

Preliminary Program

NEW YORK STATE GEOLOGICAL ASSOCIATION
16th Annual Meeting, Catskill, N. Y., April 26-27, 1940.

Thursday, April 25.

8 P. M. Preliminary conference at High School for all who can come.

Friday, April 26.

8 A. M. Trip A. Those compelled to arrive late will have Boy Scout guidance to overtake party. Birdseye of physiography, reconnaissance of strata, Lower Ordovician to Devonian. Walking optional.*
12 M. Box lunches delivered fresh to rendezvous. Those who wish, return to town for lunch, 1 mile.

12:30 P. M. Trip B. Continue up through formations, Lower to Upper Devonian, to mountain top. Physiography; piracy. Walking optional.

7 P. M. Annual dinner, talks, social; at High School

Saturday, April 27.

8 A. M. Trip C. More intimate and leisurely collecting from Ordovician to Lower Devonian, fossils, folds, faults, in Austin's Glen; type localities. Two miles walking on good trails.* Use Camera
12 M. Box lunches as before, or eat at Margraf's (parking place for trip) or in town, 3 miles.

12:30 P. M. Trip D. Type localities and fossils, structure, physiography, south from Catskill. Very little walking. Parties may leave as necessary for return home. Camera desirable.

On Saturday, small special parties will operate separately:

8 A. M. Trip E. to see complicated structure (nested folds, unconformity); 5 miles of severe walking in rocky jungle; carry lunch.

8 A. M. Trip G. to cement plants and quarries; carry lunch*.

12:30 P. M. Trip F. auto caravan, 100 mile drive to Fly Brook local glacier (40 miles), where groups going west may leave; peneplains,

1:00 P. M. Trip H. to east side of Hudson; Becraft Mt. Burden mines, older formations (graptolites), glacial; bridge toll 50¢ each way.

*All trips require use of cars; walking is superadded. So far as possible those without cars will be billeted in other's cars. Non-members are advised not to count on this assistance.

If demand warrants, some trips may be repeated on Sunday, or a special trip (I) be taken for Devonian facies transitions (50 miles).

Catskill and Kaaterskill topo maps needed; will be on sale.

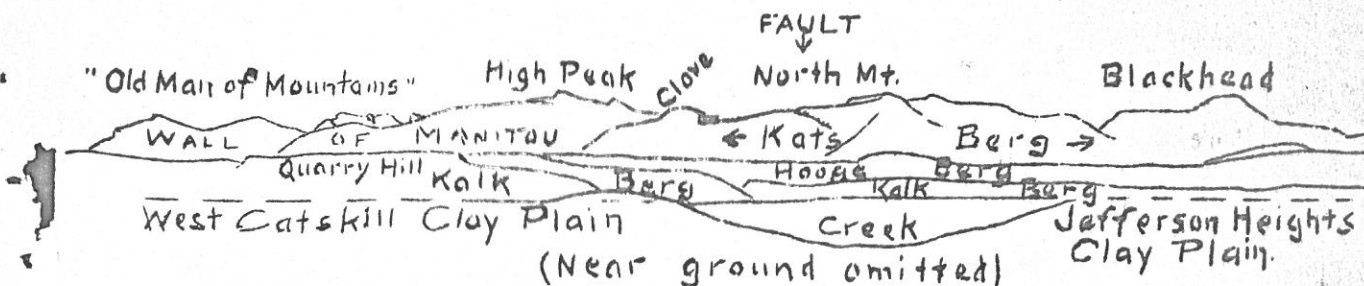
REGISTRATION FEE 25¢; pay on arrival, receive tags, field guides. Dinner tickets \$1, including social. Final announcements later.

Trip A. Friday morning, April 26.

Catskill topo map. ROAD page 1, Physiography; page 2, formation 1 to 7 (Becraft); page 4, upper half; page 5, Lake Albany and Rip Van Winkle Bridge. See route map on next page. All exposures to beyond 23-A junction are Normanskill graywacke, early Ordovician (Chazy?).

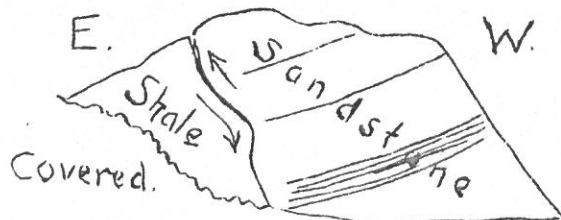
8:10 A.M. First section leaves Catskill High School parking area. Follow leader to Rip Van Winkle Bridge; park behind Administration Building. Rock cut (1) in isoclinally compressed upper Normanskill beds. View of "inner gorge" of Hudson, alluvial deposits of the river (consult also back of printed letter-sheets). Hark for whistle;

8:40 A.M. Return to intersection of 305; park at south end, (2), face mountains, shut off motor, open windows and listen to megaphone, Kats Berg escarpment on skyline, Hooge Berg scarp next below, Kalk Berg scarp, breached by Keaters Kill, nearer; Lake Albany clay-plain, bisected by Cats Kill, in foreground. Hudson Valley peneplane on the crests of the ridges of upturned or folded hard rocks. See diagram:



Read page 1. Take plenty of time to understand this view. See p. 4.

9:00 A.M. Follow leader thru village, cross "Uncle Sam Bridge" over Catskill, then slow to see (a) "Uncle Sam" Wilson's house, (b) Post quarry (3), eurypterid locality, upedged thrust (see bottom of page 4 and diagram:), and (c) Broome Street high level meander loop (4), in passing.



Cross Lake Albany clay-plain (5) and park in Turtle Pond quarry (6). Upturned Manlius, Coeymans and Kalkberg limestones; fossils. Rest of morning on Quarry Hill; see next page for map, sections.

10:00 A.M. Follow leader, on foot, to Holdridge's quarry (7), Becraft limestone, rain

runlets, synclinal hill, coquinite; and north, 1/4 mile in all, to the north point of this limestone ridge. (The more vigorous will wish to explore the stratigraphy down the north end to the great unconformity, etc.) Return by road on east to cars or stay to picnic. A good spring on northwest; do NOT drink on northeast side near highway.

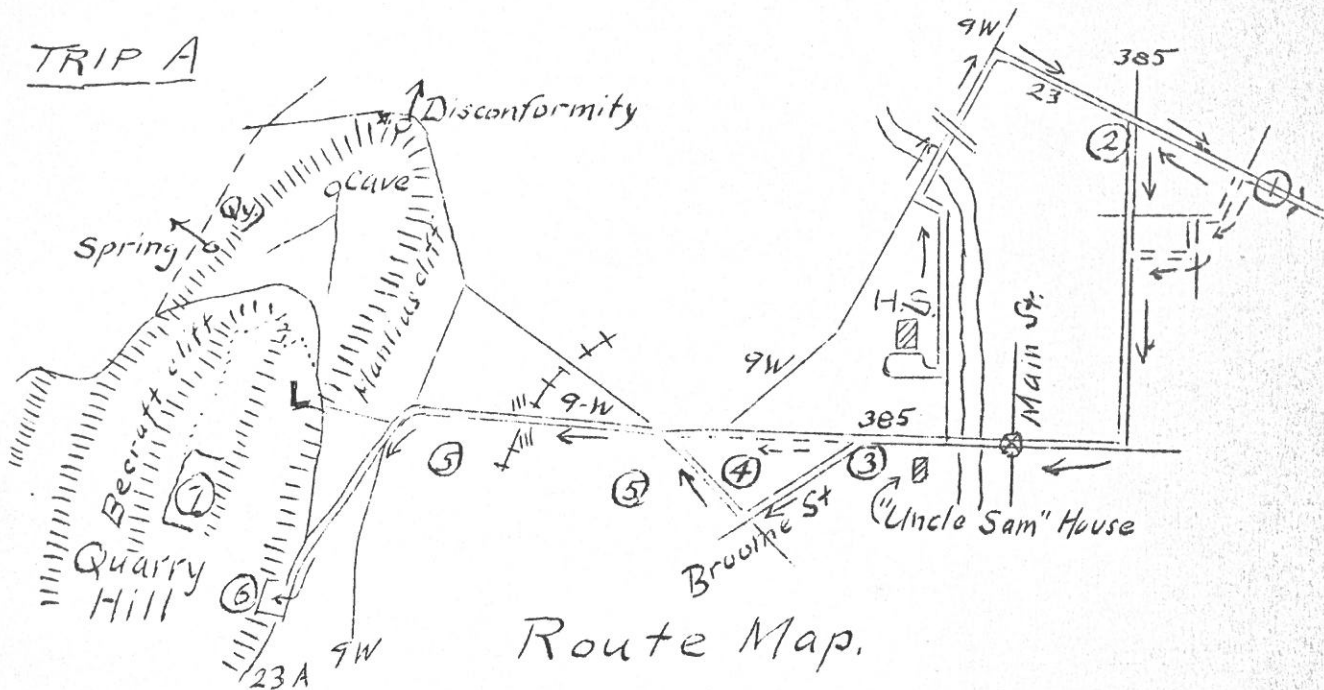
8:30 A.M. Second section leaves, joins first section at (2); at 9:00 A.M. goes on to (1), leaving at 9:25 A.M. for Turtle Pond quarry.

11:45 A.M. All who return to village for lunch should leave the quarry, (be prepared to report at School for afternoon trip at 12:30).

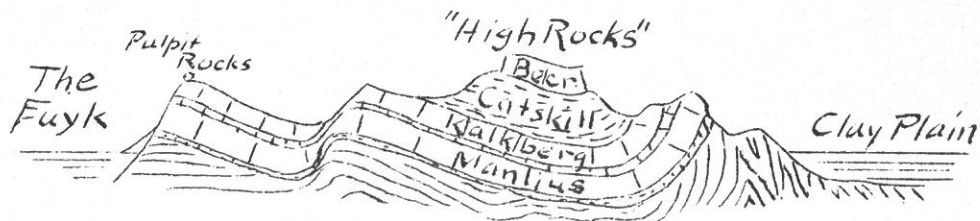
12:00 M. Picnickers claim box lunches at point marked L on map.

12:45 P.M. Picnickers be ready at cars to join trip B.

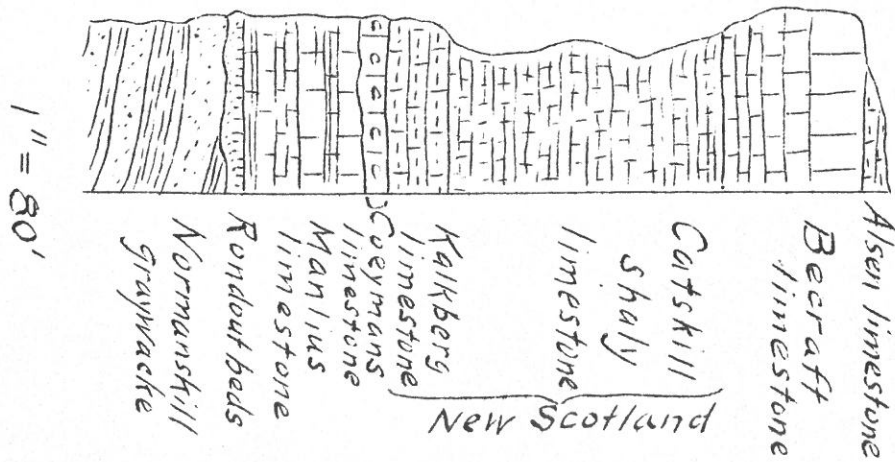
TRIP A



Route Map.



General Cross-section of Quarry Hill



Columnar Section

Trip B. Friday afternoon, April 26.

Catskill and Kaaterskill topo maps. READ page 1, Physiography; page 2, Strata; page 4 and page 5. See route map on next page.

12:30 P.M. Cars leave High School by rear exit, out 285, 9W, 23A. High level meander (4) of Cats Kill on left near top of hill. Cross Lake Albany plain (5). Normanskill beds vertical on right after leaving 9-W. Upturned Manlius to Catskill shaly in Turtle Pond quarry on right (6), with fossils. REMAIN IN CARS AND IN LINE.

12:45 P.M. All leave Turtle Pond quarry. Bed slickensides on upturned Manlius; curve west across overlying limestones to Alsen and Glenerie beds in heart of syncline, soon overlain on left by Esopus. Park by roadside at Ellsworth Jones's (C). Glenerie chert disconformable on Alsen "yellow" limestone; phosphate pebbles at contact. Fossils in these, also Leptocoelia in Esopus shale pit back of house.

1:15 P.M. Continue to Town Toolhouse (9); park. Anticline in Onondaga over Saugerties' limestone; Fossiliferous; cleavage in Saugerties; 1:45 P.M. Continue, through diagonal syncline to Webber's Bridge (10); park on bridge. Type exposure Bakoven shale, on Onondaga, under bridge; disconformity. Monoclinial shale valley, Lake Albany clay and "bake-ovens," monoclinial Hooge Berg ridge (Mount Marion beds) at west.

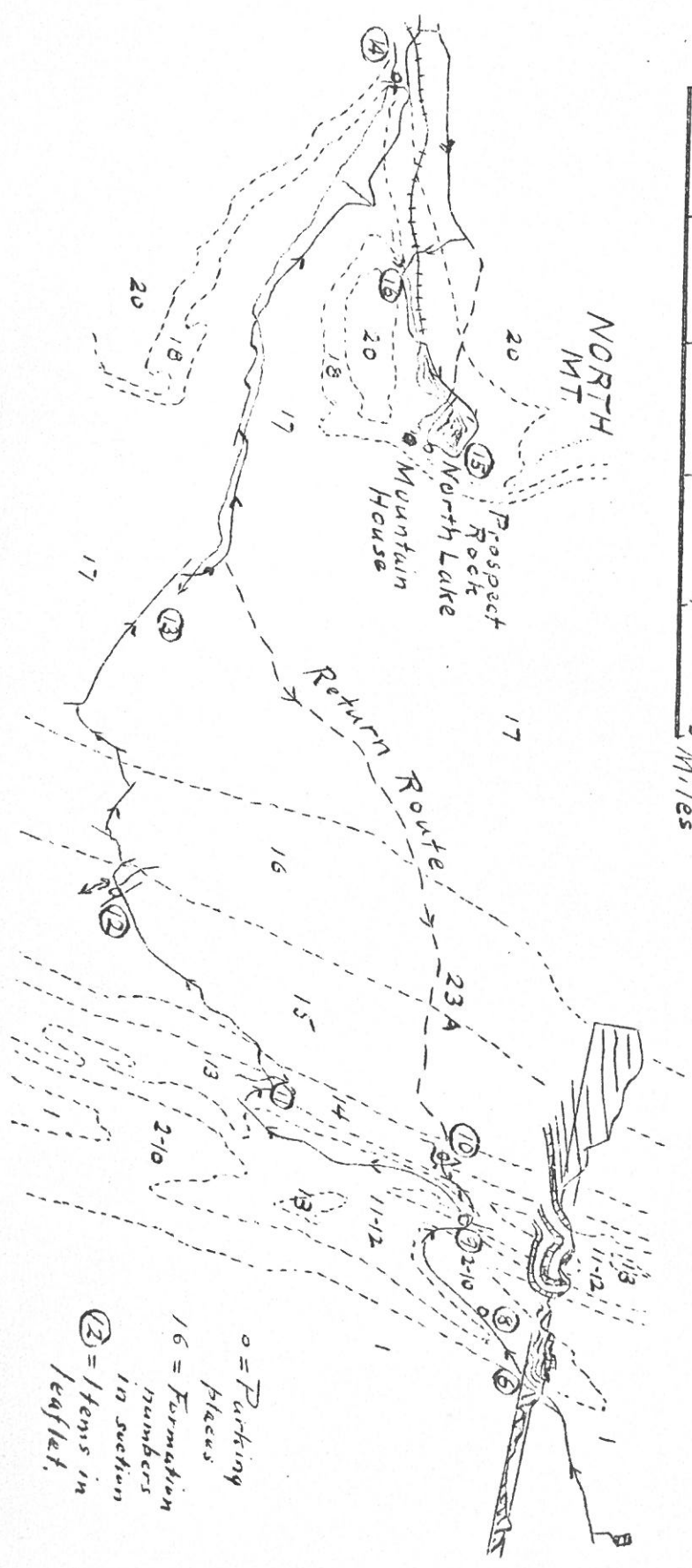
2:15 P.M. Return, via Toolhouse south on Old King's Road (royal colonial postroad, used by Continental armies). Follow leader; slow past Quatawichtasch (11), Onondaga limestone arch, underground drainage, clay-filled monoclinial valley, Hooge Berg, Kalk Berg. Esker in gravel pit, on left beyond. Look right to landslide of 1927. Climb along east front of Hooge Berg, then through abandoned glacial river valley to High Falls (12); park. Fossiliferous marine Mount Marion beds in monoclinial Hooge Berg ridge; postglacial gorge and falls.

3:30 P.M. All leave High Falls. Follow leader west, climbing past old flagstone quarries (spoil banks) in Ashokan continental beds and then on first reds (Kiskatom beds) to Saxton; turn right on 32. Deceptive upgrade for a mile on recent cobble fan (13) of Kaaterskill to Palenville. Mural front of Kats Berg (Wall of Manitou), due to repeated ice-erosion (page 5); truncated spurs; horizontal ledges.

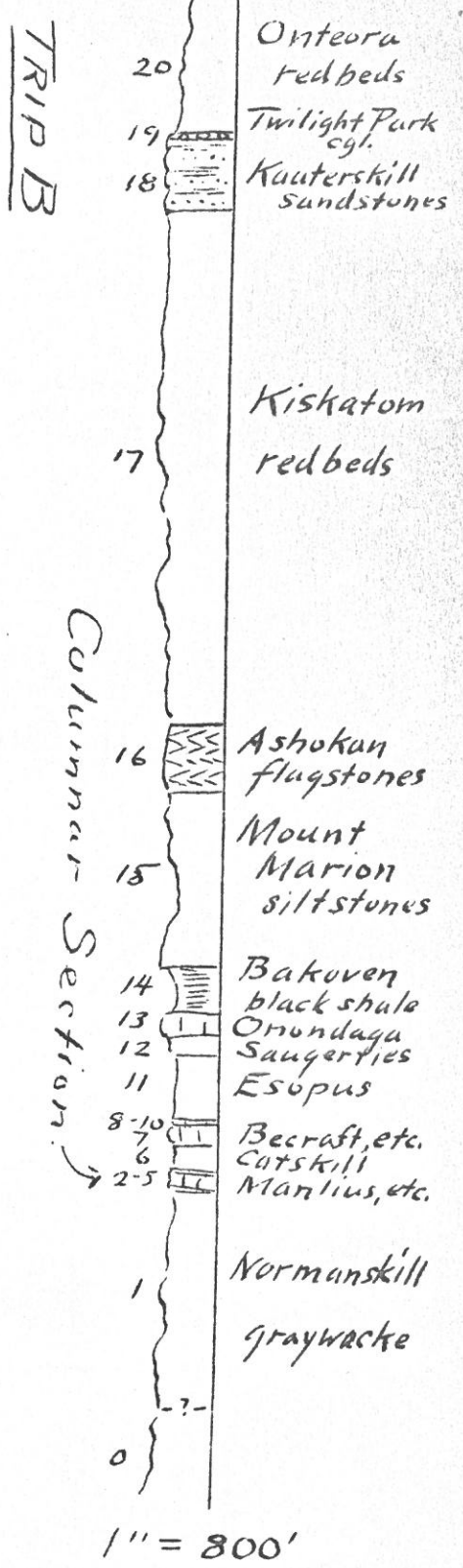
3:50 P.M. All leave Palenville on 23-A up Kaaterskill Clove (14) to Haines' Falls; turn in left and park by bridge over falls. YOU HAVE CROSSED, on the way, the continental Hamilton beds (Ashokan, Kiskatom, Kaaterskill) lying nearly flat, with much red shale and gray flagstone; Centerfield horizon at Palenville, Portland Point at Fawn's Leap (above second bridge), Tully in the three heavy Kaaterskill sandstones above Lockout to top of hill. Falls are over these. Short postglacial notch (landslide to north marks preglacial valley); contrast of old and new cycles of erosion; noted stream piracy.

4:30 P.M. Follow leader to North Lake (15) if time permits. A detour to see the ice cone at Kaaterskill Falls (16) may be feasible for such as desire to see this memorable sight. DANGER at the Falls; use great caution. Stream piracy; type exposure Kaaterskill sandstones; short postglacial notch; contrasting cycles of erosion AT NORTH LAKE Park, open west-draining valley truncated by Hudson Valley, glacial striae in three directions on col, view of Hudson Valley penplain and total geography, below. Kaaterskill sandstones. Fine climbs and views for the vigorous (consult leader for direction).

5:30 P.M. LAST CALL for return, 18 miles, via 23-A, for DINNER.




o = Parking place
 16 = Formation numbers in section
 (2) = Items in leaflet.



Trip C. Saturday morning, April 27.

Catskill (and Coxsackie) topo maps. READ page 1, Kalk Berg; page 2, formations 1 to 11 (Esopus) and lower half; page 3 through Glenerie; page 4, lower half; page 5, lower half, Lake Albany, etc.

8:00 A. M. Cars leave High School parking area. Follow leader out 23 across Lake Albany delta-plain of Cats Kill (Jefferson plain) to far end; debark, then drivers run cars to Margraf's to park, returning in few cars to rejoin party. Descend into Austin's Glen (17) over Normanskill, Rondout, Manlius beds; suggestion of unconformity. Calcite-filled thrust planes and joints, Manlius fossils; very huge Stromatoporoids; small cave; mouth of postglacial gorge; rock folds. (Besides the big folds, a short climb up bank above the first Rondout exposure reaches small sharp recumbent drag-folds in lower Manlius.) The old mill-road crosses axis of syncline near the cave, and old houses at foot (once occupied by artist Blakelock's family) are on Normanskill, well exposed in creek (former paper-mill damsite) and back down the old railway grade (Canajoharie & Catskill 1837-1842; Catskill Mountain Railroad 1882-1918); rarely graptolites, quartzes. Hill across creek is our sole outlier ("Eagle Cliff") west of river; synclinal, includes Rondout-Manlius-Coeymans-Kalkberg limestones.

One-quarter mile of straight track, running northwest from the mill-site, crosses a clay-filled anticlinal valley (preglacial), and beyond this the limestones come rapidly down to track and creek-bed. At first exposure of Rondout, climb down left to water to see these beds much exposed, the bottom layer (calcareous feather-edge of Fuyk sandstone) rolled into an S-fold, thus:--

the overlying waterlime driven in multiple wedges into the gap beneath the Manlius, at base of which is the "curly bed" of lime shale intensely crumpled by heavy bed overriding. (At low water, about 10° angular unconformity visible, tiny potholes)

Track curves over Manlius-Coeymans limestones, good exposures, fossils, to Kalkberg limestone dipping into creek and making waterfall at "Flat Rocks" (or "Coffin Rocks"); type exposure of Kalkberg. Cliff rising on opposite bank is type exposure of Catskill shaly limestone, topped at high left by Becraft limestone. A cave (shaft) in right gutter of track, in Kalkberg and underlying strata; a more interesting cave in a depressed space about 4 or 5 rods upslope and a bit back from that; both require ropes to explore; dangerous. Best fossil hunting of Kalkberg limestone is in loose dirt (silicified).

Around curve past Flat Rocks, on opposite limb of syncline, a good thrust fault in cut; Catskill shaly, dragged and cleaved, rides west over Becraft limestone (good fossils). Somewhat mashed anticline of the Catskill shaly thence to former "Third Bridge" of railway.

Note zigzag alternations of longitudinal (strike) and transverse sections of the creek in crossing these folded limestones of Kalk Berg.

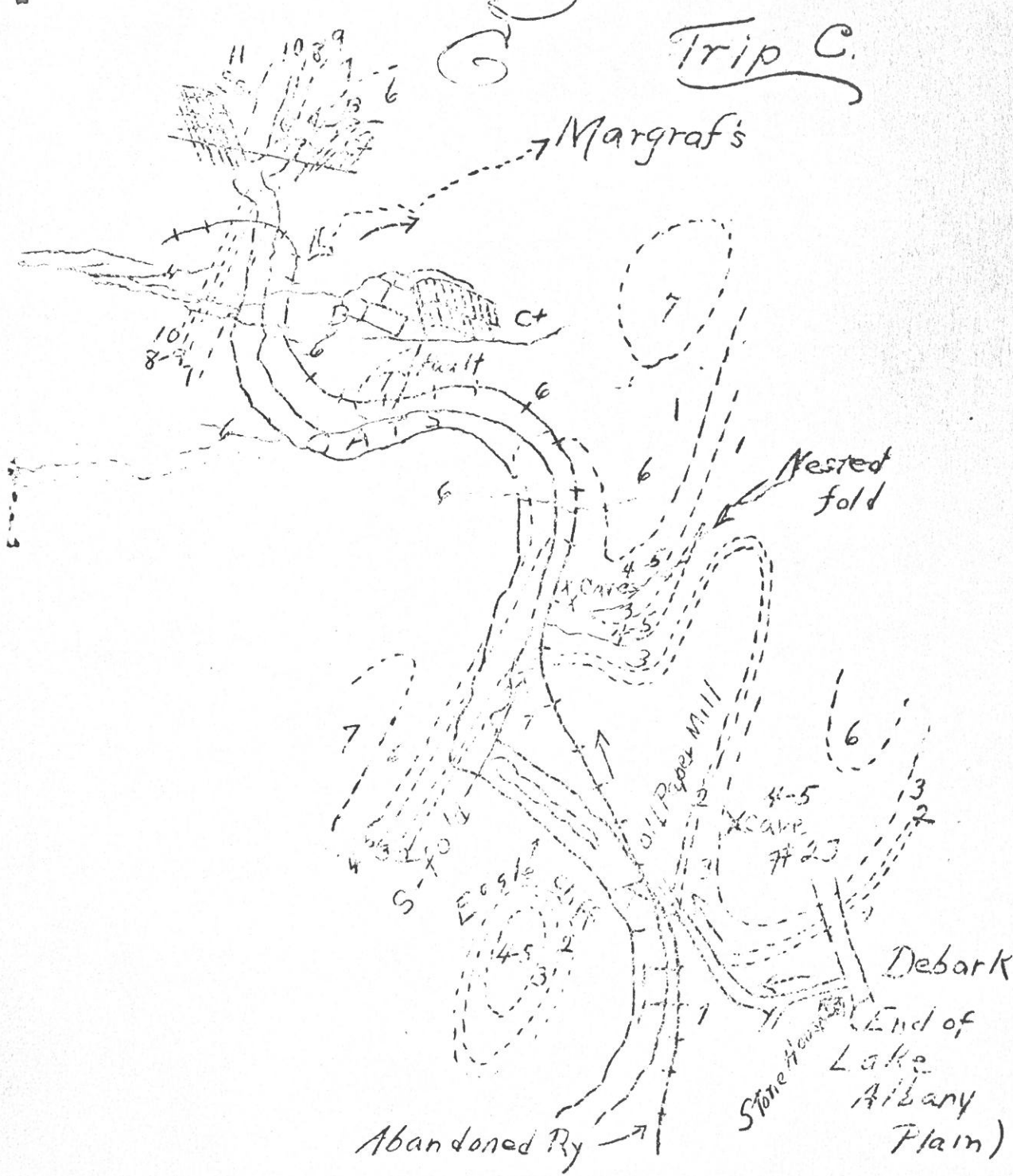
See page 1. Note an Onondaga limestone boulder on right near the Flat Rocks, showing that the gorge is really interglacial in part.

Natural Dam at third bridge is vertical Becraft-Alsen-Glenerie beds, with a few feet of shaly Port Ewen under the Glenerie at south. Some repetition by faulting; entire section of Catskill shaly in creek. Esopus shale cliff beyond. Best Glenerie fossils at next bend above.

11:45 A. M. LEAVE for lunch in town or at Margraf's (cars there).
12:00 M. Picnickers claim box lunches at "L" of map: LEAVE 12:20.

Geology

Trip C.



Trip D. Saturday afternoon, April 27.

Catskill and Kaaterskill topo maps. READ pages 2 and 3, page 5 lower half. Of type localities (marked * on page 2), trip B has covered type Bakoven, type Kaaterskill; and, on return, type Kiskatom; trip C has type Kalkberg and type Catskill shaly; trip H type Becraft.

12:30 P.M. Cars leave High School by rear exit. Follow leader down 9-W to Alsen (18). Park at railway station. Visit quarries on west by special courtesy of Lehigh cement company. Complicated structures in beds and much repetition from Fuyk sandstone (local sandbar replacing most of the Rondout limestone, but with some fossiliferous interbeddings of that) through Manlius, Coeymans, Kalkberg, Catskill shaly, Becraft limestone (principal high-lime cement rock), Alsen limestone (type exposure) and Glenerie dark chert beds. Silicified fossils in Alsen, especially loose in dirt-filled joint-cracks. The front quarry, south of crusher, is in vertical Manlius with east wall of Rondout (Fuyk), west wall of Coeymans; basal lime shale of Manlius in southeast corner. South quarry, in Becraft and Alsen, shows syncline with up-squeezed core (page 4, thrusts "b"). Opposite (north) quarry shows vertical Catskill-Becraft-Alsen overthrust on horizontal Alsen (repeated) and Becraft. (Nothing additional in west quarries.)

2:00 P.M. Follow leader down 9-W to Glasco quarry (19). Park by roadside and see fossiliferous marine limestone phase of Rondout, north of the old quarry and close to chicken yard. To east and north is the Lake Albany delta-plain of the Esopus Creek which was crossed at Saugerties. Manlius and higher limestones in ridge on west.

3:00 P.M. Continue down 9-W to Glenerie old lead mills (20). Park in wide space on right just beyond mills, where road starts up from the creek valley. Anticline of Glenerie limestone; type exposure is in quarry east of road some rods north; best collecting is in weathered joints north along road for $\frac{1}{2}$ mile. WATCH OUT FOR TRAFFIC.

3:45 P.M. Return to first bridge, cross it to type exposure of Esopus shale; vertical cleavage, obscure bedding dips west; see heavy bed at north in water. Continue west over Esopus-Saugerties-Onondaga beds to West Shore railway and cross clay-filled Bakoven monoclinical shale valley, past Mount Marion cross-roads, see lower heavy beds of the Mount Marion formation in roadcut and then making fall in Platte Kill on left; cross creek at high cliff of Mount Marion shale (21), type exposure, with fossils in basal strata; coral bed in water at downstream end, below a small (Keystone?) fault. Parties departing south may turn back from here to 9-W at Glenerie or Lake Katrine.

Suggested route continues around through Ashokan flags (quarries) at Fish Creek to Unionville, right fork to storm rollers (22) in top marine Mount Marion beds in two cuts just east of the fork; then turn sharp left up new road, through a deep cut in the flagstones (rarely ostracods, though flags are continental), keeping right fork over red basal transition of Kiskatom beds past Fawns back to Quarryville and Katsbaan (route 32); north on Old King's Foad and turn left (as trip B) to Quatawichnaach (II) for Onondaga corals. By 5:30 P.M., follow leader back east on cross-road to see Fuyk sandstone crowning hill above Red Schoolhouse (23). Contact down on Normanskill sandstone is very irregular; just above road on west side it holds rotted limestone with fossils (also Whitfieldella in hard quartzose sandstone by road).

Return down hill, to village via 9-W. SCHEDULE VARIED AT WILL.

Trip E. Saturday morning, April 27.

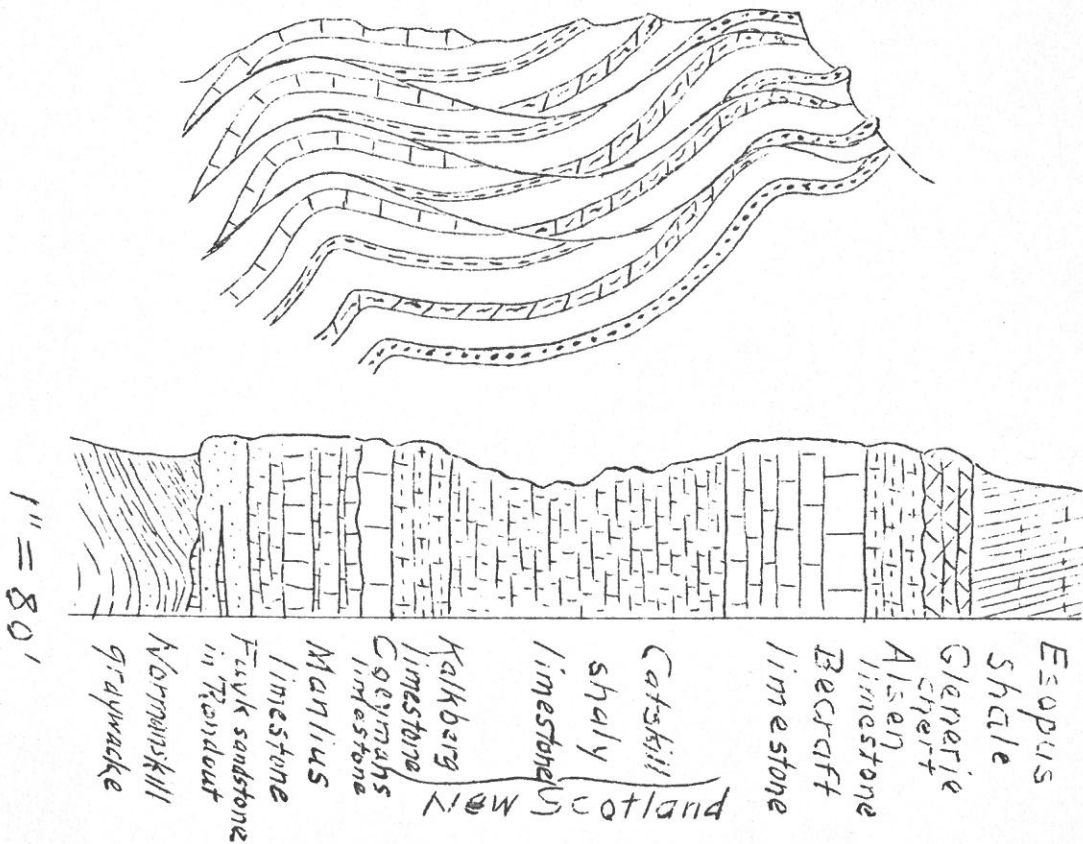
Catskill topo sheet (1938 edition). Involves formations 1 to 10, page 2, in "nested folds" (page 4). FIVE MILES OF HARD AND FAST WALKING over the worst kind of going; not for tenderfeet or weak hearts. Time limit (must be back for lunch and afternoon trips) prevents any holding back of party for laggards. Anyone getting lost is advised to retrace route back to starting point, or cut over east down to 9-W. Watch your footing for copperhead snakes crawling out for a sunning.

8:00 A. M. Cars leave High School by rear exit, down 9-W to "Idsall" filling station. Discharge passengers; cars continue to Alsen and park in railway station yard; drivers return in one car to Idsall.

Party will be personally conducted over the nested folds of the Streeke (pronounced stray-key) ridge to the fenster at the vanishing Streeke Lake (prairie bottom), continuing south over the same imbricated thrust sheets to the basal unconformity on 9-W north of the No. Amer. cement plant, then by back trails through the North American and Lone Star properties to the basal unconformity in the back Lehigh quarry railway cut and tunnel entrance; out to cars through old Alsen (now Lehigh) quarries with their successive overthrusts and folds.

11:30 A.M. Start back to village from Alsen for lunch.

Schematic diagram of nested folds (subsequently folded overthrusts);



Trip F. Saturday afternoon, April 27.

Catskill, Coxsackie, Durham, Gilboa topo maps. Read page 1 and page 5. This trip emphasizes glacial deposits and peneplains.

12:30 P.M. Dr. Heinrich Ries will discuss the varved clays of Lake Albany exposed in the rear of the High School; are postglacial?

12:45 P.M. Cars leave circle in front of High School, out 23. After crossing the Cats Kill, road climbs on Lake Albany delta-plain in Jefferson Heights and crosses it headward. Rises on folded limestones (see map in trip C) of Kalk Berg. Between Margraf's and Leeds look down left into interglacial-postglacial gorge of the Cats Kill in Austin's Glen (17). Then anticline in Esopus shale, large cliff, on left before entering Leeds. Crossing Cats Kill beyond Leeds, enter much refilled ancient valley of this creek, coming diagonally through Hooge Berg (note remnants of a moraine crossing this gap in the hills) and now aggraded, with terraces and abandoned channels. (Old Catskill village was on this first flat, with cornfields bought of aborigines.)

Old fairgrounds on right at far end of Cairo are on delta of the Cats Kill into glacial Lake Cairo (outlet east of the Roundtop to Vly Brook and Kiskatom). Small drumlins and drumlinized red shale hills on left before Acra, continue on right beyond. Just above South Durham, road curves around south end of sizable moraine, climbs up on it. Farther up, on left, pit in remarkable steeply stratified red-shale gravels. Helderberg plateau (peneplain) soon in sight on right, skyline, to beyond Point Lookout. Road crosses divide through glacial pass at East Windham into mature valley of that peneplain cycle.

Stream (Batavia Kill) soon sinks into a fresher inner valley, the road following down with it, and later (Gilboa quadrangle) becomes distinctly intrenched against south wall of old valley, whose bottom is dissected by tributaries into long spurs (see map). East of Windham, a hollow-backed proglacial delta (in Grand Gorge glacial lake) with many ice-contact. Two miles west of Windham, cemetery on flat-topped gravel delta in same lake, at Pleasant Valley, town Ashland. Slight moraines blockade valley at Ashland and Red Falls, formed by ice-tongue from east. Take first left beyond Prattsville, up Fly (Vlaie) Brook, and each left fork, climbing out of inner valley up to peneplain level; wide view of these larger features. Road (none too good) ends at house looking down on small morainial pond of Dr. John L. Rich's local glacier and up into its circ. Several pretty concentric little moraines, plainly post-Wisconsin-continental-sheet, overlying a broad Wisconsin morainial ridge on east and looping down also into this parallel valley. View of Schoharie-Helderberg plateau and ranges of the Catskills rising as monadnocks above this peneplain that bevels south-dipping strata.

If time permits, visit the Grand Gorge glacial outlet (on Hobart quadrangle) through main range a few miles northwest, used by railway.

4:00 P.M. Return via Gilboa dam (on great morainial terrace that crosses the Schoharie inner valley) and up the Manorkill valley with its numerous morainial loops of an ice-tongue from east. Sinuous esker up on hill-slope south of West Conesville (Rich, Bull. 299: fig. 44, 45). Cross summit divide through glacial pass into Cats Kill drainage. Perhaps continue east via 81 through Norton Hill (south "break" of Helderberg plateau) for wide views, to Greenville; south on 32 over big drumlin just south of Greenville, to Cairo, Catskill.

Au revoir.

Trip H. Saturday afternoon, April 27.

- Catskill topo map. Compare structure section on page 4 and glacial on page 5. Stratigraphic sequence east of River includes:
6. Rysedorph limestone conglomerate, Black River and Lower Trenton shells, trilobites and ostracods in the pebbles.
 5. Normanskill graywacke beds, very thick formation; upper part with grits and shales, lower part with chert and shale. Graptolites (*Climocograptus becornis*, *Diplograptus incisus*, *Dicellograptus sextans*, *Dicranograptus ramosus*, etc.). Chazy age.
 4. Deep Kill shales and chert. Graptolites (*Phyllograptus ilicifolius*, *Didymograptus extensus*). Beekmantown age.
 - - - Hiatus - - -
 3. Zion Hill? ferruginous quartzite (barely represented).
 2. Schodack interbedded shale and limestone. Hyolithes and trilobites. In base, the sideritic Burden ore. Lower Cambrian age.
 - - - Hiatus - - -
 1. Nassau shales and quartzite. *Oldhamia* only. Lower Cambrian age.

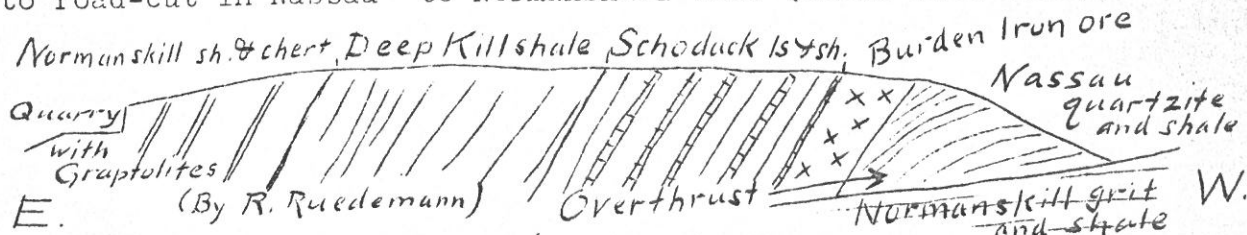
--oOo--

1:00 P.M. Cars leave High School. Leaders: R. W. Jones; Outcrops and graptolites, Dr. Ruedemann; Cherts, Yates Wilson; Economic, Dr. Newland; Burden Mines, Leavitt Loomis; Glacial, John Cook; Becraft mountain, Dr. Ruedemann; Cement works, Company representatives.

Follow leader across Rip Van Winkle Bridge (cars 50¢, buses more) and examine Deep Kill chert and shale in summit road-cut toward Hudson. Small exposure of Rysedorph conglomerate at north end. (May be revisited while returning to Catskill at close of trip.)

1:30 P.M. Return on 9-G to beyond bridge approaches; view sigmoid fold in upper Normanskill shales at east base of Church's Hill.

1:50 P.M. Continue south 1 mile, turning left on Greendale Road to road-cut in Nassau to Normanskill beds (lacks Zion Hill). Section:



2:40 P.M. Return to 9-G, south 2 miles to Linlithgo road; turn left across Lake Albany delta of Roeliff Jansen Kill to old Burden iron-mines in south end of Mount Tom. The ore (siderite) is in unconformable contact of Schodack on Nassau beds (see diagram above). Persons most interested in the mines may remain, with Mr. Loomis (need at least an hour to explore fully). Others will push on at

3:15 P.M. Continue east to Livingston; examine exposures of Lower Normanskill shale less than a mile north on US9, east of road.

3:30 P.M. Examine glacial terrace north of Maplewood Camps.

4:00 P.M. Continue past Bell's Pond kettle-lake 3 miles to road-cut in Schodack beds near transmission line; visit abandoned quarry south of road with ferruginous quartzite (Zion Hill?), etc.

4:30 P.M. Stop at Cherry Hill; visit ice-pond. Discuss theories.

5:00 P.M. Atlas cement works and quarry in Becraft Mountain, etc. The famous Normanskill and Deep Kill graptolite quarries lie near to route 23 on return trip to Catskill. Consult with leaders, to reach.

Condensed Bibliography, Catskill Region.

Fossils:

- Vols. 3-7 N. Y. State Paleontology, Hall 1859-1888.
Mem. 3 N. Y. State Museum, Clarke 1900, Becraft Mt.
Bull. 92 N. Y. S. Museum, Grabau 1906, (useful)
Bull. 251 N. Y. S. Mus.: 50-92, Goldring 1924, Plants.

Physiography:

- Amer. Jour. Sci. (3) 19: 429-51, Guyot 1880.
Bull. Geol. Soc. Am. 7: 505-7, Darton 1896, Piracy
Bull. Am. Geog. Soc, 39: 193-201, Heilprin 1907, MAP.
Science n.s. 33: 550-1, Merwin 1911, Topography.
Am. J. Sci. (5) 26: 319-31, Mackin 1933, Drainage.
Proc. Geol. Soc. Am. 1934: 73, Cressey 1935, Piracy.
A. J. S. (5) 32: 21-42, Meyerhoff & Olmsted 1936, Rivers.

Stratigraphy & Structure:

- Bull. Mus. Comp. Zool. 7: 311-29, Davis 1883, Folds.
Rp. 13 N. Y. S. Geologist: 199-228, Darton 1894, Limestone.
Jour. Am. Ceram. Soc. 2: 870-82, Jones 1919, Cement Region.
Handbk 10 N. Y. S. Mus., Goldring 1931, Formations.
A. J. S. (5): 26: 537-51; 27: 1-12, Cooper 1933, Hamilton.
Guidebk 9a Int. Geol. Cong., Kay & Chadwick 1933,
Guidebk 1 Int. Geol. Cong., Longwell 1933: Pp. 12, 13.
Bull. 307 N. Y. S. Museum, Chadwick 1936, "Catskill" Reds.

Historical Geology:

- A. J. S. (4) 36: 429-72; 37: 87-109, 225-53, Barrell 1913-1914, Redbeds Delta.
Bull. Geol. Soc. Am. 41: 701-24, Schuchert 1930, Orogenies.
A. J. S. (5) 23: 305-26, Schuchert & Longwell 1932, Uplift.
Bull. 187 N. Y. S. Mus.: 79-105, Newland 1928, Landslides.
Bull. Geol. Soc. Am. 47: 1535-86, Ruedemann 1936, Cherts.
Bull. G. S. A. 50: 1761-94, Mencher 1939, Redbeds Facies.

Glacial:

- Bull. 84 N. Y. S. Mus., Woodworth 1905, Water Levels.
Science n.s. 32: 27-28, Chadwick 1910, Glacial Lakes.
Bull. 209 N. Y. S. Mus., Fairchild 1919, Submergence.
Bull. 251 N. Y. S. Mus.: 158-76, Cook 1924, Stagnation.
Bull. 299 N. Y. S. Mus., Rich 1935, Glaciers, C. Mts,

Economic:

- Bull. 35 N. Y. S. Mus., Ries 1900, Clays: pp. 576-9, 590-1, 702-4, 756, 832-4; pl. 26, 45.
Bull. 44 N. Y. S. Mus., Ries 1901, Cement; pp. 786-7, 851, 858-9, 862; pl. 39.
Bull. 286 N. Y. S. Mus.: 135-49, Ruedemann 1931, Iron Ore.

The geological map and bulletin on Catskill and Kaaterskill quadrangles (Ruedemann & Chadwick) awaits publication at Albany. Contents will be covered by field leaflets.

Geology of the Catskill Region

Physiography. Catskill is in the Appalachian Valley, locally the "Middle Hudson Valley." Eight miles west of it rises the Appalachian (or Allegheny) Plateau, fronted toward east by the "Wall of Manitou" and topped by the three northwesterly trending ranges (with westerly spur ranges) of the Catskill Mountains (Englishman's error for Kats Berg¹ of Dutch, On-ti-ora² of Amerindians). This plateau, represented by the wide valleys between the ranges, is a peneplain. Remnants of an earlier peneplain are found on the peaks. The Hudson Valley peneplain, much lower and later (pre-Wisconsin) has been etched and partly dissected to below present tide-level. The Hudson itself follows a drowned "inner gorge." Its "inner delta" in this estuary now reaches from Troy nearly to Catskill, as mud flats. Eastward, the hills climb slowly to the Taconic³ mountain-range.

The western and southern Catskills drain to the Esopus⁴ Creek; the Cats Kill skirts the northeast front of the mountains; but the central area of these, between the front and main ranges, has flow in the opposite direction, through the Schoharie⁵ Kill, its waters returning in the Hudson past Catskill after a circuit of 150 miles. The northerly course (pine-tree drainage) of many Hudson tributaries is notable (Esopus, Kaaters⁶ Kill, Roeliff Jansen⁷ Kill, etc.) Stream piracy on the steep east front of the plateau (Kaaterskill and Plattekill⁸ Cloves and Falls) is famous. Dendritic drainage in the flat-lying strata of the mountains contrasts with trellised patterns in the folded or tilted strata (strike ridges) of the valley, especially west of the river. Here are two valley ranges:

(a) Hooge Berg,⁹ a single persistent line of massive hills with westerly dip-slope and steep east scarp, midway between river and Wall of Manitou. West of the Hooge Berg lies the broad Kiskatom¹⁰ plain; east of these hills lies the deep clay-filled Bakoven¹¹ valley.

(b) Kalk Berg,¹² a chain of folded-limestone ridges with a mural front, often a sheer cliff, which converges on the river from Catskill south to Kingston. Northward, it rises into the great cliff of the Helderberg escarpment and combines with the Hooge Berg into the Helderberg (Allegheny) plateau, a peneplain best seen from East Windham. In the Kalk Berg chain are perfect examples of synclinal hills, anticlinal valleys, synclinal valleys, anticlinal hills, followed west by monoclinical Bakoven valley and monoclinical Hooge Berg range.

There are, thus, three successive escarpments from the Hudson west: (1) Kalk Berg, (2) Hooge Berg, (3) Kats Berg or Catskill scarp. Roughly, these represent Lower, Middle and Upper Devonian formations. A fourth scarp, facing northeast and forming the main or central range of the mountains, may be added (Upper Devonian, Enfield rocks).

Glacial features are discussed beyond.

The Dutch and Amerind names often bother those unfamiliar with the tongues. Pronounced as follows: ¹Cots-barrakh, ²(accent the or), ³(accent the on), ⁴(accent the o), ⁵Sho-harry, ⁶Cauters, ⁷Roeliff Yensen, ⁸Flah-tay-hill, ⁹Hoh-gay-barrakh, ¹⁰(accent tom), ¹¹Bok-ohfen, ¹²Colla-barrakh (original spelling Kale Berg); also the following: Ash-o-kan', Saugerties (saw-ger-chaze), Gen-erie, Alsen (ahl-sen), Becraft (bee-craft), Coeymans (kwee-manz, hoo-ee-manz), Coxsackie (cook-sokky; Dutch Koepshaghi), Cairo (care-oh, not Hi-ro).

Stratigraphy. The rock sequence runs from east to west and covers from Lower Cambrian to Upper Devonian with a large gap and unconformity between Lower Ordovician (Eochamplainic) and Upper Silurian (Neontaric). The older rocks ("Hudson River," Cambrian and Ordovician) are discussed under Trip H. West of the river there are:--

#	Name of Formation	Feet Thick	Kind and Character
22	Katsberg*	2050	Continental, flags and red shales
21	Stony Clove*	900	" , gray flags and shale
20	Onteora*	1060	" , flags, red sh. & ss.
19	Twilight Park*	40	" , cobbly puddingstone
18	Kaaterskill*	300	" , 3 heavy sandstones
17	Kiskatom*	2300	" , red shale, gray flag
16	Ashokan#	300	" , gray flags, green sh.
15	Mount Marion*	800	Marine, shales and silt-sandstone
14	Bakoven*	200	" , bituminous shales, "coal"
13	Onondaga	75-100	" , white cherty limestones
12	Saugerties*	80	" , calcareous mudstone
11	Esopus*	300	" , silicious siltstone
10	Glenerie*	5-40	" , chert and (or) limestone
9	Port Ewen#	0-7	" , shaly limestone or shale
8	Alsen*	5-30	" , limestone with chert seams
7	Becraft*	60	" , "shell marble," coquinite
6	Catskill*	120	" , shaly limestone or shale
5	Kalkberg*	25	" , limestone with chert seams
4	Coeymans#	10-15	" , coarse knotty limestone
3	Manlius, Olney	50	" , fine, dark limestone
2	Rondout#	2-40	" , (includes Fuyk sandstone)
1	Normanskill	1000±?	" , graywacke shales, grits
(0	Older rocks east of river)		

*Type localities on Catskill or Kaaterskill quadrangles

#Type localities on adjacent quadrangles to south or north

(For pronunciations, see a previous sheet, on Physiography.)

The Ordovician ("Hudson River Beds") comprises 0 and 1, followed by a great unconformity (Taconic orogeny) with angular contacts generally; The Silurian (Cayuga) comprises 2 and 3, with sandbar and lagoon calcilutites in 2 around Catskill, Halysites ("Glasco") limestone south. (The supposed Cobleskill is lentils at various levels in the Rondout.) An erosional break (upper Manlius absent) separates Silurian and next. Silurian (Helderbergian) comprises 4 to 9 inclusive, followed by an erosional break with phosphate nodules; Port Ewen is missing, north. Lower Devonian (Oriskanian) includes 10, 11, perhaps 12 (formerly the supposed "Schoharie grit" equivalent; probable true Schoharie locally present on route 32 in base of Onondaga); glauconite present at top. Middle Devonian includes 13 (Ulsterian), 14 to 18 inclusive (Erian or Hamiltonian, including Tully, 18). Upper Devonian from 19 upward, all of which is Senecan (Genesee-Ithaca-Enfield equivalents in reds).

The limestones, from 2 to 13 inclusive, folded, compose the Kalk Berg. The Mount Marion beds (15), west tilted, form the Hooge Berg range. The Katsberg (Catskill Mountains) consists of the redbeds (17 up).

Fossils. The outstanding or common forms for each formation:

Normanskill: 4. *Climacograptus bicornis*, *Dicellograptus gurleyi*, *Glossograptus whitfieldi*; 9. *Prolobella trentonensis*; 15. Eurypterids in Post Quarry. (For more extensive list east of river, see trip H.)

Rondout: 3. *Halysites catenularia*; 6. *Camarotoechia lamellata*, *Schellwienella interstriata*, *Leptaena rhomboidalis*, *Whitfieldella sulcata*, *Atrypa reticularis*; 16. *Leperditia scalaris*; 5. Bryozoa undetermined.

Manlius: 2. *Stromatopora* sp., etc.; 5. *Monotrypella arbuscula*; 6. *Spirifer vanuxemi*, *Brachyprion varistriatum*; 9. *Leiopteria aviculoidea*; 10. *Holopea elongata*; 11. *Tentaculites gyracanthus*; 16. *Leperditia alta*

Coeymans: 3. *Favosites helderbergiae*; 7. *Mariacrinus nobilissimus*; 6. *Sieberella coeymanensis* ("Pentamerus galeatus"), *Atrypa reticularis*.

Kalkberg: 1. *Hindia inornata*; 3. *Favosites helderbergiae*, *Enterolasma strictum*; 6. *Sieberella coeymanensis*, *Atrypa reticularis*, *Dalmanella perelegans*, *Rhipidomella oblata*, *Bilobites varicus*, *Delthyris perlamellosa*, *Anastrophia verneuili*; 7. *Mariacrinus stoloniferus* (stems).

Catskill shaly: 1. *Hindia inornata*; 5. Bryozoa, abundant; 6. *Spirifer macropleura*, *S. cyclopterus*, *Delthyris perlamellosa*, *Schellwienella woolworthana*, *Leptaena rhomboidalis*, *Leptostrophia becki*, *Eatonia medialis*; 10. *Platyceras ventricosum*; 11. *Tentaculites elongatus*; 14. *Dalmanites pleuroptyx*, *Phacops logani*; 9. *Actinopteria communis* (rare).

Beecraft: 6. *Spirifer concinnus*, *Atrypa reticularis*, *Uncinulus campbellanus*; 7. *Aspidocrinus scutelliformis* anchor-plates (characteristic).

Alsen: 1. *Hindia inornata*; 5. *Monotrypa tabulata*; 6. *Atrypa reticularis*, *Rhipidomella oblata*, *Spirifer cyclopterus*, *S. concinnus*, *Schizophoria multistriata*; 7. *Mariacrinus macropetalus*; 10. *Platyceras obesum*.

Port Ewen: 5. *Fistulipora ponderosa*; 6. *Leptostrophia becki*, etc.

Glenerie: 6. *Spirifer murchisoni*, *S. arenosus*, *Leptocoelia flabellites*, *Leptaena ventricosa*, *Leptostrophia magnifica*, *Rhipidomella musculosa*, *Eatonia peculiaris*; 7. *Edriocrinus saeculus*; 10. *Platyceras gebhardi*, *Diaphorostoma desmatum*; 13. *Taonurus caudagalli*; 14. *Homalonotus vanuxemi*; 16. *Thlipsurella diclefta*, *T. chadwicki*, *T. multipunctata*, etc.

Esopus: 6. *Leptocoelia flabellites*; 13. *Taonurus caudagalli* chiefly.

Saugerties: 6. *Atrypa impressa*, *Strophonella ampla*, *Schellwienella pandora*, *Spirifer macrus*, *Delthyris raricosta*, *Dalmanella peloris*; 12. *Orthoceras zeus*; 14. *Calymena calypso*, *Dalmanites anchiops*.

Onondaga: 3. *Synaptophyllum simcoense*; 6. *Atrypa aspera*, *Schellwienella pandora*, *Spirifer duodenarius*, *Leptaena rhomboidalis*, *Strophonella ampla*, *Delthyris raricosta*, *Schizophoria propinqua*; 10. *Platyceras dumosum*; 14. *Odontocephalus selenurus*; 17. *Onychodus sigmoides* teeth.

Bakoven: 0. *Protosalvinia huronensis*; 6. *Leiorhynchus limitare*; 11. *Styliolina fissurella*, *Tentaculites gracilistriatus*; 17. *Onychodus hopkinsi* teeth; also apparently a Phylloped crustacean, *Estheria* sp.

Mount Marion: 6. *Chonetes coronatus*, *Rhipidomella vanuxemi*, *Camarotoechia congregata*, *Spirifer pennatus*, *S. granulatus*, *S. acuminatus*, *Leptostrophia perplana*, *Schellwienella pandora*; 7. *Ancyrocrinus bulbosus*; 8. *Devonaster eucharis*; 9. *Grammysia bisulcata*, *Nuculites triquetra*, *Palaconeilo constricta*, *Paracyclas lirata*; 10. *Bucanopsis lyra*, *Diaphorostoma lineatum*; 11. *Tentaculites bellulus*; 12. *Tornoceras uniangulare*, *Spyroceras crotalum*; 13. *Taonurus velum*; 17. "Fish" plates.

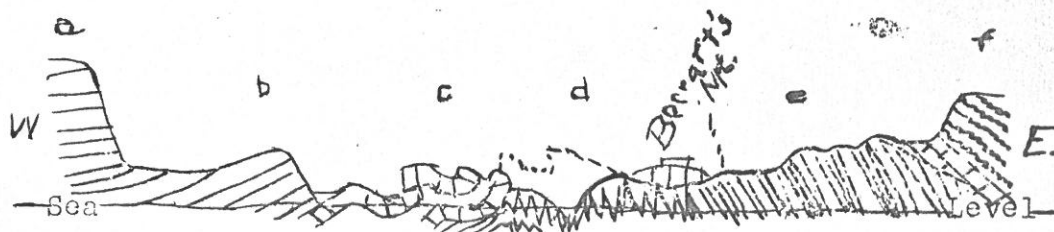
Redbeds: 9. *Archanodon catskillensis*; 0. Plants; 17. "Fish" plates.

(For key to numbers, see next page.)

Key to numbers in fossil list: 0. Plants, 1. Sponges, 2. Stromatoporoids, 3. Corals, 4. Graptolites, 5. Bryozoans, 6. Trachiopods, 7. Crinoids, 8. Starfish, 9. Pelecypods, 10. Gastropods, 11. Pteropods, 12. Cephalopods, 13. Worms, 14. Trilobites, 15. Lurypterids, 16. Ostracods, --. Phyllopoeds, 17. Ostracoderms and Fishes.

Structure. The structural features are in belts, corresponding with the hill ranges, and structural complexity increases west to east from flat-lying beds in the Catskill mountains to highly compressed and metamorphosed rocks in the Taconic mountains, thus:

- a. Horizontal strata (1° to 3° west dip) in eastern Catskills.
- b. West-dipping (10° to 15°) in Hooge Berg, flattening westward.
- c. Folds, west-tipped or overturned, in Kalk Berg, with westward overthrusts partly folded with the strata. Complicated in cement area. (Becraft's mountain is a broadly synclinal outlier east of the river.)
- d. Isoclinally plicated and mashed "Hudson River" beds east of Kalk Berg, to well east of the Hudson; have been through two orogenies.
- e. Slaty cleaved older rocks (largely Cambrian) east of preceding.
- f. Schists and marbles of New England, overthrust westward.



General Cross-Section

Folds -- The folding in the Kalk Berg belt is of the usual Appalachian type, unsymmetrical (axial planes tipped over towards west), but all in miniature, permitting quick and easy study. The west limb of each anticline is steep or even overturned (to 135° or more); the east limb (east dip) is more gentle (seldom 30°). These folds die out westward.

Thrusts -- There are three types of thrusts: (a) The apex of overturned anticlines is usually ruptured and overthrust; (b) the pinched core of a syncline may be forced up as a wedge (point downward) between short diagonal thrust planes in each limb; (c) successive thin slices driven west (implicated) and subsequently folded along with the strata produce "nested folds" and on west dips the "downward overthrusts." Occasionally, sharp little buckles in these sheets afford a "take-up."

Cleavage -- The minor effects of fault-drag and drag-cleavage are seen at many points. Cleavage is particularly notable in the shaly limestones (Catskill, Port Lven), also in the east front of the Hooge Berg (Mount Marion beds), and it obscures the bedding of the Esopus shale.

Faults -- True normal faulting is hard to find. The remarkable succession of parallel lineaments in and below the mountains, having the trend of the Stony Clove and the mountain front (major joint system) seems due to keystone faults. This is proved for one visible from Catskill as a diagonal line on the face of North Mountain (trip B). In the valley, long open corridors in the Onondaga limestone suggest a like origin. The "normal" fault in Post quarry is an upedged thrust.

Glacial. The conspicuous ice-work is Wisconsin; any prior glaciation is inferential. "All types of glacial phenomena are known but not all will be seen on the trips. Trip H emphasizes glacial features and trip F is largely glacial, local and continental, plus peneplains.

Ice-erosion features -- Glaciated surfaces are common. At North Lake (trip B), striae criss-cross in three directions. Chattermarks occur on hard beds, especially at Watson Bogardus's. The saw-tooth mountain peaks are due to plucking. It is likely that the rigid alignment and truncated spurs of the plateau front (Wall of Manitou) are due to repeated crowding by ice-lobes in the valley: (view this from Palenville). Glacial erratic boulders are common at all altitudes; the large ones are of local origin. Adirondack and Vermont blocks, though plentiful, are mostly small. General flow was west of south.

Moraines -- Fragmentary and mostly small moraines are known, chiefly west of the river, but cannot be reached except on trip F.

Drumlins -- Large drumlins are just out of reach, at Greenville and south of Coxsackie, but smaller ones will be seen on trip F. Drumlinized shale hills (rocdrumlins) are numerous east of the Hudson River.

Eskers -- An esker, buried under clay, is exposed on route of trip B.

Kames -- Gravel pits or cemeteries disclose many small kame knolls.

Kettle-plains -- The great Livingston lateral terrace, 6 miles east of the river (trip H), 10 miles long, is full of kettles and ponds.

Glacial lakes -- Only trip F will reach the glacial lake deposits and outlets, of the Schoharie and Cats Kill valleys. Ice-margin streams cut around the east base of the mountains, as seen on return of trip B. A glacial channel and delta occur at High Falls (same trip).

Lake Albany plains -- Conspicuous below the 200-foot contour are the (sand-capped) terraces of varved clays, which are well-exposed by grading in the school grounds and will be briefly visited on Saturday noon and described by Dr. H. Ries, including their use in bricks. This is part of the Lake Albany delta of the Cats Kill, now bisected by the creek into the Jefferson Heights plain (trips C, F) and the West Catskill plain (trips A, B, D, G), with an abandoned meander of the creek a little below the summit level of the latter, on W. Bridge St. Saugerties and Glasco are on the delta of the Esopus (trip D). Lake Albany clays occupy the Bakeoven valley (Trip B) and Fuyk (trip A)

Post-glacial. Modern deltas are building at mouths of Cats Kill and Esopus Creek. In the millpond above the bridge at Saugerties, 40 acres of land were made in 40 years. The deposits seen in the river from Rip Van Winkle Bridge have increased very fast in a lifetime. Meander sweeps, floodplains and clay-slides are common phenomena near Catskill and Saugerties. At Palenville and West Saugerties large alluvial fans of cobblestones have formed of the outwash from the two Cloves, evidently since the latest glaciation. Alluviation is conspicuous on the mountains, especially steep fans at mouths of torrential brooks; a lake (millpond) at Tannersville was soon filled up. Austin's Glen (trip C) and the Esopus vale at Glenerie (trip D) are post-glacial gorges crossing the Kalk Berg, with fresh Waterfalls, in contrast with the broad valleys of these creeks through the Hooge Berg. Post-glacial dissection of valley-fills has been deep, to below present sea-level; Hudson and mouths of creeks have since been drowned.