FIELD GUIDE TO DUTCHESS COUNTY, NEW YORK, BARROVIAN SEQUENCE

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The Barrovian sequence begins in the vicinity of Poughskeepsie, New York.

A detailed road map of the county is: Hagstrom Map of Dutchess County, New York (1: 48 000).

Metapelitic rocks, with lesser amounts of metacarbonate, calc-silicate, and quartz-rich metasedimentary rocks dominate the Barrovian sequence. Rare amphibolites occur in the vicinity of Clove Valley. [eventually there will be more intro text here]. Protoliths of the metapelitic rocks were Cambrian and Ordovician clastic sedimentary rocks deposited along the eastern margin of North America during the early stages of the Taconic orogeny.

The sequence was first mapped by Robert Balk in the 1920's and 1930's (Balk, 1936); see also Barth (1936) in the same issue of the Geological Society of America Bulletin, although you may want to ignore the interpretation that metamorphism was related to igneous activity.

References to the geology of Dutchess County include:

Balk, R. (1936) Structural and petrological studies in Dutchess County, New York, Part I. Geologic structure of sedimentary rocks. Geological Society of America Bulletin, 47, 685-774.

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Bence, A.E., and McLelland, J.M. (1976) Progressive Metamorphism in Dutchess County, New York. New York State Geological Association Guidebook, Trip B-7.

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Garlick, G.D., and Epstein, S. (1967) Oxygen-isotope ratios in coexisting minerals of regionally metamorphosed rocks. Geochimica et Cosmochimica Acta, 31, 181-214.

Ratcliffe, N.M., and Burton, W.C. (1990) Bedrock Geology of the Poughquag Quadrangle, New York. United States Geological Survey, GQ 1662.

Vidale, R.J. (1974) Vein assemblages and metamorphism in Dutchess County, New York. Geological Society of America Bulletin, 85, 303-306.

Vidale, R.J. (1973) Metamorphic differentiation layering in pelitic rocks of Dutchess County, New York. In A.W. Hoffman, B.J. Giletti, H.S. Yoder, Jr., and R.A. Yund, Eds., Geochemical Transport and Kinetics, p. 273-286. Carnegie Institution of Washington, Publication 634.

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Whitney, D.L., Mechum, T.A., Kuehner, S.M., and Dilek, Y. (1996) Progressive metamorphism of pelitic rocks from protolith to granulite facies, Dutchess County, New York: constraints on the timing of fluid infiltration during regional metamorphism. Journal of Metamorphic Geology, 14, 163-181.

Guide to collecting at least one sample from each Barrovian zone

The protoliths of the metamorphic rocks likely resembled the turbiditic sedimentary rocks exposed in outcrops near the Hudson River, in and around Poughkeepsie, New York. These are very slightly metamorphosed and some outcrops display a faint fabric, but in outcrop and in thin section they mostly look like sedimentary rocks. The rocks have been called the “Hudson River Shales” (Austin Glen member of the Normanskill Formation), and have well-developed bedding, including graded bedding.

The field trip has two possible starting points: “protolith” outcrops on the western side of the Hudson River (Stop 1A), or on the eastern side (Stop 1 B; east of Poughkeepsie, close to the chlorite zone outcrops). The Hudson River outcrop is the better of the two, but requires driving through Poughkeepsie to get to the other stops.

Stop 1A. Protoliths at Johnson Lorio Memorial Park.

This stop is ~ 0.5 miles north of the Mid-Hudson bridge on Route 9, west of the river. Turn east on Haviland Rd (you will see signs for pedestrian access to the bridge). The park entrance is 0.9 miles from the Rt 9 and Haviland turnoff. The park has two picnic benches and a nice view of the Hudson.

Both in the park and around the corner in the approach to the Mid-Hudson Bridge are spectacular outcrops of Austin Glen sedimentary rocks. Although not correlative with the metamorphic units to the east, these outcrops are good examples of interbedded sandstone, siltstone, and shale, and resemble what the protoliths of the metamorphic rocks likely were. Metamorphic units to the east (e.g., garnet zone rocks) contain meter-scale layers of schist that vary in the amount of quartz and mica.

Exit park and proceed back to the junction of Haviland and Route 9.

"Protolith" outcrop near Mid-Hudson Bridge

"Protolith" outcrop on Route 9W (not on map yet)

Miles/Cumulative

1.0/1.0	Turn left on Route 9, take the ramp onto the Mid-Hudson Bridge on combined 44 & 55, then drive east through Poughkeepsie.
4.45/5.45	Follow 55 when 44 & 55 split
2.05/7.50	Follow 55 to corner of Noxon Rd (Dutchess County Rt. 21). If you want to see the second "protolith" stop, park on the north side of Rt 55. If you've had enough of "protoliths", continue to the Chlorite Zone outcrop by turning right (south) on Noxon Rd. **Reset odometer.**

Stop 1B. Protolith at NE corner of 55 and Noxon Rd.

This is a small, shaley outcrop on the corner between the gas station and other businesses. The rocks show a weak schistosity and minor folding, and white mica is visible in hand sample.

Cross Rt 55 and proceed south on Noxon Rd. Reset odometer.

Follow Noxon Rd (Rt 21) to the southeast. The first substantial outcrops are seen after ~ 3.7 miles. A good parking spot is on the north side of the road between the first and second set of outcrops after 4.35 miles. The parking spot is on the inside of a curve, so be alert. If you reach Arthursburg Rd or the Taconic Parkway, you have gone too far east.

4.35/4.35 Stop 2. Chlorite Zone of Noxon Rd.

Stop 2. Chlorite Zone at Noxon Road

The east end of the road cut consists of red and green slates. The west end has black slates, phyllites, and other low-grade metamorphic rocks. Similar rocks can be found in James Baird State Park to the north.

There are nice folds at this outcrop.

Noxon road green and red slates.

Folds in green slate/phyllite

Continue on Noxon Rd (Rt 21) to the southeast.

0.75/5.05	Follow Route 21 (now East Noxon Rd) when it turns to the left (north). If you miss the turn you will end up on Arthursburg Rd.
3.70/8.75	Cross Rt. 55 (unmarked on East Noxon). Small cemetery at NW corner of intersection, with stoplight and street sign for Perkins Lane.
0.85/9.60	Beginnings of small outcroppings of black, graphitic slates. There is no good place for parking, but if traffic is light, you can pull of the road at mileage 9.5 on a straight bit of Rt 21.

In some outcrops of graphitic slate, biotite is macroscopic (you may need a hand lens to see it). Biotite grows across the main foliation (do not confuse with ilmenite, which also does this but is not platy).

Continue east on Rt 21

0.45/10.05	Pass poorly signed entrance for Tymore Park on left. Pull off and park on Perkins Rd (left) at bottom of hill.
0.30/10.35	Stop 3: Biotite Zone at Perkins Rd.

Stop 3. Biotite Zone at Perkins Rd.

Examine the extensive outcrops of biotite phyllite, traveling west on foot up the hill. Note the prominent quartz veins.

Biotite zone phyllite

There are more outcrops of biotite zone slates as the road goes downhill on the west side of Clove Valley. Some outcrops have abundant vein quartz. Larger outcrops are on private land next to the road.

Continue east on Route 21. Cross roundabout intersection with Route 9.

1.25/11.6 Intersection with Route 9. Rt 9 goes along Clove Valley, which is underlain by metacarbonates. Route 21 becomes the Wingdale Rd after it crosses Rt 9. Travel up the east side of Clove Valley.

0.65/12.25 Stop 4. Garnet Zone near Clove Valley. Parking is on the right in a small pull-off along the road.

Stop 4. Garnet Zone near Clove Valley.

There are excellent outcrops in this vicinity, both along the road and in the woods (note: some of the land is owned by a private hunting/fishing club that typically does not grant permission to visit; unfortunately, the best outcrops are on their land). Garnet is sparse in some outcrops and layers, and abundant in others. If you walk back down the hill (west), you will see outcrops of graphitic, biotite-rich schists as layers alternating with more quartz-rich (± garnet) layers. Prominent garnet-bearing outcrops also occur uphill on the north side of the road.

Some of the best exposures of garnet (+ chloritoid)-bearing rocks are of Route 21 but close to the parking area, about ~ 200' along a gated jeep trail and to the east in the woods. Black chloritoid grains can be seen growing across the foliation, although in thin section it can be seen that some chloritoid grains are themselves deformed even as they grow across the primary matrix foliation. Most (but not all) of the chloritoid-bearing rocks lack biotite.

Garnet zone schist

East of here, in outcrops along and near the road, chloritoid is sporadically developed. You can collect a variety of rocks with different mineral assemblages but the same metamorphic grade to illustrate the effect of bulk composition on metamorphic assemblages.

An interesting aside: Barth (1936) reported glaucophane in amphibolite from this region (in the woods heavily posted with No Trespassing signs to the north of the road). Later workers (Zen, 1976) have dismissed this possibility and proposed that Barth confused chloritoid for glaucophane. I have personally always believed that Barth really did find glaucophane, but I have not found the outcrops and I was not able to find Barth's Dutchess County sample collection (formerly housed at the Geophysical Lab). I think that if someone spent time systematically wandering around in these woods looking at all the outcrops (consult the map in Balk (1936) for an idea of where the amphibolite outcrops are), they might find something interesting. Blueschist pods in this sequence would be no more unusual than the blueschist occurrences in Vermont, but would be well worth finding.

Continue east on Rt 21 (Wingdale Rd) to the intersection with Pleasant Ridge Road (Dutchess County 32). Turn right.

1.15/13.40 Proceed south on Pleasant Ridge Rd (32) to the intersection with Still Road. Still Rd. is not marked, but meets Pleasant Ridge Rd at ~ 70°. Take the soft right onto Still Rd.

0.60/14.00 Drive on Still Road to the Lower Staurolite Zone outcrops at:
0.65/14.65 Stop 5. Lower Staurolite Zone outcrops at Still Rd.

Stop 5. Lower Staurolite Zone outcrops at Still Road

Look for small, rounded outcrops north of the road. These outcrops are nearly on strike with the garnet zone outcrops of the last stop, but the rocks here are slightly higher grade. Although it may be difficult to see in hand sample, some chloritoid grains have been partially replaced by staurolite, and there is some staurolite in the matrix as well. The mineral assemblage here is garnet-staurolite-chloritoid-chlorite-biotite-quartz-muscovite-plagioclase-ilmenite (5 AFM phases, but not all in equilibrium). Both biotite and chloritoid can be seen in hand sample.

These outcrops are the lowest grade rocks in which staurolite is found in the sequence (lower staurolite zone of Whitney et al., 1996). Watch out for poison ivy at this stop.

Lower staurolite zone outcrop on Still Road (garnet-chloritoid-staurolite)


Still Road outcrop (lower staurolite zone)

Proceed west on Still Road and turn around at Mennella Road.

0.05/14.70	Follow Still Road and Pleasant Ridge Rd (32) back to the intersection with Rt 21. Turn right (east). Note that to the east, Rt 21 is now (somewhat confusingly) also named Pleasant Ridge Rd.
1.35/16.05	Travel east on Rt 21 to a descending south-trending series of road cuts. The best way to find a place to park (and to get pointed in the right direction) is to turn around using the right-hand shoulder where an old fenced access road juts off the outside of a curve in Rt. 21 near the bottom of the series of road cuts.
1.55/17.60	Travel back west along Rt 21, climbing back up the hill. Park on the broad right-hand shoulder on the north side of the road.
0.25/17.85	Stop 6: Upper Staurolite Zone outcrop on Rt 21

Stop 6. Upper Staurolite Zone on Route 21

There are excellent outcrops of staurolite schist along Route 21, east and west of the big bend in the road (upper staurolite zone of Whitney et al., 1996). Just west of the bend, staurolite schist with abundant quartz veins occurs. Staurolite and garnet are locally very coarse (5-8 mm), and in rare cases up to 1 cm.

Garnets occur in the quartz veins (pieces removed from the matrix) and veins truncate some matrix garnets. Interaction between the vein-forming fluids and the matrix assemblage can be seen in thin section (Whitney et al., 1996).

Upper staurolite zone outcrop on Rt 21

Upper staurolite zone outcrop on Rt 21

Follow Route 21 back (west) to the intersection with Pleasant Ridge Rd (32)

1.35/19.20 Turn left (south) on Pleasant Ridge Rd (Rt 32). Follow Rt 32 to the intersection with Rt 55.

3.75/22.95 Turn left (south) on Rt 55. Follow Rt 55 (crossing the Appalachian Trail and the intersection with Route 292) to the intersection with northbound Old Rt 55. Turn left on Old Rt 55.

1.80/24.75 Follow Old Rt. 55, which parallels modern Rt 55. Old 55 leads to Edward R. Murrow Park, and there are many excellent outcrops for ~ 1.5 miles along and near the road between the west end of the road and the neighborhoods near Parce Pond (Woodinville). There are also good outcrops along some of the side roads (Penny Rd, Wilkinson Hollow Rd). A good place to stop is on the right shoulder near the crest of the hill on Old Rt 55 across from some trophy homes.

0.90/25.65 Stop 7. Kyanite Zone on Old Route 55.

Stop 7. Kyanite Zone on Old Route 55

Kyanite is easily seen in outcrop as blue blades, some nearly 1" long. The rocks contain garnet-kyanite-biotite-muscovite-quartz-plagioclase ± rutile. Staurolite is rare in these rocks. The lack of staurolite has been attributed to bulk composition effects (Bence and McLelland, 1976); the kyanite schists are more Mg-rich than the staurolite schists to the north and west.

Kyanite zone outcrop on Old 55


Kyanite blades in outcrop (Old Rt 55)

Quartz veins are abundant here. Garnet and kyanite occur in the veins, and appear to be matrix grains that have been incorporated into the vein. Interaction between the vein-forming fluids and the matrix garnet-kyanite assemblage can be seen in thin section (Whitney et al., 1996).

You may also find local hornblende-rich pods associated with the kyanite schists.

Turn around here in one of the wide driveways and travel back along Old Rt 55 to Route 55.

0.90/26.55 Turn left (south) on Route 55 towards Pawling. There are many good Kyanite Zone outcrops along the next mile of Route 55. If you stop at these, warn your students that they should not confuse black spots of tar on the surface of some outcrops for an interesting mineral.

You will pass outcrops of the Precambrian Hudson Highland massifs (granitic gneiss with a carapace of quartzite; the quartzite is exposed near Poughquag, and the granitic gneiss in outcrops along Rt 55).

2.75/29.30 Abundant calcite marble, with lesser amounts of calc-silicate and dolomitic marble, crop out to the east, in and around the village of Pawling, and north, underlying the Harlem Valley. Large road cuts of calc-silicate along Rt 55 (just SW of Pawling) contain diopside, tremolite, and phlogopite. These calc-silicates are in the sillimanite zone. At this mileage there is a good outcrop on the north side of the road, and room to pull off on the right (south) side. Once you admire the Metacarbonates, proceed along Rt 55 to the Rt 22 northbound on-ramp.

2.0/31.30 Follow Route 22 north and turn right (east) on Quaker Hill Rd (Rt 67).

0.65/31.95 Ascend Quaker Hill Rd to the Sillimanite Zone outcrops along Tracy Hill. They crop out along the 2nd leg of a hairpin turn. The best bet for parking is at the base of these outcrops at the 'hairpin' of the curve, where the road is broad and there is good visibility.

0.40/32.35 Stop 8. Sillimanite Zone on Quaker Hill Rd.

Stop 8. Sillimanite Zone on Quaker Hill Road

Road cuts along Quaker Hill Rd (and also north on Tracy Rd) are sillimanite schist. Large garnets are locally developed, and abundant, coarse muscovite is easily seen. Sillimanite is difficult to see in outcrop, but there is visible sillimanite in some layers. It is primarily fibrous sillimanite. Relicts of staurolite locally occur and can be seen in thin section.

Tourmaline-bearing granitic veins (pegmatites) have been interpreted as suggesting the onset of partial melting (Bence and McLelland, 1976). There are no major plutons at exposed levels anywhere in the Dutchess County sequence.

Garnet-sillimanite schist

Garnet-sillimanite schist

Continue east (uphill) along Quaker Hill Road. Pass Tracy Hill Road.

0.60/32.95 Continue east along Quaker Hill Rd to the junction of Rt 66. Turn right (south) on Rt 66.

0.25/33.20 Follow Rt 66, passing turnoff with Rt 67. Park on Burgess Rd, which branches off to the left (south).

0.85/34.05 Stop 9. Sillimanite + K-feldspar Zone on Burgess Rd.

Stop 9. Sillimanite - K-feldspar Zone outcrop on Burgess Road

There is no particular 'best' outcrop of sillimanite-kspar zone rocks, and this region near the New York-Connecticut border is being rapidly developed (many former outcrops are now in yards of private homes or have been removed by construction). Outcrops of sil-kspar gneiss can be seen by continuing on Quaker Hill Rd where it turns north and parallels the NY-CT border, and along Rt 67 in both NY and CT. The rocks contain some muscovite, which can be seen in hand sample.

The directions above lead you to one accessible outcrop (more information in subsequent editions of the field guide).