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Geology of Southern Connecticut, North-South Transect

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Trip C-1: Geology of Southern Connecticut, North-South Transect.

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This trip crosses the following quadrangles, published quadrangle maps of which are listed below:

	Bedrock Geology	Surficial Geology
(New Haven, only on way to first stop)		CG&NHS QR 18
(Mt. Carmel, only on way to first stop)	USGS GQ-199	CG&NHS QR 12
Southington (Stop 1)	USGS GQ-200	USGS GQ-146
Meriden (Stops 2 to 6)	USGS GQ-738	USGS GQ-150
Middletown (Stops 6 and 7)	CG&NHS QR 8	
Hartford South (Stops 7 and 8)		CG&NHS QR 20
Durham (Stops 9 and 10)		USGS GQ-756
Guilford	CG&NHS Bull 86	CG&NHS QR 28
Branford (Stops 11 and 12)		CG&NHS QR 14

Stratigraphic Column: Newark group in Hartford basin (Central Lowland).

Lower Jurassic	Equivalent dikes, according to Philpotts and Martello, ms.
Portland arkose	
"Meriden formation" of Krynine (1950)	
Hampden basalt (3rd flow)	Bridgeport-Pelham dike
East Berlin formation	
Holyoke basalt (2nd flow)	Buttress-Ware dike
Shuttle Meadow formation	
Talcott basalt (1st flow)	Fair Haven and Higganum dikes

Upper Triassic

New Haven arkose

DON'T FORGET TO SET YOUR ODOMETER TO 0.0 BEFORE STARTING OUT!

(The mileage for this itinerary was measured on a car whose odometer is about 1% fast.)

To reach STOP 1 from New Haven, take Whitney Avenue north.

Mileage

0.0 Corner of Whitney and Humphrey Streets, at outlet of Kline Parking lot. (Turn left if leaving parking lot.)

1.1 Enter town of Hamden. As road ahead bends to left, one sees to the right the dam of Lake Whitney, which covers the original dam for water power for the works of Eli Whitney, the inventor of standardized parts and the cotton gin. An industrial museum has been established at the site, the location of his gun factory. The dam was located where Mill River had a natural waterfall over the Mill Rock dike, which connects the East Rock sill, visible to the right (east), through Mill Rock, to the left (west), and Pine Rock to the south end of the West Rock sill in West Rock. The dike is exposed on the left (west) side of Whitney Avenue at 1.4.

4.2 Enter Mount Carmel quadrangle.

4.8 Village of Centerville. From here north Whitney Avenue is Route 10.

7.5 Traffic light in village of Mount Carmel. At this point the road cuts diagonally across the feeder dike for the Mt. Carmel or Sleeping Giant stock, which is visible on the right just beyond the corner.

10.0 Enter town of Cheshire.

13.1 Village of Cheshire; enter Southington quadrangle. Continue on Route 10.

16.5 The West Rock sill, which for about 13 miles north of West Rock in New Haven lies near the base of the Triassic New Haven arkose, at its north end cuts upward in the sequence (though not as sharply as along the Mill Rock dike at its south end). Here it expands into a sill that is like but much smaller than the East Rock sill. Outcrops are visible in the little ridge just west of the road for the next mile.

17.5 Enter town of Southington. The sill here crosses the road obliquely; it disappears about a mile farther north-northeast.

17.6 Intersection of Routes 10 and (old) 66. Keep straight or bear right where Route 10 bears left; at traffic light, turn left (west) on Route 66.

18.9 Intersections with Route I-84. Continue straight (route becomes Route 322 but isn't marked).

19.5 Traffic light in village of Marion. Turn right (north) on Marion Road.

20.2 Blinker. Marion Road bears right; turn left on Mt. Vernon Road.

20.3 Turn sharp right with Mt. Vernon Road (road ahead is dead end).

22.6 Corner of Roaring Brook Drive; turn left (west) up drive and go to circle at end (22.9).

MILEAGE NOW STARTS AT 0.0 AGAIN

STOP 1: This is Locality 10 of Wheeler (1937), 39 of Krynine (1950; see Roaring Brook in index). Proceed across vacant lot to right (north) of circle and, bearing right, enter woods and descend into gorge of Roaring Brook. At first, outcrops are of (Devonian?) Southington Mountain schist (the type locality is the mountain rising to the west), but downstream a short distance, the schist on the north (left) bank is overlain unconformably by the basal conglomerate of the Triassic New Haven arkose. Note that the unconformity, projected upstream, will not pass over Southington Mountain, which is schist to the top. Hence a fault must pass between this locality and the mountain. Moreover, according to Fritts (GQ 200), another fault passes between this outcrop and a prominent outcrop of New Haven arkose (also conglomeratic) not far downstream on the south (right) side of the brook. These faults are interpreted as western branches of the main Mixville fault, whose existence at the western border of the Connecticut Valley Mesozoic basin is proved at several places by drilling or excavation (as in the Bristol copper mine, 13 km (8 miles) north of this locality), though it leaves the border and cuts into the older rocks about 20 km (12 miles) south of here. Krynine's petrographic work confirmed Barrell's original conclusion that the Triassic arkose is not derived from the underlying schist to any considerable degree, but comes from the Eastern Highlands, 27 km (17 miles) east of here.

0.0 Return down Roaring Brook Drive.

0.3 Turn right (south) on Mt. Vernon Road.

2.6 Right-angle turn to left (east).

2.7 Stop sign and blinker. Turn right (south) on Marion Road.

3.4 Traffic light in village of Marion. Turn left (east) on Route 322.

4.0 Crossing I-84 (at its Exit 27). (Just beyond, road becomes Route 66 at present; this may soon change.) Fine view of Hanging Hills of Meriden; cliffs are Holyoke (2nd) lava flow. This flow, dipping east, forms the (irregular) north-south mountain (Talcott Mtn.) to the north (left), but in the Hanging Hills it dips gently north. The prominent bench (marked by pines) halfway down is held up by the Talcott (1st) flow with the same dips.

5.3 Intersection with Route 10; continue east on 66.

(5.7-5.9) (Brief excursion into town of Cheshire and return into Southington.)

6.1 Enter Meriden quadrangle.

7.7 Traffic light at exit from Route 66 (present west end of four-lane divided highway). Park on right at light (until it becomes the entrance ramp for 66 west).

STOP 2: Cross to far side of exit ramp at light and walk east to outcrops. Excellent display of relatively fine-grained stream (channel and flood-plain) deposits of New Haven arkose. Dip here is gently north under the lava flows of the Hanging Hills, instead of the usual slightly steeper east dip.

Proceed on old Route 66 (Main Street of Meriden).

7.9 Enter town (and city) of Meriden.

8.6 Traffic light; exit from Hubbard Park on left (north). Continue on Main Street; we will return here.

8.8 Entrance to Hubbard Park on left (north). Continue on Main Street.

9.3 First of three traffic lights; continue (slightly left) on Main Street.

9.5 Third traffic light; intersection with Centennial Avenue. Turn right (south) on Centennial Avenue and proceed past another traffic light (at which street becomes Oregon Road).

11.1 Oregon Road crosses bridge (Quinnipiac River) and ends in T-junction. Park where you can (best on right, just beyond corner).

STOP 3: Hanover Pond (pond is just to east). Outcrops on south side of road across river; all are fairly conglomeratic New Haven arkose. Close to intersection (and along Quinnipiac River to west) they dip gently north, but to east along road, they dip more and more steeply west, quite unusual for the Triassic-Jurassic rocks of the Connecticut basin, and farther east several rather small faults can be demonstrated, mostly with east side upthrown. As shown on Hanshaw's map (GQ 738), we are close to the projection of perhaps the largest fault in this part of the Connecticut Mesozoic basin (Cathole Mtn.-Lamentation Mtn. fault, to name it for the two offset portions of the Holyoke flow). Turn around and proceed back (north) along Oregon Road.

12.7 Traffic light at Centennial Avenue and Main Street; turn left (west) on Main Street.

12.9 Traffic light; bear right on Main Street. Go slow and watch for next turn, which is blind.

13.4 Just beyond projecting outcrop, turn right (north) into Hubbard Park.

13.7 Road intersections in park; continue straight ahead under overpass of Route 66 and up hill beyond.

14.0 Quarry to right is in Talcott flow, which displays pillows and poison ivy. We will see the pillows better at a later stop.

14.2 South end of Lake Merimere.

STOP 4 (Optional): We are here close to the top of the Talcott flow, which can be seen, dipping north, at the top of the outcrops on the right side of the road. The cliffs above us on both sides of the lake are the Holyoke flow, also evidently dipping north. The little island in front of us appears to be a horst of the Talcott flow; the lake is artificial but the valley was excavated along one or more minor faults.

Continue north along east side of lake.

14.4 Outcrops of sediments on right; Shuttle Meadow formation. Rather fine-grained and thin-bedded flood-plain or lake sediments. (Enter town of Berlin.)

14.6 Outcrops of base of Holyoke flow on right.

14.9 Road climbs to north-dipping top of Holyoke flow and descends dip slope.

15.1 North end of Lake Merimere. Turn left (west) on rather poor road and follow it, first on strike along foot of dip slope (to 15.6), then (re-entering town of Meriden) up the dip slope (south).

16.5 Forks; take left fork towards East Peak. Note cliffs below to right.

16.9 Bear right into East Peak parking lot; park at upper end of lot (17.0) if feasible.

STOP 5: East Peak of the Hanging Hills. The base of the tower stands about 955 feet above sea level, whereas Hanover Pond (at STOP 3), visible off to the southeast, is 87. We are standing approximately on the upper surface of the Holyoke lava flow, which holds up all the highest hills in the Valley except those on the West Rock, Mount Carmel, and Barndoor intrusives. The characteristic double jointing in the Holyoke flow is particularly well displayed here. The older columnar joints show narrow altered (silicified?) selvages, which weather in slight relief above both the normal rock and the joint itself; the younger systematic joints cut undeflected across the columnar joints, implying that they had been entirely healed. Large boulders of this rock showing the characteristic jointing pattern are scattered over the countryside from here to Long Island Sound. The well known "Judges Cave" on West Rock in New Haven is a group of such boulders so placed as to provide some shelter; in 1661, three regicides (Dixwell, Goffe, and Whalley) hid there from the agents of Charles II.

The Talcott flow forms the bench at our feet, between us and the lake in Hubbard Park. The Hampden flow forms low ridges in the country to the northeast, beyond the dip slope on the Holyoke flow, but they are not clearly seen from here. The city of Meriden, spread out before us to the southeast, and all the country to the south is underlain by the New Haven arkose, drained by the Quinnipiac River to Long Island Sound at New Haven Harbor.

In the Hanging Hills, the Holyoke flow and the beds above and below strike nearly east-west and dip gently north, in strong contrast to their normal north-south strike and moderate east dip; the change is evidently associated with the particularly intense faulting in the Meriden region (see USGS GQ 738, 494; CG&NHS QR 8) and especially with the large sinistral offset in map pattern caused by the largest of these faults (sinistral offset does not prove sinistral strike slip, of course).

To the east across Lake Merimere is South Mountain, Holyoke lava displaced only a little to the left from what we are standing on; half hidden behind it is Cathole Mountain, displaced somewhat more. The largest fault (or group of faults) then offsets the Holyoke flow 8 miles to the northeast, to the north end of the Lamentation Mountain, the northernmost of the north-south mountains in the middle distance to the east, in which the Holyoke flow resumes its normal strike and dip. The main Hartford line of the New Haven Railroad and the Berlin Turnpike (visible at the foot of the mountain) go through the gap between, the .pa lowest divide into the Connecticut River drainage (175 feet). Chauncey Peak, the south end of Lamentation Mountain, is slightly offset from the

rest. Anouther fault then displaces the flow another 5 miles to the northeast, to the north end of Higby Mountain; Rt. I-91 goes through this gap. Smaller gaps are visible in the ridge from Higby Mountain south, each caused by a smaller offset along a similar fault; Rt. 66 and the old Air Line of the New Haven Railroad follow two of these gaps toward Middletown. From here it is not easy to pick out the larger gaps between Pistapaug Mountain (gap used by Rt. 17) or between Totoket Mountain and Saltonstall Ridge (used by Rt. 80); the latter gap is not caused by faulting within the Triassic but by a transverse anticline that abuts southeastward against the eastern border fault, interrupting the outcrop of the Holyoke flow (we will pass along it after 69.1).

Off to the north of Lamentation Mountain is Cedar Mountain, again upheld by the Holyoke flow brought up along a northern branch of the fault behind Cathole Mountain. The Hampden flow east of Cedar Mountain can be traced onto the Trinity College campus in Hartford. On a good day, the insurance towers of Hartford can be seen behind Cedar Mountain.

Behind Higby and Lamentation mountains and off to the northeast are the Eastern Highlands, separated from the Central Valley by the eastern border fault and the chief source of the Triassic and Jurassic sediments. Due east of us, one can make out the break in the Highlands at Middletown, where the Connecticut River turns away from the valley to find its way through the Highlands to the Sound.

In the opposite direction, the Holyoke flow extends west to West Peak (1,024 feet above sea level) and then turns abruptly north, resuming its normal strike and dip. Thence it extends north for many miles, though broken and somewhat offset by faults, forming Talcott Mountain west of Hartford and reaching Mt. Tom and Mt. Holyoke, on opposite sides of the Connecticut River in central Massachusetts - these can be seen from the top of the tower on a very clear day. (This spring the tower was closed to visitors, because the iron staircase is rusting out.)

Beyond West Peak is the valley underlain by the New Haven arkose, and behind that the Western Highlands. To the south, however, the West Rock sill appears, first as low hills within the valley, then higher and higher in front of the Western Highlands until Mount Sanford reaches the skyline and hides them. Out in the valley southwest of Mount Sanford is the large mass of Mount Carmel or the Sleeping Giant, an irregular sill or stock higher in the New Haven arkose than the West Rock sill and probably nearly above the main basement feeder dike.

Just to the left of and behind Mount Carmel, on a clear day one can see the Civil War monument on top of East Rock in New Haven and behind that the waters of Long Island Sound and Long Island. Thus one can see entirely across the 55-mile width of Connecticut, to points in Massachusetts and New York State 95 miles apart.

From the latitude of the Hanging Hills south, the hills upheld by the Holyoke lava and the Mount Carmel and West Rock sills reach to heights that decline steadily southward, reaching sea level around New Haven .pa Harbor; the slope is about 45 feet per mile (8 meters per kilometer). From the Hanging Hills north, however, no peaks on the Holyoke flow reach 1,000 feet until Mt. Tom (1,200 ft.) and the Holyoke Range; the slope

from West Peak to Mt. Tom would be only about 4 feet per mile (less than a meter per kilometer). The sloping hill-top surface to the south is continuous with the surface beneath the Cretaceous rocks on Long Island - for this reason, from the Hanging Hills Long Island Sound and Long Island appear higher than any of the hills between - and it therefore represents the Fall Zone surface or facet (Flint, 1963); even the highest hills to the north have been reduced by erosion well below this surface. One can therefore imagine that when that erosion was going on, Cretaceous rocks still reached inland as far as Meriden. As Barrell pointed out long ago, it is probably no coincidence that the Conencticut River deserts the Connecticut Valley just at this latitude. Return to Lake Merimere, south along it, and back down under the overpass of Route 66.

20.3 (= 13.6 above) Corner in Hubbard Park; must turn right; then take next left (20.4) and proceed to traffic light on Main Street.

20.6 (= 8.6 above) Turn right (west) on Main Street.

21.5 Turn left onto ramp for Route 66 East; we will drive by the outcrops of STOP 2 and others, all dipping gently north under the Hanging Hills and its lower bench (Talcott flow).

23.3 Exit 5; continue on Route 66. Road here approaches base of Talcott flow, which crops out in the northern entrance ramp of Exit 5. Just beyond, however, the road crosses the Cathole-Lamentation fault, upthrown to the east, and the cuts are in beds much lower in the New Haven arkose, which dip east at a fairly high angle. Higby Mountain, east-dipping Holyoke flow, bars the view eastward, and the bench formed by the Talcott flow is visible beneath it. Continue to exit 12.

26.8 Take Exit 12 off Route 66.

27.2 Turn left (north) on Preston Avenue.

28.0 Take entrance ramp onto I-91 North (Exit 19), and park near top of ramp but not on main highway.

STOP 6: Proceed north to outcrops along right (east) side of I-91. These are the Talcott flow, partly vesicular, in places showing excellent pillows, especially on glacially smoothed and striated surfaces. (The top of the flow could be seen still farther along, but the outcrops have been degraded by weathering and geologists.)

28.2 Continue north onto I-91, following it to Exit 21. Enter town of Middletown and Middletown quadrangle. At first, road follows swampy belt over Shuttle Meadow formation between bench (Talcott flow) to west and Higby Mtn. (Holyoke flow) to east, but about where it begins to descend, it approaches a major fault (offsetting Higby Mtn. from Lamentation Mtn. or its southern satellite, Chauncey Peak) that cuts off the Talcott flow to the west and then bevels the Holyoke flow, which crops out along the road. At about 31.3, one catches a glimpse of Westfield Falls in a gorge just east of the road; the falls is over virtually the north tip of the Holyoke flow as it is cut off by the fault.

32.9 Mattabassett River; enter town of Cromwell.

33.0 Exit 21; turn off toward Route 72.

33.3 Traffic light at Route 72. Turn left (east).

33.7 Traffic light; turn left (north) on Coles Road.

34.3 Turn left (northwest) on North Road Extension, which goes under I-91 and becomes North Road.

35.1 Cross-roads; continue straight ahead on road marked No Outlet.

35.5 Park as road descends toward brook, and climb well beaten path into brush to right.

STOP 7: Large highway cuts built for projected extension of Route 9 west of its intersection with I-91. (These cuts lie astride Middletown-Hartford South quadrangle line.) They display about the upper half of the East Berlin formation and its contact with the overlying Hampden (3rd) flow. The East Berlin formation exposed here consists of a triple alternation of fine-grained red flood-plain deposits and even finer grained gray and black lake deposits (the cycles are about 10 meters thick, except the uppermost). At the top of each group of lake beds is a sandstone layer. Carbonate (mainly dolomite) is common, especially in the lake beds and the overlying sandstone. The sandstone at the top of the highest lake beds is the level of the dinosaur trackways at Dinosaur State Park, our next stop. A few tracks have been observed here, but the nature of the outcrops (vertical faces instead of pavement outcrops) is unfavorable to finding them. Plant remains and fish scales have also been found in this cut, but in general fossils are rare here.

The Hampden flow is formed of several flow-units (Chapman, 1965), as can be seen here. Vesicles and amydgales are visible in the tops and bottoms of some of the flow-units. Fine specimens of amethyst have been found in the Hampden flow in this cut. Turn around and return to I-91, turning onto ramp for I-91 N at **37.7** (=33.3 above). For next 3 miles, route follows east foot of dip slope of Hampden flow.

39.2 Intersection with Route 9; the cross-ramps, over and under, lead to the cuts visited at STOP 7. Continue on I-91. Enter Hartford South quadrangle.

39.9 Enter town of Rocky Hill.

41.0 Take Exit 23; just ahead, dip slope swings across I-91 (good cuts at crest of hill ahead), and exit ramp climbs up it.

41.4 End of ramp at West Road, on crest of ridge on Hampden flow. Turn right (east) on West Road.

41.8 A small fault offsets the ridge to the right, and road drops off it. Dip here is south, off Rocky Hill anticline.

42.1 Entrance to Dinosaur State Park on right.

STOP 8: In 1966, the State Highway Department chose this site for a central Highway Department Research Laboratory, close to but not on Interstate I-91 near the geographic center of the state. One Friday afternoon in August, one of the bull-dozer operators, Mr. Ed McCarthy, engaged in clearing the overburden to bedrock before construction, turned up flat slabs of sandstone on which he recognized some large dinosaur footprints (such prints have of course been well known in the Connecticut Valley for 150 years). After investigating, the project engineer, Mr. Tom Jeffreys, stopped excavation in the area and called the Yale Peabody Museum, the University of Connecticut, and the newspapers; later an announcement was broadcast on TV, and the Saturday Hartford Courant carried the story. As word of the find spread, many persons came down over the weekend to pick up examples for their patios, rock-gardens, etc. The news also reached Ms. Jane Cheney, Director of the Children's Museum in Hartford, who went directly to Governor John Dempsey (about to stand for re-election) and persuaded him that the find was exceptional and should be preserved. At a meeting of state officials on Monday morning, it was agreed that Peabody Museum would direct the bull-dozer operators while they determined the size and significance of the deposit; Prof. John Ostrom of the Museum and Prof. Joe Webb Peoples of Wesleyan University, then Director of the Connecticut Geological and Natural History Survey, were in general charge. Later the Governor declared the locality The Dinosaur State Park. A news item concerning the dinosaur trackway appeared on the front page of the Hartford Courant for twelve straight days. Clearing continued for several weeks, until a single surface of sandstone displayed over two thousand tracks. Testing elsewhere on the property showed that the layer with the tracks was even more extensive; moreover it is only one of five layers within about 2 meters of rock that display tracks.

By this time, it was thought that enough had been uncovered to make a spectacular display, and the work was stopped; the main concern after that was to preserve the tracks against the approaching winter's freezes and thaws. The tracks were therefore covered up, and, except for one or two brief spells, the main discovery site has not been uncovered since. On the other hand, in 1967 a more modest area was uncovered west of the

main site (in the same layers), which could be covered by a temporary structure (a plastic bubble kept up by excess air pressure), and this area became the main exhibit at the Park. Later the temporary structure was replaced by the present more permanent structure, but the original plan to build a larger museum over the main, original discovery has never been carried through. In any case, the Park was duly dedicated in 1967 by Governor Dempsey; honor was paid to Mr. McCarthy, the original finder of the tracks; and the Rocky Hill High School Band played a new piece of music called "Dinosaur", written for the occasion by its Director.

As the Hampden flow forms the ridge immediately south of the trackway area, the stratigraphic position is known exactly; when the I-91 cuts about 2 1/2 miles to the southwest were opened, the trackway levels were pinpointed there (see description of STOP 7). While the main trackway was still uncovered, a trench was dug down dip to the south, which showed that the trackway layers are cut downdip by a small thrust fault, dipping south more steeply than the beds, so that the trackways layers are brought back up closer to the land surface. If a museum is ever built over the original site, this trench could be reopened and the thrust fault displayed. Its westward extension is clearly responsible for the right offset of the Hampden ridge between the Park and I-91 (noted at 41.8).

The Highway Department, deprived of their original site, had to recommence operations about a mile farther east, and rumor has it that the bulldozer operators were given strict orders to stop for nothing.

Continue east on West Road.

43.0 Intersection with Route 99; turn right (south). Shortly we cross the Hampden flow into the Portland arkose.

44.2 Enter town of Cromwell.

45.1 Enter Middletown quadrangle.

48.0-48.3 Route 99 joins Route 9 (south).

48.9 Enter town (city) of Middletown. Continue on Route 9 past Middletown exits to exit for Route 17 south.

50.1 Take exit for Route 17 S.

50.6 Turn left (south) with Route 17 around traffic circle.

54.6 Enter Durham quadrangle.

54.9 Enter town of Middlefield.

55.1 Enter town of Durham. Continue through village of Durham on Route 17.

57.2 Forks of Routes 17 and 79; bear right (southwest) on 17.

57.4 Forks of Routes 17 and 77; bear left (south) on 77 and prepare to stop.

57.7 **STOP 9:** Outcrop on left (east) side of road. We are still in the Portland arkose, which is normally medium to fine grained, but here it is a polymict fangomerate. At this locality, the eastern border fault of the Connecticut basin is about a quarter mile to the southeast; as we will see in the rest of the trip, all sedimentary units of the Newark group turn into fanglomerate as they approach the fault, which, as Barrell saw clearly 70 years ago, must therefore have been active during the entire depositional history of the group. The pebbles and cobbles (none larger than about head-size here or anywhere along the fault) are made of rocks from the Eastern Highlands, and indeed by far the largest part of the Newark group in the Connecticut basin is from that source. At this locality, however, a few cobbles of basalt can be found, showing that lavas (volcanoes?) were exposed on the Eastern Highlands, perhaps over the Higganum dike, which can be followed across Connecticut within the Eastern Highlands and here is about 4 miles to the southeast. Or the basalt might be derived from "Foye's volcano" (Foye, 1930), which is exposed about 0.6 miles southwest of here just west of the border fault.

John L. Rosenfeld, during his two years at Wesleyan, instigated a study of the cobbles in the fanglomerates along the border fault and reported (pers. comm.) that the grade of metamorphism in them increases upward; i.e., that the lowest Newark strata contain fragments from lower grade metamorphic rocks, now entirely removed by erosion, and the highest strata contain rocks much more like those to be seen today in the Highlands. Unfortunately the results of this work have not been adequately published (but see Eaton and Rosenfeld, 1960, p. 174).

58.1 Road bears to right, swinging to follow the eastern border fault, here marked by a pronounced valley between the schist and gneiss (Collins Hill formation - Ordovician?) to the left (east) and strata of the Newark group to the right (west). "Foye's volcano" is exposed in an overgrown quarry at the foot of the first spur to the right. Our route now follows the border fault, more or less, for about 11 miles, as far as the village of North Branford.

59.3 Road swings a little to east into Eastern Highlands. The outcrops around and just north of the farm on the right are of mylonitized and silicified schist along the fault.

59.8 Enter town of Guilford.

61.5 Road returns to fault at the pass. The low outcrop left of the road is schist and pegmatite; the quarry right of the road is in the Holyoke flow dipping south at the east, cut-off butt end of Totoket Mtn. Within the lava is a large block of phyllite, interpreted as a block that slid off the fault scarp to the east into the flow. We cannot stop here with a large group; those who wish to stop on their own are warned that the quarry is full of poison ivy.

61.8 Road cut on right once displayed the eastern border fault, but unfortunately weathering in the forty years since it was cut has obscured the evidence. The main face is in badly weathered Holyoke lava (probably close to the top of the unit), at the south end of the face is even more badly weathered schist, and fresher pegmatite can be found in the floor of the cut. The cut was described in detail by Digman (1950) when it was fresh; between the lava and the schist on the face was about a foot of gouge, into which a shovel handle could easily be driven. The fault dipped 55° west. Beyond, schist and pegmatite are exposed on the left of the road; then the road swings back across the fault.

62.2 North end of Lake Quonnipaug, which here fills the fault-line valley. Up a private road to the right (west), there used to be exposed a mass of metamorphic rock surrounded by fanglomerate of the East Berlin formation. As suggested by de Boer (1968, Trip C-5; p. 10), the mass is probably a large landslide block, comparable to but much larger than the mass of phyllite in the Holyoke flow at 61.5. Continue south on Route 77 for 0.4 mi. down the west side of Lake Quonnipaug.

62.6 Park either just beyond or just opposite a wall made of large quarried blocks of granite (Stony Creek granite, probably from the Norcross quarry in Branford).

STOP 10: Outcrops south of and above the granite wall are the Hampden flow, here dipping 40° south and hence striking perpendicular to the border fault. North of the wall are outcrops of coarse conglomerate like that at STOP 9 (but no basalt is reported). Stratigraphically these beds are exactly at the level of those seen beneath the Hampden flow at STOP 7, but the difference in grain-size is striking. Pegmatite and gneiss of the Eastern Highlands make the outcrops across the lake.

Continue south on Route 77. The route continues to follow the west side of the valley over the fault, which makes several blunt angles. As pointed out by Wheeler (1939), where the fault makes an angle convex to the east, the strata west of it form a basin; where convex to the west, they form an arch. Thus the Hampden flow butts against the fault four times in the next four miles of its course, dipping alternately south (here and at about 65.0) and northeast or east (at about 63.8 and north of 67.3). The fault, a wide gouge zone carrying much water, was exposed in the tunnel of the New Haven Water Company from Lake Hammonnassett to Lake Gaillard, crossing our route a little south of the south end of Lake Quonnipaug (Walton and Lundgren, personal communication).

64.1 Enter Guilford quadrangle.

65.2 Road corner; exposure of conglomeratic Portland arkose in second of the two basins. At this point the fault angles sharply to the right (west), more or less followed by the road to the right, but we continue straight ahead on Route 77 into the Eastern Highlands rocks, again the Collins Hill schist.

65.8 Road crosses Higganum dike within Eastern Highlands (briefly mentioned at STOP 9).

65.9 Intersection with Route 80; turn right (west) on Route 80.

66.1–66.2 Road crosses dike again, this time obliquely.

67.3 Enter town of North Branford.

67.5 Route 80 approaches and enters fault-line valley; road from corner at 65.2 rejoins it. Conglomerate has been exposed or dug up at several points on the north side of the road from here to village of North Branford, and large blocks may be seen here and there.

67.7 Enter Branford quadrangle.

69.1 First traffic light in village of North Branford; continue on Route 80, which shortly bends to northwest around the south, cut-off butt end of Totoket Mountain, made of the Holyoke flow dipping northeast (cf. 61.5). The road here abandons the border fault and enters an anticlinal valley over Shuttle Meadow formation between Totoket Mtn. (Holyoke flow dipping northeast) and Saltonstall Ridge (Holyoke flow dipping southwest).

70.4 Entrance to North Branford traprock quarry, exploiting Holyoke flow.

70.7 Junction with Route 22; continue west (bearing left) on Route 80. Route now enters valley over Shuttle Meadow formation between scarp slope of Holyoke flow in Saltonstall Ridge (which outlines another large basin) and dip slope of Talcott flow (rather broken up by faulting); in general the road hugs the foot of the dip slope for the next 6 miles.

71.8 Traffic light in Totoket village; continue straight on Route 80.

72.3 Enter town of East Haven.

72.5 Road bends to right around outcrop of Talcott flow. Near west end of this cut a clastic dike of (baked) arkose cuts the lava flow, which shows chilled margins against it. This stop is worth making but is quite impracticable for a large group. Those wishing to stop should go beyond the outcrop and park as soon as possible, but be very careful on the outcrop as the road is busy and the corner is blind.

73.2 Junction of Routes 80 and 100 in village of Foxon; bear left on Route 100. Road continues to follow foot of dip slope of Talcott flow; Holyoke flow makes Saltonstall Ridge across the valley. The sinuous course of the valley, ridges, and road reflects the sinuous strike of the strata.

76.7 Pass under Route I-95.

76.8 Traffic light at N end of bridge over railroad. Bear left over bridge onto High Street.

(**Optional Stop:** Turn right at light onto Laurel Road and proceed about 0.1 miles to overpass of Route I-95. Park and climb up into cut of I-95 through Talcott flow. There are pillows here, but they aren't as good as those at STOP 6. West end of cut on north side of road appears to be a dike (or dikes), but at one place halfway up the cut the dike rock seems to grade into the (pillow) lava. Return to traffic light and turn right (south) across bridge.)

77.05 Traffic light (first of two). Turn left (east) on nameless street (in front of Old Stone Church).

77.3 Stop sign at intersection. If optional STOP 11 is to be made, turn left (north) with care. Otherwise turn right (south) and pick up itinerary at 77.9.

77.4 Traffic light at U.S. 1. Cross straight across U.S. 1 onto Estelle Street, which shortly bends around to the right.

77.6 End of Estelle Street.

STOP 11: (Optional) Climb up to locked gate on small bridge over railroad and I-95. The big cut ahead is in the east-dipping Holyoke flow at the south end of Saltonstall Ridge; the reservoir to the right, Lake Saltonstall, fills the valley over the East Berlin formation. The Hampden flow forms the hills east of the lake. But the pass utilized by the railroad and highway lies on a cross-fault that offsets the strata 0.1 mile to the left; on our side of the bridge the flow forms the hill to our right, and the railroad cut below and to the right of the bridge is in the Shuttle Meadow formation (pieces of fresh-water limestone have been found there). Detailed mapping by John Sanders and students in the Yale Field Geology course, during the construction of I-95, showed that the fault zone is composite, being made of several nearly vertical parallel (east-west) faults, not all with left-handed offset. The little ridge between the railroad and I-95 is worth visiting as evidence of the composite faulting, if the gate key can be obtained from the New Haven Water Company.

(A precisely similar [or slightly larger] offset 0.35 miles to the south is utilized by U.S. 1. The cuts on the north side of U.S. 1 there show rather coarse or even finely conglomeratic sediments of the Shuttle Meadow formation cut by numerous small faults. The Holyoke flow does not crop out at the roadside but can be found around the corner on the dirt road on the west side of Lake Saltonstall at its outlet. On the other

hand, if one climbs along the hillside west from that point one remains in lava almost all the way to the west end of the cuts along the road below. The main cross-fault therefore lies only a few meters north of the roadcuts and is roughly parallel to them.)

(The site of the first iron smelter in Connecticut is believed to lie on the south side of Route 1, just below the dam of Lake Saltonstall. The ore used was presumably bog iron from swamps lying upstream from the smelter and now beneath the lake.)

Turn around and retrace route to U.S. 1 (77.8) and corner beyond.

77.9 Bear left (onto Hemingway Street, not marked).

78.0 Traffic light at intersection with Main Street. Proceed straight ahead. (To see road cuts along U.S. 1 mentioned in description of STOP 11, turn left here and proceed 0.3 miles east until street approaches U.S. 1. Stop there, look across U.S. 1, and observe the relations. Although a traffic light marks the intersection, it is quite dangerous to try to cross U.S. 1 on foot and also dangerous to work along the outcrops because the road curves around the outcrop and the cars, travelling at high speed, cannot see you until they are almost on you.)

78.1 Turn left on River Street and proceed to end.

78.4 Parking lot is behind Trolley Museum office on left.

STOP 12: East Haven-Branford Trolley Museum. We will board the trolleys, cross East River into town of Branford, and proceed south about 3/4 mile, following the west foot of Beacon Hill, formed by the Holyoke flow south of the offset at U.S. 1. Where the ridge ends and the trolley track turns left (east) and ends, debark. You are now exactly on the eastern border fault again. Quartz veins in highly silicified gneiss (Light House gneiss, probably latest Precambrian) can be seen south of the tracks, and the Holyoke flow is exposed in a large quarry north of them. Coarse conglomerate can be found on the upper west slope of the ridge beneath the basalt at the summit; it is already considerably coarser than the rocks exposed along U.S. 1 less than a mile to the north.

When you are through looking, hail a trolley. On the trip back, don't fail to stop to see the main trolley museum.

End of field trip. To return to Kline Geology Laboratory, retrace itinerary to U.S. 1 (77.8 above) and turn left on it. In a little more than a mile, a left exit leads onto I-95. Follow I-95 to Exit 48 (right exit) onto I-91, then take Exit 3 (Trumbull Street). At traffic light at end of ramp, turn right on Orange Street, turn left at next traffic light onto Humphrey Street, and continue straight at next traffic light (Whitney Avenue) into Kline parking lot. KGL is to the left, at the south end of the parking lot. Distance from trolley museum is about 5 3/4 miles.

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