Buck Ridge to the vicinity of the Delaware River, where it is concealed beneath Quaternary sands and gravels, and also extends west and south into Maryland.

While exhibiting considerable variation, the gneiss as a whole may be described as a medium-grained banded rock, characterized by abundant mica, both biotite and muscovite, with quartz, orthoclase and plagioclase (oligoclase approaching andesine) as accompanying constituents, and magnetite apatite, zircon, tourmaline, garnets, andalusite, staurolite, kyanite, sillimanite and zoisite as accessory constituents. The distribution of the micaceous constituents, in association with pegmatitization is to a considerable extent responsible for the banding.

As to the origin of the gneiss there has been no question: an inconsiderable but recognized heterogeneity parallel to layers, well-rounded zircons, remarkably numerous alumina-silicate minerals, together with an excess of magnesia over lime as shown by analyses (Folio 162, p.4) all point to a sedimentary origin; that is, to an originally sandy, argillaceous sediment, now highly metamorphosed.

The age of the formation is still a disputed question: the fact that the gneiss is not found in association with the Paleozoic limestones of Chester Valley, and that it is injected by igneous intrusives otherwise confined to recognized pre-Cambrian formations have been reasons, not altogether insurmountable, for placing it with the pre-Cambrina.

Character of the exposure on Wissahickon Creek: Parallel planes of parting, crumpled or gently folded, will be noted as a conspicuous feature. This set of planes characterizes all the exposures on the Creek, exhibiting a rather uniform strike, dip, and pitch. (Strike N 55°E; pitch of the axes of the minor folds 20°, N 5°-10°W). A less conspicuous feature is a faintly discernible parting which cuts the axes of the folds, dipping in general NE. The former, more pronounced, parting probably represents the original bedding of the rock; the latter are secondary cleavage planes.

Regress on Ridge Avenue

5.8 (0.1) right on City Line Avenue

6.1 (0.3) over Schuylkill River

7.1 (1.0) right on Belmont Avenue

8.0 (0.9) left on Levering Mill Road

8.5 (0.5) right on Conshohocken State Road (Pa.23)

8.6 (0.1) weathered granite exposed

8.9 (0.3) right on Rockhill Road. Series of quarries in Wissahickon schist beyond, on both sides of road

9.2 (0.3)

STOP C-2

ROCK HILL QUARRIES, West Manayunk (D. Wyckoff)
(quarry on right, at crusher. Leave cars in line, 15 min)

Here the Wissahickon formation is seen again. It is a general similar to the rock seen at the type locality, but less intricately folded and contorted. The rock here is definitely banded, with well-defined persistent layers which differ in lithology, being more micaceous (in places garnetiferous) or less micaceous; these seem certainly to represent beds, clayey or sandy, of a sedimentary series now highly metamorphosed.

The major structure exposed at the west end of the quarry is the northern limb of a large anticline which pitches to the east. The beds here strike nearly E-W and dip 25 -30 N; they vary in thickness from about 3 in. to nearly 2 ft. and are easily separated along bedding planes, which facilitates quarrying of the material for building stone, flagstone, etc. The rock is rather fine-grained, composed of quartz, oligoclase-andesine, biotite and muscovite, with accessory apatite, magnetite and ziron (the last, when enclosed in biotite, is surrounded by very distinct pleochroic halos). The texture is crystalloblastic, with the mica well oriented during recrystallization.

Toward the east end of the quarry the beds strike about N 70° W, and dip 25° NE. Here the rock is more micaceous, in places highly garnetiferous. Its composition is similar to that of the other type, except that it contains far more mica, both biotite and muscovite, which is developed in larger plates; and in addition to the pink garnets, which may reach ½ in. in diameter, there are in some specimens microscopic needles of sillimanite.

These micaceous layers are minitely crumples, the crests of the small drag folds forming fine ridges or flutings which are seen on all the bedding surfaces, striking about N 50°- 55° E. This line of strike is the same as that of the axis of the major anticlinal fold, which has been traced by measurements in this and neighboring quarries.

At the extreme east end of the quarry there appear, intercalated between the beds of the micaceous rock, two rather thin-1-3 ft.-layers of hornblende schist. This rock is composed of quartz, andesine, abundant green hornblende and a small amount of biotite; large pink garnets occur, especially in the more biotitic layers. In a similar schist found in the quarry immediately across the road, the microscope shows a few thin layers in which the hornblende surrounds relics of colorless augite. These schists might represent beds of graywacke, but more probably they are ancient sills of basic igneous rock: the greater amount of biotite seen in the beds near the hornblende-schist, both above and below, may indicate contact action, though both sills and country rock have been highly altered by later regional metamorphism.

Here are also many small stringers of pegnatite; for the most part these follow along, or between, the less competent micaceous layers of the schist, but in some places cross-cutting dykes can be observed. The pegmatite is composed of grey, granular quartz, a little microcline, abundant oligoclase, with muscovite, biotite, and in places black tourmaline. It is probably a late differentiate from the intrusive mass of granite, which is exposed less than a mile to the southeast.

continue down Rockhill Road

9.6 (0.4) left on Belmont Avenue

9.9 (0.3) cross Schuylkill; continue straight under elevated onto Green Lane

1011 (0.2) town of Manayunk

10.8 (0.7) left on Ridge Ave. (U.S.422)

14.2 (3.4) City limits of Philadelphia

14.5 (0.#) left,at Roxborough Country Club

15.2 (0.7) Wissahickon schist on right

16.2 (1.0) Miquon,turn right along east bank Schuylkill

17.3 (1.1)
STOP C-3

BALTIMORE GNEISS (SOUTH OF SPRING MILL) (E.Armstrong)

At this locality is exposed the Baltimore gneiss,which is believed to be the oldest rock of the region.About one-half mile north of this exposure the gneiss is bounded by the Cream Valley fault,which separates it from the basal Cambrian Chickies quartzite.The contact between the Baltimore gneiss and the Wissahickon schist lies about one-half mile southeast of this outcrop.The approximate width of the gneiss is clearly shown at this locality by the topography.The north and south borders of the prominent ridge across which the Schuylkill River cuts,are here coincident with the north and south borders of the gneiss.

The gneiss appears at the surface in a belt extending from northeast of Trenton to the vicinity of Avondale,varying in width from about a quarter of a mile (north of Chestnut Hill) to at least as much as four miles (at West Chester).Its trend is approximately N 60° E,in accordance with the trend of Appalachian folding in this region.

In the Philadelphia folio the gneiss has been correlated approximately with the pre-Cambrian Stamford gneiss of western New England,the Fordham gneiss of New York,the Baltimore gneiss of Maryland,and the Carolina gneiss of the District of Columbia and Virginia.Because of its similarity to the gneiss in Maryland,both in lithology and in stratigraphic relations,it has been named the Baltimore gneiss.

Although mapped as a single unit,the gneiss exhibits two different facies,as described in the Philadelphia folio: the massive,or granitic facies,often more or less banded, of which this exposure is an example,and the gneissic,or more regularly banded facies,which is exposed both to the north and south of this locality,near the borders of the gneiss. Both to the north and to the south the banding of the gneissic facies has a steep south dip. The gneissic facies exhibits a pseudo-porphyritic character, caused by the presence of more or less lenticular masses of quartz and feldspar around which the micaceous layers are bent. Because of the presence of these rounded quartz and feldspar masses, as well as rounded apatites, and because of the sorting of the mineral constituents, this facies has been interpreted in the Philadelphia Folio as being of sedimentary origin, probably derived by subaerial disintegration from the central granitic core. (Specimens of the gneissic facies will be available for examination)

The outcrop here is in irregularly banded rock. The general trend of the banding forms a fold, slightly overturned toward the north, but the individual bands exhibit intricate folding. Along the axial plane of the main fold of the outcrop is a pegmatitic intrusion. Stringers from this intrusion appear to extend along the banding of the gneiss and in places the darker bands of the gneiss appear to fray out into the pegmatite so that the contact between the intrusive and the intruded rock is in part very indefinite.

A thin section of the intrusive rock shows the chief mineral to be microcline with granulated borders, and some interstitial quartz. Albite is present, both as separate grains, in part sericitized, and in perthitic intergrowth with microcline. Both muscovite and biotite are present, the latter being in part altered to chlorite. Accessories are apatite, zircon, epidote, and magnetite. There are veins of coarsely crystalline quartz, showing liquid cavities distributed in parallel lines. The micas, feldspars and quartz, with the possible exception of the coarser vein-quartz, have been cataclastically deformed. Only a few of the coarser quartz grains show undulose extinction. The optical orientation of all the coarser vein-quartz in the slide is sub-parallel.

A thin section cut from the banded rock where the bands are about 0.5 cm. wide shows the light colored bands to be composed chiefly of quartz and plagioclase of about the composition of calcic oligoclase. The dark bands are composed chiefly of hornblende and biotite with leucoxene, apatite, epidote, and zircon, and minor ampunts of quartz and plagioclase. There is much less evidence of cataclasis in this slide than there is in that from the pegmatite. In places the borders of the grains are granular and some grains, both of the quartz and of the plagioclase, show undulose extinction. The biotite and hornblende are only moderately well oriented parallel to the banding. A number of the biotite laths are somewhat bent and fractured.

A section from a broad band of the dark rock shows about 50% hornblende with only a small amount of biotite. Other constituents are oligoclase, calcite, and quartz. Small grains of zircon and epidote are abundant. The rock is medium-grained granitic with little or no apparent tendency toward a directive texture.

continue N.W.along River Road

17.8 (0.5) Spring Mill,bear left. Abandoned quarry in Chickies quartzite on right

17.9 (0.1) bear left towards Conshohocken

18.1 (0.2) right,then left

18.3 (0.2) enter Conshohocken on Hector St. Conshohocken is on Paleozoic limestone

19.3 (1.0) ~~xx~~ left at Bank on Fayette St. (Butler Pike)

19.4 (0.1) cross Schuylkill R. Hill on left beyond River, of Baltimore gneiss intruded by gabbro,separated from Paleozoic limestone by the Cream Valley fault

20.0 (0.6) bear right at end of ridge,then left onto Matson Ford Rd.(under traffic light)

20.3 (0.3) up small valley in Paleozoic limestone, Wissahickon (Octoraro) forming hill on right, Baltimore gneiss with gabbro forming hill on left

21.4 (1.1) Gulph Mills. Go striaght thru on Matson Ford Rd.,across Gulph Rd.and Montgomery Ave.

22.6 (1.2) Small dike of serpentine exposed on left (in Baltimore gneiss)

23.1 (0.5) Radnor Sta.(P.R.R.); turn left on King-of-Prussia Road

23.6 (0.5) right on U.S.30 (Lancaster Pike), go 100 ft., then left on Ivan Rd.

24.1 (0.5) left into Radnor Quarry (by disposal plant)

24.2 (0.1)

STOP C-4

RADNOR QUARRY - ALTERED GABBRO (E.Watson)
(park cars near crusher,-30 mins.)

Normal to somewhat basic garnetiferous gabbro altered by pegnatite solutions or injections (dominantly quartzose) cut by later garnetiferous diabase.

Quarry is near the eastern border of a large massof gabbro,intruded into Baltimore gneiss,and extending 25 miles westward.

Petrologic sequence: (1) Somewhat basic to normal gabbro with varying amounts of hypersthene first intruded.In some of this original material garnet is abundant and stable.Elsewhere biotite and then garnet (outside) form beautiful reaction structures around augite.Hypersthene commonly alters to chlorite with garnet rims.Examples are:

	center of west face %		east side near entrance %	
labradorite	45	(55 An)	53	(50 An)
garnet	20		1	
augite	24		22	
hypersthene and chlorite	6		10	
biotite	4		13	
magnetite	1		1	

(2) Injected into the normal gabbro was a more feldspathic type,with 60-80% of labradorite and varying amounts of hypersthene.Reaction rims as above.Quartz of replacement origin generally abundant.Two speciments,northwest corner,gave:

	%		%	
labradorite	52	(52 An)	52	(65 An)
garnet	5		accessory	
augite	16		14	
hypersthene	6		6	
biotite	-		accessory	
quartz	26		26	
magnetite	1		2	

(3) Quartz and quartz-rich pegmatites injected,accompanied by crushing and coarsening of constituents.Later, after crushing,abundant hydrothermal development of biotite and garnet,destroying all original mafic minerals. These pegmatites are best seen at the northwest corner of the quarry and along the north face.For the most part they are of basic character,the conspicuous constituents being: blue,quartz,green andesine,red garnet,and brown biotite.At a few places pink and grey-green microcline is developed. The following is typical:

garnet	10%	
andesine	70	(30 An)
quartz	15	
biotite	5	

In reality the sequence (1) (2) (3) above was a continuous one and all gradations appear to exist.It was accompanied by flowage of the whole rock mass,which now has the appearance of a flow gneiss.After cessation of flowage,N-S joints formed,perpendicular to the foliation, in some of which (NE corner) rosettes of biotite formed, in others,quartz.

Lastly (4) resurgence into cold rock as chilled dikes, often accompanied by faulting and shearing (NW corner), of the first rock,type (1).Abundant garnet present,even as small crystals in chilled borders,indicating its magmatic origin.The largest mass in the quarry is in the form of a domed sheet,across the south wall.It is conformable to the foliation of the gabbro and wedges out east and west.Another dike,3-5 ft.wide,cuts the foliation of the gabbro across the center of the quarry:N 65° E,70° N.

Smaller dikes are abundant wlsewhere,some only a fraction of an inch across.

Examination of the sheet in the southeast corner gave:

labradorite (65 An)	55%
garnet	10
augite	22
biotite	10
magnetite	3

regress to Ivan Road and turn left

country between Radnor Quarry and Newton Square (5.5 m.) all underlain by gabbro or altered gabbor

25.0 (0.8) cross Conestoga Road (Pa.301)-continue on Church Rd.

25.8 (0.8) left on Pa.252 (follow 252 to Newton Square)

26.3 (0.5) right

26.5 (012) left

28.0 (1.5) left

29.8 (1.8) Newton Square. Right on West Chester Pike (Pa.5)

31.6 (1.8) sheared and injected pyroxenite on left

32.3 (0.7) left into Castle Rock

32.4 (0.1)

STOP C-5

CASTLE ROCK, ALTERED PYROXENITE (J.Gillson)
(leave cars in line 15 mins.)

Castle Rock is a conspicuous outcrop of an intensely metamorphosed serpentine mass.The serpentine is another one of the altered basic rock intusions of which there are so many in eastern Pennsylvania,and throughout the belt extending from Alabama to Newfoundland.Another will be seen at Brinton' Quarry.

The basic igneous rock,subsequently serpentinized,was intruded into the Baltimre gneiss (which is exposed a short distance to the south of Castle Rock) apparently later than the period of regional metamorphism that gave the gneissic character to that rock.The gneiss,as exposed in the hill next south of Castle Rock,is a quartz-oligoclase-hornblende-biotite rock carrying considerable apatite.

The original character of the serpentine is shown by outcrops at the east base of Castle Rock itself.The rock here is a typical green serpentine,and minerals of the primary basic intrusion are preserved,but can be recognized only by the microscope.These primary minerals are olivine and an orthorhombic pyroxene,and these are largely replaced by the serpentine mineral antigorite.The main mass of Castle Rock is a coarsely crystalline tough rock of greyish color consisting almost entirely of an amphibole known as anthophyllite.Near the lane on the west side of the summit large glistening crystals of bronzite can be seen in the anthophyllite and some are present in all samples studied under the microscope.Few other minerals occurin the rock.In some places microscopic crystals of a green spinel occur,and tiny crystals of magnetite are abundant.The bronzite is slightly altered in places to a secondary mineral of micaceous habit,similar to iddingsite.

Stringers of anthophyllite,chlorite and talc cut the anthophyllite rock in places,and these have a general similarity to those at Brinton's quarry.No feldspar has been identified in these stringers,and the small thickness of the stringers is in contrast to the wide conspicuous mineral zones,paralleling the dikes of albitites in Brinton's quarry.Nevertheless,the manner of recrystallization must have been similar at Castle Rock and in the serpentine at Brinton's quarry.

Castle Rock was obviously recrystallized by contact metamorphism accompanying some intrusion in depth.The mineral antigorite (in the original serpentine) was very unstable under the conditions of metamorphism and it was entirely recrystallized,with loss of water,to the anthophyllite, whereas the pyroxene of the serpentine was stable,and persisted,possibly with some recrystallization as the bronzite of the Castle Rock mass.The entire random orientation of the prismatic grains of the anthophyllite indicate that there was no contemporaneous regional metamorphism during the recrystallization.

The stringers of anthophyllite,chlorite and talc presumably represent channels along which there was a pronounced movement of solutions.Throughout the mass as a whole,these solutions permeated generally,causing the universal recrystallization.

continue around hill and out by same entrance

32.8 (0.4) left onto West Chester Pike again.Between here and West Chester country underlain by Baltimre gneiss heavily intruded by gabbro.

35.4 (2.6) serpentine on left

41.6 (6.2) enter West Chester

42.5 (0.9) bear right,on Pa.5

42.8 (0.3) keep straight,onto route Pa.162

45.0 (3.2) cross Brandywine Creek at Copesville, enter area of Wissahickon schist

45.3 (0.3) Triassic diabase dike

46.4 (1.1) Marshallton (thru on 162)

46.5 (0.1) bear right on 162

47.1 (0.6) Wissahickon schist exposed

47.3 (0.2) down into narrow valley underlain by Cockeysville marble, Wissahickon on left (S), Baltimore gneiss in hill to right (N).

48.7 (1.4) entrance to Poorhouse Quarry. Cars must be turned one by one in order to return towards Marshalltown. Walk right to quarry (N)

STOP C-6

POORHOUSE QUARRY. COCKEYSVILLE MARBLE AND WISSAHICKON SCHIST (E.Watson) (10 mins.)

The Poorhouse quarry exposed the Cockeysville marble, overlain in the upper third of the quarry face by what is interpreted to be Wissahickon schist. The bedding planes are well seen and lie nearly horizontal. The contact between the schist and marble appears conformable, although modified by solution at the top of the marble.

The Cockeysville is typical of that seen elsewhere in the Piedmont: a white saccharoidal marble carrying phlogopite. The Wissahickon is more gniessic than usual, having been modified by pegmatitic injections. The same injections are probably responsible for segregation of pegmatitic minerals found in the limestone: quartz, microcline (var."chesterlite"), muscovite, etc. Occasional small brilliant red euhedral rutile crystals have been found.

At several places within this valley Wissahickon schist is found overlying marble (the normal sequence). The same interpretation is given here although the hill immediately to the north is mapped as Baltimore gneiss. In the latter case they must be separated by a fault.

This valley is only a little more than three miles south of the Paleozoic limestones of Chester Valley, and is considered by many as also of Paleozoic age.

Regress toward Marshallton

52.8 (4.1) right into dirt road, down left (east) bank of Brandywine Creek. Three miles through region of Baltimore gneiss intruded by gabbro.

54.8 (2.0) route Pa.842. From here on for several miles is the site of the Battle of the Brandywine.

57.0 (2.2) right

57.2 (0.2) Lenape. Slow. On left is an exposure of Wissahickon schist with a conformable, sheared pegmatite.

57.7 (0.5) Wissahickon schist exposures

58.2 (0.5) Wissahickon schist exposures

58.4 (0.2) Pocopson

58.5 (0.1) leave Brandywine Creek, turn left on Street Road

60.4 (1.9) park cars in line at cross road, walk 150 yds. to left. (35 minutes)

STOP C-7

BRINTONS QUARRY. SERPENTINE AND ALTERATION VEINS (J. Gillson)

Brinton's Quarry is one of the most fampus of the old mineral collecting localities of southeastern Pennsylvania. The quarry was first opened in 1730 and for many years the serpentine stone was in great demand for building purposes. It was used, for example, in four building of the University of Pennsylvania, the Academy of Natural Sciences, Philadelphia (which has since been refaced), the West Chester State Normal School, and many churches in Philadelphia, Wilmington, and Baltimore. Experience has shown that the stone disintegrates rapidly in the acid-laden atmospheres of cities, and it is no longer used.

The minerals found in the quarry have attracted collectors for over a century. The quarry is the type locality for the mineral jefferisite (a brown altered mica) , and it is noted for the fine crystals of clinochlore (a variety of chlorite) which have been found there. Twenty-five mineral species have been reported as found in the quarry, and many of these can be readily found now in spite of the weathered condition of the walls of the quarryl

The main rock of the quarry is a massive green serpentine, which represents an alteration of an original ultra-basic rock, intruded into the surrounding Wissahickon gneiss. There was a large number of these basic intrusions, not only in this vicinity, but in a belt extending from Alabama to Quebec, and Newfoundland. The serpentine is cut by dikes and stringers of a pegmatite consisting largely of albite and, called on that account, albitite. Bordering these dikes and stringers of albitite are zones of jefferisite, anthophyllite and talc.

These mineral zones paralleling the albitite bodies are the striking and interesting feature of the quarry. On both sides of the albitite, and separating it from the serpentine, are three distinct layers. The jefferisite (vermiculite) layer is made up largely of vermiculite, but contains apatite and chlorite. The micaceous plates are arranged parallel to the walls. The next layer contains anthophyllite,or in some cases tremolite,with or without talc,and then the zone of more or less pure talc,next to the serpentine.

The origin of these mineral zones has attracted the attention of a number of geologists. Similar features have been found in other serpentine bodies in South Africa and North Carolina. The South African geologist,duToit,suggested the idea that the albitites were normal pegmatites which had been desilicated by intrusion into the basic serpentine,and that the zones bordering the albitite had resultied from the reaction between the high silica pegmatite magma,and the basic rock.Mr.Gordon of the Philadelphia Academy enlarged on this conception,and applied it to the interpretation of the interesting mineralization in Brinton's Quarry. Professor Larsen,of Harvard University,proposed an alternative conception of origin, stating that the width of the zones is too great for magmatic reaction,and bears no relation to the thickness of the albitite,as it should;that the mineral assemblages of the reaction zones are those of hydrothermal origin,rather than of magmatic reaction,and concluded that the whole masses are hydrothermal in origin.

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Gordon,Samuel G.	Desilicated Granitic Pegmatites : Proc.Acad. Nat.Sci.of Phila.,Part 1,1921,pp.169-192.
Larsen,E.S.	A Hydrothermal Origin of Corundum and Albitite Bodies : Econ.Geol.,vol.23,pp.398-433.

continue NE on Street Road

61.8 (1.4) Wissahickon schist underlies country in this vicinity

63.6 (1.8) turn right (just past covered bridge) down left bank (E) of Chester Creek

65.2 (1.6) right (Baltimore gneiss and gabbro in this area)

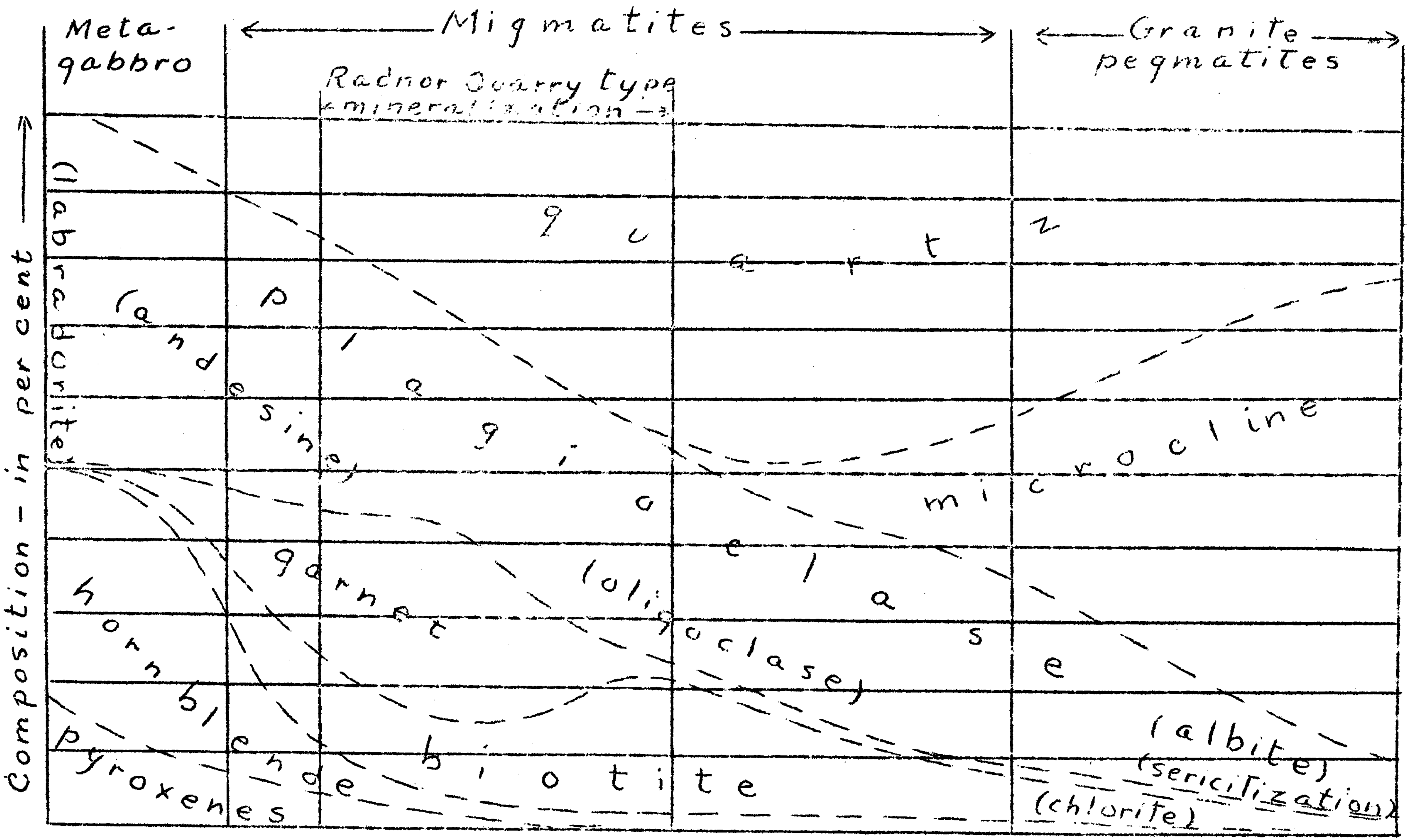
67.2 (2.0) turn left before entering Glen Mills

67.3 (0.1) right into Glen Mills quarry

67.6 (0.3) <u>STOP 8</u> (25 minutes)

GLEN MILLS QUARRY. GRANITIZED GABBRO. (E.Watson)

Granitization of gabbro,with all intermediate gradations,producing mixed rock types (migmatites).



Composite graph (somewhat diagramatic) from 14 measured sections showing progressive granitization of gabbro at Glen Mills Quarry.

The action seen here is genetically related to that seen at Radnor Quarry, but differs in being on a larger scale and in the mineralization proceeding further toward the acidic end of the sequence. It is not a phenomenon limited to this quarry, but covers a wide area in this vicinity. The mineral changes accompanying granitization are shown in the diagram.

The rock has the appearance of a highly banded flow gneiss, the bands varying widely in thickness and composition. Generally the bands are conformable and sub-parallel, but at places become much contorted. The texture is commonly medium to fine grained, with gneissic structure, except in the final pegmatitic injections, which may be quite coarse and undeformed. In some places the mixed rocks of intermediate composition are seen directly related to pegmatite dikes: banded rocks of increasingly darker color arranged symmetrically on both sides of the dike, and grading into dark, ungranitized metagabbro. More commonly the relations of the rock are not so clear: whole sections of the rock show granitization to varying degrees in bands of varying color ("arteritic migmatites").

In places fine-grained dark to grey rocks with a reddish caste are seen, which are found (with a hand lens) to be rich in garnet, and in some cases biotite. In section these are seen to be similar to the mineralization at Radnor and to carry considerable quartz. They represent an early stage in the alteration of the gabbro and differ from the Radnor type in being fine-grained rather than pegmatitic.

Cataclastic structures are present to varying degrees; in general the intermediate migmatites show it most intensely and it becomes progressively less toward the more acidic types. Some of the final pegmatites are quite undeformed and cross-cut the gneissic structure, at places filling cross-joints perpendicular to the foliation.

The following interpretation is offered: The least altered rock of the quarry is a meta-gabbro, largely of hornblende and sodic labradorite. Residual pyroxene (augite and hypersthene) indicates that a normal gabbro was the original rock. Solutions of hydrothermal character penetrated certain zones of the meta-gabbro to produce rocks rich in garnet, biotite, and quartz, diluting the original constituents. This was followed by the introduction of increasingly large quantities of pegmatitic material, probably both in the form of hydrothermal solutions and aqueo-igneous injections. Increasing pressure and heat accompanying these ~~injections~~ additions now made the heterogeneous mass sufficiently plastic to flow, producing a banded gneiss and causing interaction between the various types. The action then lessened and the rock began to cool the final pegmatites cross-cutting the structure or filling contraction joints.

regress out road leading into quarry

67.9 (0.3) turn right at public road

69.0 (1.1) right

69.8 (0.8) left, then immediately right

70.0 (0.2) straight ahead

71.2 (1.2) left on Baltimore Pike (U.S.1) at Wawa Dairies

72.1 (0.9) Lima

72.3 (0.2) leave cars in line on U.S.1, walk left (N) to

STOP C-9 LIMA GRANITE QUARRY (E.Watson) 10 minutes

Crushed pyroxene granite, with inclusions of altered serpentine.

The quarry is near the north end of the small mass of granite southwest of Media (see map, fig.1). The granite is partially surrounded by serpentine, which it intrudes. Diking of the serpentine by granite is well exposed in cuts on the branch line of the Pennsylvania RR which runs across the south end of the granite (especially at Glen Riddle Station, and 1/2 mile east).

The most conspicuous feature of the granite is a pronounced horizontal sheeting which gives at a distance the appearance of a bedded rock. Closer examination shows that the granite is foliated, and microscopic examination reveals it to be highly crushed cataclastically, all the constituents showing strain and their borders being granulated. At the northeast corner of the quarry several dark vertical bands only a few millimeters wide can be seen. These are mylonitized crush zones along which movement has occurred. In the southwest corner there is a sheared pegmatite.

Xenoliths of altered serpentine are sparingly encountered, and on the west wall what appears to be a sheet-like mass of serpentine is included in the granite.

Beside the other minerals in the granite, abundant small wedge-shaped crystals of titanite are a prominent accessory in hand specimen.

Petrographic examination gives:

orthoclase	47%
quartz	24
sodic oligoclase	15
green pyroxene	9
hornblende	2
magnetite	2
titanite	1
apatite - accessory.	

continue east on U.S.1

74.9 (2.6) Media. Wissahickon schist in this vicinity; hills capped by gravel.

78.1 (3.2) left (north) On Pa.420

78.3 (0.2) park cars in line on road, walk left (west) to

STOP C-10 SPRINGFIELD GRANITE QUARRY (E. Watson) 20 minutes

Foliated porphyritic granite with later dikes of aplitic granite and pegmatite.

The quarry is situated within a few hundred feet of the western border of the large granite complex extending from the Schuylkill River to the Delaware River west of Philadelphia. In general, in this area, the foliation of the granite becomes more pronounced toward its contact with the Wissahickon schist, and the foliation of the schist is also more or less parallel to this contact.

The different rock types and their eruptive sequence are as follows:

1. Dominant type - coarse porphyritic granodiorite, rich in biotite. Contains striking Carlsbad twins of microcline (maximum length 4 inches). Strongly foliated, as shown by streaking of biotite and orientation of tabular microcline phenocrysts. Also, basic schlieren, richer in biotite, 1- 2 inches thick and several feet long, are parallel to the foliation. Foliation is N 0° to N 10°W, vertical to 80°W. A pronounced streaking within the foliation plane dips 15°-20° N. (Flow lines ?)

Microscopic examination of the matrix to the larger phenocrysts gives the following results:

oligoclase (15-20 An)	50%
microcline	15
quartz	25
biotite	10
accessories: titanite (abundant)	
epidote (with cores of altered allanite)	
muscovite	
apatite	

This shows quite a basic composition, but at many places the microcline phenocrysts are thickly crowded together, showing a more acidic composition.

Biotite, titanite, and epidote occur together in aggregates and muscovite replaces the biotite. The texture indicates considerable deformation and myrmekite is abundant between microcline and plagioclase.

Examination of the basic schlieren gives the following results:

calcic oligoclase (30 An)	50%
quartz	23
biotite	22
microcline	1
muscovite	2
titanite	1
epidote and allanite	1
apatite - accessory	

The schlieren were possibly formed by flowage during an early stage of crystallization.

2. Fine-grained aplitic granite dikes, light grey in color, generally parallel to the foliation of the porphyritic granodiorite, but cross-cutting at 10° -15° at a few places. Dikes from a few inches to several feet in thickness, average 3 - 12 inches. These are also foliated parallel to the enclosing rock. Sometimes granite #2 is indefinitely bounded against the porphyritic type (especially in S end of quarry).

Examination gives the following results:

microcline	65%
quartz	20
untwinned oligoclase (20An)	10±
biotite	5
apatite - accessory	

These dikes may represent an acidic differentiate of the porphyritic granodiorite.

3. Pegmatites, with coarse pink microcline, albite, quartz, and laths of biotite.
- (a) parallel to the main foliation, often accompanying the aplitic granite, at places somewhat foliated - generally not. Common.
- (b) Rarer. Undeformed pegmatites in joint planes perpendicular to foliation (contraction joints ?)

Probably formed from final granitic liquid at the cessation of flowage.

4. Sheared basic dike, one foot thick, strikes through the center of the quarry parallel to the foliation. It may also be seen in the smaller quarry to the south. Its composition is:

calcic andesine	30%
deep green hornblende	30
biotite	25
quartz	15
accessories: epidote, apatite, zircon.	

This is an altered quartz gabbro.

continue north on Pa.420
(distances from here on are approximate)

79.6 (1.3) right on Pa.320 (Sproul Road)
80.0 (0.4) right on state road
86.4 (6.4) cross West Chester Pike (Pa.5)
87.4 (1.0) bear right onto Lansdowne Ave., crossing Haverford Ave.
88.4 (1.0) bear left on 52nd Street, crossing Lancaster Ave.
88.6 (0.2) right onto Parkside Ave.
89.7 (1.1) left onto Girard Ave.
90.5 (0.8) turn right, far side of bridge over Schuylkill
91.0 (0.5) left on River Drive
91.7 (017) left around Art Museum and right onto Fairmount Pkway
92.5 (0.8) Academy of Natural Sciences at Race and 19th Streets

Trip D: 8 A.M. - 6 P.M. Sunday, June 2.

Lower Paleozoic Formations and their Relations to the pre-Cambrian Rocks.

Leader: B. L. Miller
Assisted by: E. Watson, E. Wherry, L. Dryden

ITINERARY

0.0 (0.0) Academy of Natural Sciences. Go around circle and northwest out the Parkway.

0.8 (0.8) Art Museum on left

1.2 (0.4) Schuylkill River on left

5.5 (4.3) Left on Ridge Ave. (Penna. 422) Follow 422 for 7.9 miles, to Butler Pike

6.2 (1.7) Left, leave Ridge Ave., begin detour. Follow detour signs.

6.9 (0.7) Left, back on Ridge Ave.

7.0 (0.1) Roxborpugh

11.0(4.0) Lafayette Hill, on ridge of Chickies quartzite; Whitemarsh Valley beyond (Paleozoic limestone); Triassic Lowland in the distance.

12.5(1.5) Exposure of thin-bedded limestone

13.4(0.9) Left (S W) on Butler Pike

13.8(0.4) Park cars in line, walk to pits on right.

STOP D-1 (10 minutes)

HARMANVILLE, CRETACEOUS (?) OUTLIERS (L. Dryden)

The clay, sand and gravel pits are at an elevation of about 160-180 ft. and overlie Paleozoic limestone (exposed nearby). The sands and clays below are mapped as Cretaceous (Patapsco) because of resemblance to those beds in Maryland and Delaware. The gravel capping is mapped as Pleistocene. Borings show a depth of some 50 ft. of "Patapsco type". Limestone exposures at higher elevations nearby indicate that the materials lie in "pockets" in limestone. The mapped extent of the "Patapsco" is about ½ mile in all directions from this locality

Difficulty of accepting interpretation is that Cretaceous deposits lie in a supposedly rather recent topographic valley. Is all the topography hereabouts pre-Cretaceous ?

Other intrepretations are that the limestone has been down-faulted, or that solution has "let down" the unconsolidated deposits. Still other possibilities are that the materials are all Pleistocene in age, or even Triassic, which possibly at one time covered all the limestone; "recent" removal of the Triassic would have made possible the cutting of the valley.

Structure and litholcgy: (1) current bedding (?) dips about 25° E, and the material is in wedges and lenses. In trench on road was seen very irregular arrangement with possibly minor squeezing and faulting; (2) of larger material (circular or north pit) fine grained sandstone, sugary and fine quarzite, pinkish vein quartz and coarse "Media" type ironstone are very common. Rare are:"Qhickies type" quarzite, chert (unfossiliferous), bluish vein quartz, weathered serpentine (large), and fine-grained quartz-mica rock. Maximum size 8-10"; average maximum 4-5"; average 1" . Rounding: some large blocks angular; things 6" or more have general retention of shape; 1-2" material rounded best; small material fairly well rounded. Heavy minerals (from sand-pit): small suite, estimated 60% of tourmaline, 10% zircon, 10% rutile, 10% epidote (?); very few other types. Tourmaline could have come from limestone, having crystal form fairly well preserved; other minerals much worn.

Discussion will be directed towards relationships of these beds to other unconsolidated deposits nearby, and to their possible origin.

Continue S W on Butler Pike

14.3 (0.5) Enter Conshohocken on Fayette Street

15.0 (0.7) Left on 3rd Ave (at second church), go two blocks and turn sharp right onto 2nd Ave. go a little beyond and park cars in line at

STOP D-2

CONSHOHOCKEN TRIASSIC DIABASE DIKE (E. Wherry)

Exposed here is a dike of Triassic diabase which has been traced for about 5 miles along its strike. It has a width of about 75 ft. at this place and shows a complex system of joints. The rocks which it cuts (Octoraro schist) has been covered by stone walls and pavement. On the way to the next stop, in West Conshohocken, a smaller exposure of the same dike will be passed, and again at Gulph Mills.

Continue on 2nd Ave.

15.3 (0.1) Left onto Fayette St. again

15.4 (0.1) Schuylkill River

15.6 (0.2) At far side of bridge keep right through traffic light

15.8 (0.2) SLOW - note Triassic dike on left

16.6 (0.8) Left into Valley Forge Cement Plant (at far end of plant beyong bins). Drive up hill keeping right of flotation plant

16.9 (0.3) Turn sharp left and drive to flotation plant, parking cars in line.

STOP D-3
VALLEY FORGE CEMENT CO. W. CONSHCHOCKEN (B.L. Miller)
(30 minutes)

Visit to quarry where the Conestoga limestone is being worked for the manufacture of Portland cement. The stone is a micaceous crystalline limestone. The Conestoga limestone is prevailingly low in $MgCO_3$ although certain beds are too high for the manufacture of Portland cement. There are some beds exposed in the north side of the quarry relatively high in $MgCO_3$. Small isoclinal folds such as are common throughout Chester Valley can be seen along south of incline part way down the quarry.

A good exposure of the decomposed limestone can be seen at east end of quarry.

The flotation plant of the company will be visited. Here, excess silica is removed from the pulverized limestone by froth flotation. This is the only installation of its kind in operation by a cement company.

A brief visit will be made to the kiln room.

Leave plant by the same route as entered.

17.1 (0.2) Right at exit

17.7 (0.6) Acute right turn - CAUTION

18.1 (0.4) Park cars in line near limestone cut

STOP D-4

W. CONSHOHOCKEN. WISSAHICKON (OCTORARO)-PALEOZOIC CONTACT (B. L. Miller) (15 minutes)

Wissahickon (Octoraro) schist in near contact with Conestoga limestone. Certain geologists believe that the Wissahickon schist is of pre-Cambrian age and has been thrust over the Conestoga limestone of Ordovician age by a great thrust, named the "Martic Overthrust", that extends from New Jersey to Alabama. Other geologists believe that the Wissahickon is of Ordovician age and rests conformably on the Conestoga limestone throughout the entire extent of the Chester Valley. The agreement of the strike and dip of the strata in the two formations, the absence of fragmentation and mylonite and the regularity and straight line of contact seen in this region constitute part of the evidence for this alternative view. Other evidence will be considered at later stops.

Continue westward to Gulph Mills (1.1 miles), along north side of Wissahickon schist hill; the highway follows closely the contact of the schist and limestone and crosses it at a few places.

19.2 (1.1) Gulph Mills, turn right (N) onto Penna. 23

19.3 (0.1) Keep left (23)

20.0 (0.7) At schoolhouse note Triassic lowland in distance to right

20.3 (0.3) South Valley Hills (Wissahickon) escarpment on left

21.1 (0.8) Enter Chester Valley. From here to Port Kennedy (4 miles) route is diagonally across Chester Valley floored with Cambrian and Ordovician limestones (prevailingly dolomites). Few exposures.

22.7 (1.6) King of Prussia. Keep straight through on Penna. 23

23.6 (0.9) Chickies quarzite ridge (North Valley Hills) in the distance on left

24.0 (0.4) Right (Penna. 23)

24.8 (0.8) Valley Forge Park begins on left

25.1 (0.3) Park cars in line on Penna 23 beyond cross-roads. Walk 150 yards west to quarry.

STOP D-5

PORT KENNEDY. TRIASSIC-PALEOZOIC UNCONFORMITY
(E. Wherry) (10 minutes)

The quarry wall shows the Ordovician limestone, for which it was worked, its upturned strata bevelled off to an irregular surface, with the lowermost Triassic beds resting on this surface. In pre-Triassic times the limestone had evidently weathered to a series of pinnacles with hollows between them, and the sediments from the Triassic lake filled up the hollows and then covered everything. The material thus deposited was a fine mud, which hardened to a red shale, indicating that the lake at this point was quiescent, with no inflowing streams nearby.

Some years ago a cave was encountered in this quarry, and from it were collected bones of a number of Pleistocene mammals

Continue on Penna 23.

25.2 (0.1) Enter Valley Forge Park

25.4 (0.2) Schuylkill River on right. Triassic Lowland beyond

26.0 (0.6) Valley Forge Memorial Chapel on right

26.8 (0.8) Straight -(23)

27.4 (0.6) Washington Inn, Valley Forge. Continue through on 23.

27.5 (0.1) Up hill onto Triassic beds

28.0 (0.5) Keep right (23) on to road relocation

28.2 (0.2) Drive through cut to far end, turn cars around in private entrance and side road and regress towards Valley Forge

28.6 (0.4) Park cars along road in cut

STOP D-6

TRIASSIC (STOCKTON)FORMATION) W. OF VALLEY FORGE
(E. Wherry) (15 minutes)

Outcrops of the Stockton formation, the basal member of the Triassic. Shows alternation of beds of varying texture, from fine red shale to coarse arkose sandstone and, just west of hill summit, a conglomerate with pebbles up to several inches in diameter. The beds dip northwestward at a small angle, and show minor cross-bedding. Some weather crumbly, others resist weathering well. The streams bringing sediment into the Triassic lake evidently varied markedly in rapidity of flow from time to time, and the coarseness of the sediments varied accordingly.

Toward the southeast end of the cut there is a small normal fault, such as occur frequently in Triassic strata

Continue toward Valley Forge

29.6 (1.0) Washington Inn. Turn right onto Penna. 83, up left (east) bank of Valley Creek

29.9 (0.3) Park cars in line at road cuts

STOP D-7

VALLEY FORGE. CHICKIES QUARTZITE
(E. Watson) (5 minutes)

The gorge of Valley Creek here is in Chickies quarzite, which lies at the base of the Cambrian. This formation makes the North Valley Hills, which extend for 40 miles to the west, beginning at this place. It rests on the pre-Cambrian rocks of the Mine Ridge uplift, which are exposed about 3/4 miles west of here.

The exposure at this point is near the base of the formation and shows a phyllitic member below (north) and quartzite with phyllitic partings above (south). The main jointing of the rock follows the bedding, which strikes perpendicular to the valley and dips 30-40 south. Other joints are prominent. A large quartz vein cuts the quartzite in the center of the outcrop.

The whole gorge is in Chickies quarzite.

Continue on Penna. 83. up east bank of Valley Creek.

30.6 (0.7) Bear left (83) Note mature flat on right

31.1 (0.5) Left. Leave Penna. 83, enter Park

31.4 (0.3) Keep left around redoubt and ascend hill to Observatory

32.2 (0.8) Bear left

32.5 (0.3) Park cars at Observatory (Mt. Joy)

STOP D-8
Observatory VALLEY FORGE PARK (20 minutes)
(E. Watson, L. Dryden)

From the top of the Observatory an excellent view is obtained of the surrounding country, including the Triassic Lowland, Chester Valley, and the North and South Valley Hills The antecedent course of the Schuylkill River can be seen, and the vazious erosion levels of the region. The anomalous position of Valley Creek is also well seen: superimposed over the hard quartzite near the end of the North Valley Hills.

Continue down from Observatory by the same route.

32.7 (0.2) Right

33.5 (0.8) Keep right around redoubt

33.8 (0.3) laave Park, continue straight on Penna. 83

34.9 (1.1) Right on U.S. 202. West out Chester Valley

36.8 (1.9) Bear left (202)

37.0 (0.2) Keep cars parked in line near entrance to quarry

STOP D-9
ORDOVICIAN LIMESTONE WITH INTERBEDDED PHYLLITE
(B. L. Miller) (20 minutes)

At this point 115 ft. of schists are seen interbedded with Conestoga limestone at the south side of large quarry. These schists are so similar to the Wissahickon schists about $\frac{1}{4}$ mile to the south that they have by some been considered as part of this formation in-folded within the valley limestones. The different kinds of limestones on either side of the schists seems to disprove this belief. The Ordovician age of these interbedded schists does not now appear to be disputed.

Continue S W on Penna. 202

37.7 (0.7) Park cars in line, walk back to road cut

STOP D-10

SOUTH VALLEY HILLS, WISSAHICKON (OCTORARO) SCHIST
(B. L. Miller) (10 minutes)

Here the Wissahickon schists of the South Valley Hills are observed. Visitors are asked to compare these schists with the interbedded ones at Howellville to determine whether the similarity or dissimilarity affords any evidence for the reference of the Wissahickon to the Ordovician or to the pre-Cambrian.

The parallelism of the strata as exposed at stops 9 and 10, and the contact of the limestones and schists as shown by the topography should also be noted.

Continue up hill on Penna 202.

38.3 (0.6) Right (W) on U. S. 30 (Lancaster Pike)
Distances from here on only approximate

39.2 (0.5) Paoli

41.0 (1.8) Descend South Valley Hills escarpment. Chester Valley and the ridge of Chickies quartzite beyond. Between this point and stop 11 (Atglen) many exposures of Conestoga limestone can be seen. Note strike as approximately parallel to the trend of the valley and parallel to the contact of the South Valley Hills schists which bound the valley on the south and the Paleozoic limestones. The hills limiting the valley on the north are composed of Cambrian sandstone quartzites and schists. In a number of places numerous specimens of Scolithus linearis are present in these Cambrian sandstones.

50.9 (9.9) Downingtown. Through on U. S. 30

58.1 (7.2) Coatesville
At the far end of Coatesville (two blocks beyond the overpass of the "Lukens Steel Co.") turn left on Penna. 82. Go three blocks and turn right on Penna. 372 to Parkesburg.

63.9 (5.8) Parkesburg. Straight through on Penna. 372

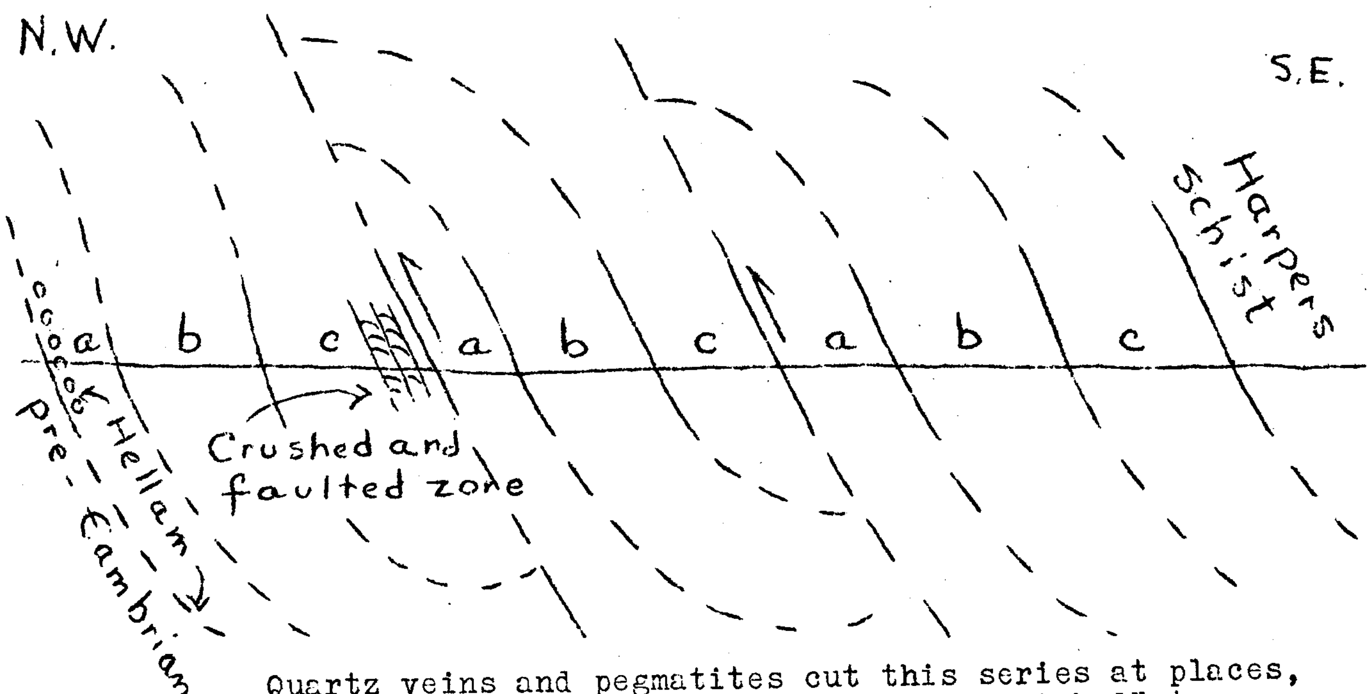
67.2 (3.3) Right onto Penna. 41 into Atglen. Turn left in Atglen. Do not go under P. R. R. About one mile west is a long cut of main line of P. R. R. through the Chickies quartzite.

68.7 (1.5) STOP D-11

ATGLEN. CHICKIES QUARTZITE
(E. Watson - after G. W. Stose) (25 minutes)

This cut affords the best section of the Chickies to be found in the Chester Valley- Mine Ridge area.

It is over 2000 ft. long and exposes what is interpreted as three repetitions of the Chickies formation and part of the overlying Harpers schist. The Chickies is normally about 500 ft. thick in the Coatesville area and is divided into three members by Stose: (a) (lower) pebbly quartzite (Hellam conglomerate member - 50 ft.±) and overlying schist; (b) (middle) thick bedded quartzite; and (c) (top) intercalated thin-bedded quartzite and schist. These members are thought to be repeated by thrust-faulting three times from north to south through the cut, with Harpers schist on the south. They may be represented thus (after Stose - personal communication):



Quartz veins and pegmatites cut this series at places, and some of them carry tourmaline. "Stretched" tourmalines are also abundant at many places, on the cleavage surfaces of the rock.

Continue north through Christiania, bearing left (west) on Penna. 372 towards Green Tree.

73.7 (5.0) Left towards Green Tree (372)

74.7 (1.0) Right at Green Tree. West out Chester Valley again. Penna. 372

79.2 (4.5) Martic Hills ahead in the distance (west)

80.2 (5.5) Quarryville

80.8 (0.6) Right (north) onto U. S. 222

81.6 (0.8) Anticline brings up Antietam schist (lower Cambrian) here

82.6 (1.0) Another anticline showing Antietam schist (here a biotite gneiss !)

83.7 (1.1) New Providence. Turn left (west) on dirt road and through R. R. underpass, taking left fork just beyond.

84.7 (1.0) Park near bridge over P. R. R. Descend into cut.

STOP D-12

WISSAHICKON-CONESTOGA CONTACT. NEW PROVIDENCE

(B. L. Miller) (25 minutes)

One of the few places where the actual contact of Conestoga limestone and Wissahickon schist can be seen. Both limestones and schists have been folded. The exposure is claimed by some geologists to afford evidence that the Wissahickon schist rests conformably upon the Conestoga limestones, pointing to the Ordovician age of the former. Others claim that the Martic Overthrust separates the two and that the Wissahickon is pre-Cambrian. Note the absence of fragmentation as well as the parallelism of strata. The decomposition products of the impure limestones and the schists are so similar that they are distinguished only by careful examination

Regress to New Providence

Return to Philadelphia (Those living in western Pennsylvania may go north on U. S. 222 towards Lancaster).

5th Annual Field Conference of Pennsylvania Geologists

Trip Crossing Coastal Plain of New Jersey, Monday, June 3, 1935

PROGRAM OF ROUTE

Leave Academy of Natural Sciences 9 A.M. headed East on Race Street. Follow Race Street to end over Delaware River Bridge. Toll, 25¢ per car, paid at Camden, New Jersey. To save time, have 25¢ piece in hand. 3 miles.

Note: Lower Race Street is old section of Philadelphia, now "Chinatown". Delaware Bridge is one of the largest suspension bridges in the world. The Delaware River is a tidal river carrying a large international freight commerce. More mineral products are handled through the Port of Philadelphia than any other American port. Crystalline rocks are encountered under relatively thin Pleistocene Deposits on the Pennsylvania side. On New Jersey side of the Bridge are Cretaceous sediments. It has been suggested that the Delaware River marks a profound fault. The City of Philadelphia lies over one of the most marked geological unconformities in the eastern part of the United States; it is a sharp contact between the Piedmont Area and the Coastal Plain.

Speedometer 3 miles: Continue East on Admiral Wilson Bvd. to Crescent Circle. Turn Circle to Route 130 / 25; 5.2 miles.

Note: On left is Cooper River which enters Delaware River at Camden. Here are located many important industries in international business. Central Air Port handles most of the air service of this section.

Speedometer 5.2 miles: Follow Route 130 / 25 to Maple Avenue.

Speedometer 6.6 miles: Turn Right on Maple Avenue, Merchantville.

Note: At 8.2 miles cross bridge over R.R. cut. This is the type locality of "Merchantville Clay" now obscured. Do not Stop.

Speedometer 10.7 miles: Turn Right into side road at Graham Brick Company. Do not cross R. R. track, but turn right and park cars opposite plant. 1 hour stop. Short address by Prof. Ehrenfeld, University of Pennsylvania.

Note: Pits in Merchantville Clay. Upper Cretaceous Age. Many fossils. Be careful not to get under overhanging clay banks as these suddenly fall. Be careful of R. R. track as train due before 11 o'clock. Inspect Kilns where variety of brick are made owing to natural variation of clays burning at Cones #2 to #6.

Leave Brick Plant and return to main road (Franklin Avenue) and Turn Left toward Moorestown.

Note: Speedometer 14 miles. Look right to see "low level Collington Soil". At Speedometer 15.9 miles on coming from under R.R., see Englishtown sand outcrop.

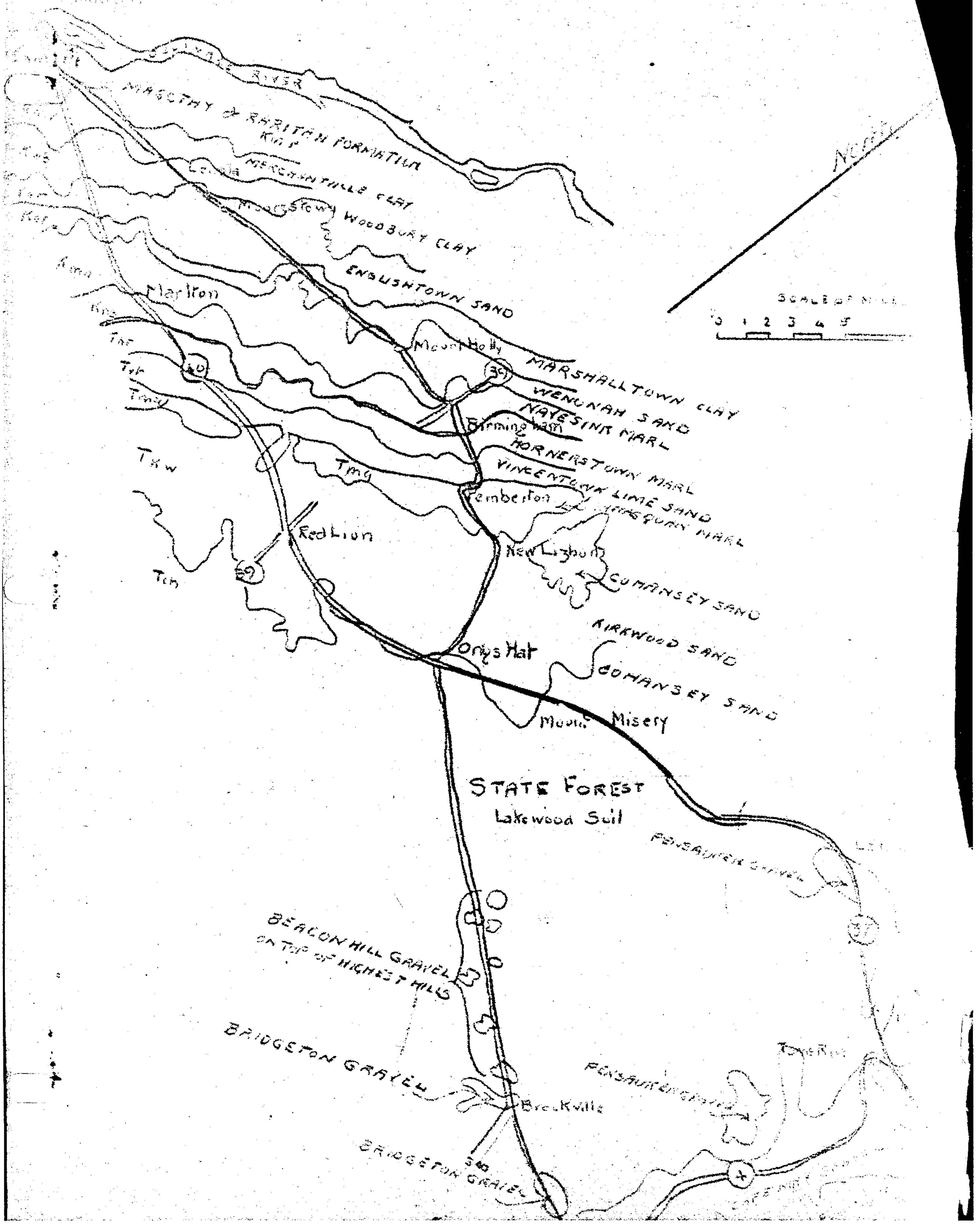
Speedometer 22.3 miles. Turn Right in Mount Holly at Traffic Light.

Speedometer 23 miles: Turn left.

Speedometer 24.1 miles: Park side of road. 10 minute Stop to inspect excavation for molding (foundary sand).

Note: Molding sand is near contact of Upper Cretaceous. The Navesink Marl has probably been reworked in part with Wenonah Sand.

Leave Molding Sand Excavation; continue on 38 to junction with 39. Turn left. Meet Dr. H. B. Kummel, State Geologist of New Jersey. Follow Dr. Kummel on Route 39 to fossil locality. Navesink Marl--top of Cretaceous. Speedometer 29 miles. Turn around on 39. Collect fossils. Leave 12 noon.


RIVER
MAGOTHY & RARITAN FORMATION
MERCHANTVILLE CLAY
WOODBURY CLAY
ENGLISHTOWN SAND
MARSHALLTOWN CLAY
WENONAH SAND
NAVESINK MARL
HORNERSTOWN MARL
VINCENTOWN LIME SAND
MANASQUAN MARL
COHANSEY SAND
KIRKWOOD SAND
COHANSEY SAND
SCALE OF MILES
0 1 2 3 4 5
Marlton
Mount Holly
Birmingham
Pemberton
New Lisbon
Red Lion
Ong's Hat
Mount Misery
Tmg
Tkw
Tch
STATE FOREST
Lakewood Soil
PENSAUKEN GRAVEL
BEACON HILL GRAVEL
ON TOP OF HIGHEST HILL
BRIDGETON GRAVEL
PENSAUKEN GRAVEL
Brookville
BRIDGETON GRAVEL

Speedometer 31 miles. Turn left. Speedometer 32 miles. Turn left at "Birmingham Inn" sign. Continue across R.R. at Birmingham Station to excavations. Park cars as shown to return to Permutit Plant at Birmingham Station. Inspect contact of Cretaceous—Eocene, i.e. Navesink — Hornerstown marls. The Permutit Company works this marl for water softener. Collect fossils 30 minutes. Return over same road to Plant of Permutit Company. Park cars in Company yard. Permutit Company Manager will explain use of marl as water softener (20 minutes).

Return to Main Road 38. Speedometer 36 miles Turn Half Right.

Speedometer 40 miles plus. State Forest. Speedometer 43 miles, S 40 Route.

Stop at Beer sign for Lunch, 30 minutes. Address by Dr. Kummel. Leave at 2.00 P.M. Continue on S 40 Route.

Speedometer 50 miles. Stop 10 minutes to examine gravel and note leached character of the soil (Lakewood soil).

Speedometer 53 miles. Note "High Pine Barrens". No stop.

Speedometer 53 miles. Stop 10 minutes, examine gravel. 5 minute address by Dr. Ehrenfeld.

Note: Contact of "Pine Barrens" approximately 100' A. T. and "High Plains" approximately 200' A. T. Sharp distinction in vegetation from tall pines to scrub pines and oaks. This is one of major physiographic features of this part of Coastal Plain. Swamps are of Pleistocene derivation.

Speedometer 59 miles. Take Left Fork. No Stop.

Speedometer 66 miles. Turn Left Route 4 Cape May Formation. At or near Forked River, 5-minute address by Dr. Dummel. Watch for Stop.

Speedometer 79 miles. See cranberry bogs on left.

Speedometer 82 miles. Turn Right. Toms River; Note Tidal River and salt Marsh.

Speedometer 87 miles. Cross Barnegat Bay.
Note: Here is Outer Barrier Beach.

Speedometer 90 miles. Atlantic Ocean. All Stop. 30-minutes to see strand, [illegible]
6 P.M. Return to far side of Barnegat Bay. Park in yard of Deutcher Cafe. Fresh Salt Ocean Dinner, 75¢.

7.30 P.M. Say Good Night. Disband.

Return to Philadelphia by 37 Route through Lakehurst. (Osprey nest in dead tree on Right of road just beyond Toms River Junction.) Take 40 Route to Camden and Philadelphia. 62 miles. 2 hours' run.