ABSTRACT

The Day Mountain thrust sheet is part of the Berkshire massif in western Massachusetts. Mesoproterozoic basement gneisses and unconformably overlying Neoproterozoic Dalton Formation and Cambrian Cheshire Quartzite were thrust westward over Cambrian to Ordovician marbles of the Stockbridge Formation. Thrusting was interpreted by Ratcliffe (1984) to be part of the Ordovician Taconic orogeny, although Karabinos et al. (2005, and Trip B2) reported monazite ages suggesting that faulting was Silurian to Early Devonian. The basal unit of the Dalton Formation is a well-exposed quartz-pebble conglomerate. Deformed quartz pebbles serve as excellent strain markers, and we applied the $R_\phi$ method to 10 outcrops and 9 hand-samples to estimate strain gradients within the thrust sheet. Where possible, we measured 30 to 50 pebbles on each of three nearly orthogonal joint faces in outcrops or slabbed surfaces on oriented samples. Strain ellipsoids vary from nearly prolate ($4:1:1$) to nearly oblate ($4:4:1$); most ellipsoids are triaxial. Typically, one principal strain axis is approximately vertical and the other two plunge shallowly and trend roughly east-west and north-south. The long axis of the strain ellipsoid most commonly plunges gently to the west or east and the intermediate axis is either horizontal (north-south) or vertical. Locally, however, the long ellipsoid axis is oriented north-south, and the short axis plunges gently to the east. Rarely, the long axis is steep and the short axis plunges gently to the north or south. In some areas the strain varies dramatically over distances of only 200 m.

The observed strain gradients, indicate that emplacement of the thrust sheet was not accomplished by simple plane-strain. Thrusting involved complex ductile deformation characterized by regions of extending and compressive flow. Indentation of adjacent quartz pebbles indicates that volume loss was an important deformation mechanism not taken into account by our measurements. Furthermore, the mica-rich matrix of the conglomerate deformed more readily than the quartz pebbles. Thus, although the quartz pebbles record a significant shape change, they underestimate the true amount of strain in the conglomerate. Strong thrust-related deformation fabrics are restricted to the conglomerate and other members of the Dalton Formation; they did not develop in the underlying basement gneisses or in the overlying Cheshire Quartzite. Strain partitioning concentrated deformation in the intermediate, more micaceous Dalton Formation between the two other more competent units. We suggest that the dramatic strain gradients reflect complex flow of the basal conglomerate unit around the more rigid basement gneisses.

INTRODUCTION

The Day Mountain thrust in Dalton, Massachusetts, separates Mesoproterozoic basement gneisses, Neoproterozoic Dalton Formation, and Cambrian Cheshire Quartzite from the Cambrian to Ordovician Stockbridge Formation. It is part of the western frontal thrust of the Berkshire massif; its arcuate path and the contrast in resistance to erosion between hanging-wall and foot-wall rocks gives it a dramatic topographic expression (Fig. 1). As mapped by Ratcliffe (1984), the Day Mountain thrust sheet is part of the leading edge of the massif and is approximately 5 km in diameter. The unconformity between Mesoproterozoic basement gneisses and the Neoproterozoic Dalton Formation is beautifully exposed in the thrust sheet. In addition, the Dalton Formation contains a spectacularly deformed quartz-pebble conglomerate that records strain from Paleozoic deformation. We used the conglomerate to estimate strain throughout the thrust sheet to assess the deformation that accompanied thrusting. We were surprised to discover that strain in the conglomerate is extremely heterogeneous over very short distances. The shape of the strain ellipses varies from prolate to oblate, and the direction of maximum elongation varies considerably over distances of less than 200 m.

This field trip will be a walking tour of the northern part of the Day Mountain thrust sheet to examine outcrops of basement gneisses and conglomerate to see first-hand how much strain varies in the Dalton Formation. We will also see how fabric in the basement gneiss appears little affected by Paleozoic orogeny; the gneiss seems to preserve Grenville deformation faithfully. This pattern of deformation
Figure 1A. Digital elevation model of western Massachusetts (higher elevation shown as lighter shade). Box shows location of Day Mountain. Dark area between the Berkshire massif and Taconic Range is underlain by the marbles of the Cambrian to Ordovician Stockbridge Formation,
indicates dramatic strain partitioning into the Dalton Formation, and suggests that the heterogeneous strain reflects irregular flow of the more ductile Dalton Formation as dictated by the distribution of less ductile basement gneisses. If this notion is correct, the irregular flow pattern of the Dalton Formation may coincide with original topographic relief of the unconformity surface, and variations in thickness of the basal conglomerate; perhaps such variations reflect Neoproterozoic normal faults that formed during rifting of Rodinia.

GEOLOGIC SETTING

Most of the Berkshire massif is composed of Mesoproterozoic para- and ortho-gneisses that are commonly correlated with Laurentian crust found in the Grenville Province of Canada and the Adirondack Mountains of New York (i.e. Ratcliffe and Zartman, 1976). Neoproterozoic to Cambrian basal clastic rocks of the Dalton Formation and Cheshire Quartzite unconformably overlie basement gneisses in the massif, and together they were thrust westward over Cambrian to Ordovician shelf sequence marbles of the Stockbridge Formation. Thrusting of the Berkshire massif was interpreted to be part of the Ordovician Taconic orogeny, and numerous thrusts were mapped within the basement rocks of the massif (Ratcliffe and Harwood, 1975; Ratcliffe and Hatch, 1979).

The Neoproterozoic Dalton Formation is a heterogeneous unit composed of metamorphosed conglomerate, arkose, sandstone, and siltstone. Large variations in the thickness and relative abundance of these lithologies reflect its deposition in an active rift environment as the ancient super-continent, Rodinia,
broke apart. The relatively pure basal Cambrian Cheshire Quartzite was deposited in a more stable shelf environment. Tectonic stability from Early Cambrian to Early Ordovician is recorded by the dolomitic and calcitic marbles that dominate the Stockbridge Formation. During this time, the Laurentian margin (that is now preserved in the Appalachians) faced south and was located at approximately 20° S latitude.

During the Ordovician Taconic orogeny (470 to 455 Ma), Laurentia collided with the Shelburne Falls arc (Karabinos and others, 1998). The Silurian Salinic orogeny occurred during the accretion of Ganderia (van Staal and others, 2004) and the Early Devonian Acadian orogeny resulted from the collision of Laurentia and Avalon (Robinson and others, 1998; Bradley and others, 2000; Tucker and others, 2001; van Staal and others, 2004).

Although imbrication and westward thrusting of the Berkshire massif have been assumed to be part of the Taconic orogeny, Karabinos and others (2005, Trip B2 of this field guide) argued that the Berkshire massif was emplaced as a rigid block after the Taconic orogeny. Displacement of the massif could have occurred during the Taconic, Salinic, or Acadian orogenies, or during more than one event, and monazite ages from fault zone rocks suggest Silurian to Devonian thrusting.

Basement gneisses in the Day Mountain sheet include the (1179 ± 9 Ma) Tyringham Gneiss, mafic hornblende-biotite gneiss, meta-arkose of the Washington Gneiss, and minor calc-silicate rock. The Dalton Formation contains a distinctive, and highly deformed, quartz-pebble conglomerate near its contact with the basement gneisses. Above this are metamorphosed beds of arkose, sandstone, and siltstone. Ratcliffe (1984) mapped numerous sub-units in the Dalton Formation in intricate detail, including a second conglomerate member with a quartz-rich matrix higher in the section. Despite our intense efforts to measure strain in this structurally higher conglomerate member to compare with strain in the lower member, we were unable to reproduce Ratcliffe’s map pattern; our map shows a single conglomerate member (Fig. 2).

The quartz-pebble conglomerate that we studied in detail is clast supported and contains white, grey, and black quartz pebbles up to 10 cm in longest dimension. In slabbed samples, outlines of relict granitic clasts are still discernable, but in outcrop these patches are indistinguishable from the matrix. The matrix is composed of quartz, microcline, plagioclase, muscovite, biotite, and tourmaline. Bed thickness varies from 0.5 to 2 m, and individual beds are defined by variations in clast size and density.

**STRAIN ANALYSIS**

Methods- Deformed conglomerates are popular targets for strain studies because measurements can be made in the field and directly integrated with other observations about the deformation. They are also dramatic rocks that are visually appealing. We used Ratcliffe’s (1984) geologic map to locate outcrops of conglomerate and selected ten large exposures with joint faces at roughly right angles to each other to study in detail. We also collected nine large oriented hand samples, which we slabbed into parallepipeds for measurement of smaller clasts. We collected the hand samples at some outcrops because no large pebbles were available, and at several outcrops we collected hand samples in addition to our measurements of large clasts to determine if clast size affected our strain estimates (Pierce, 2007).

We measured 30 to 50 pebbles on each joint face and used the $R_\phi$ method to calculate two-dimensional strain for each face. We then used a Mathematica program called Geobestfit written by Matt Stine, when he was a graduate student at the University of Rochester, to combine the strain ellipse measurements from the three joint faces into a three-dimensional strain ellipsoid.

Strain ellipsoids are most accurately and easily obtained from data on three mutually perpendicular faces. With a bit more effort and help from programs written by Declan DePaor, ellipsoids can be determined from data from three non-perpendicular faces. If only two joint faces are available, and a strong cleavage or lineation is present and assumed to be parallel to the plane of flattening or longest axis of the strain ellipsoid, respectively, the shape and orientation of the ellipsoid can be estimated. Finally, at outcrops where conditions were not ideal for measuring clasts, we visually estimated the axial ratios and orientation of the pebbles to provide an approximation of the strain ellipsoid. This approach helps identify areas with steep strain gradients quickly, and it is what we will do on the field trip.

It is important to bear in mind the limitations of the $R_\phi$ method for measuring strain. The method assumes an initially random orientation of elliptical pebbles, an unlikely starting point for most pebble
Figure 2A. Geologic map of the Day Mountain thrust sheet. Mesoproterozoic basement gneiss- cross-hachured; Neoproterozoic Dalton Formation conglomerate- dark gray; Dalton Formation undifferentiated- medium gray coarse-dotted pattern; Cambrian Cheshire Quartzite- white fine-dotted pattern; Cambrian to Ordovician Stockbridge Formation- unpatterned.
Figure 2B. Outline map showing the distribution of the Dalton Formation conglomerate member (gray) and the shape of the measured strain ellipsoids (black) projected onto a horizontal surface.
conglomerates. Furthermore, combining three 2-dimensional strain ellipsoids into a 3-dimensional strain ellipsoid introduces uncertainties. Besides measurement and computational uncertainties, errors also arise from different amounts of deformation of clasts and the surrounding matrix; in a rock such as the Dalton Formation, deformation recorded by the quartz clasts is almost certainly an underestimate of the bulk strain. Volume change during deformation is another important limitation for this method, and all strain studies. On Day Mountain, indentation of pebbles is clearly visible in outcrop, and attests to volume loss through pressure solution. There are clearly significant errors attached to our strain estimates, but we are confident that the variation in strain throughout the thrust sheet is much larger than all the errors and uncertainties combined, and that we have documented significant strain gradients.

Data- The strain data collected in the Day Mountain thrust sheet are discussed in detail by Pierce (2007), and here we concentrate on the results bearing on the northern part of the area seen on this field trip.

By far the most common orientation of the strain ellipsoid long axis is east-west with a shallow plunge in either direction. Likewise, the short axis of the strain ellipsoid is most commonly contained in a steeply dipping north-south plane, and it typically plunges steeply. However, as seen at many of the stops on this trip, significant deviations from this pattern exist.

Lode’s number $\nu$ is a useful way to describe the shape of the strain ellipsoid, which takes advantage of the properties of natural logarithms (Hossack, 1968).

$$\nu = \frac{[2\ln(S_2) - \ln(S_1) - \ln(S_3)]}{[\ln(S_1) - \ln(S_3)]}$$

For a prolate strain ellipsoid $\nu=-1$, for an oblate ellipsoid $\nu=1$, and the boundary between prolate and oblate shapes is 0. Thus, in Table 1, values of $\nu$ between 0 and -1 have more prolate shapes, and larger negative numbers represent strain ellipsoids that are closer to the ideal prolate shape ($S_1 > S_2 = S_3$). Similarly, values of $\nu$ between 0 and 1 correspond to more oblate strain ellipsoids, and a value of 1 corresponds to the ideal oblate ellipsoid ($S_1 = S_2 > S_3$). Table 1 shows that strain ellipsoids commonly have prolate-like shapes in the area of the field trip, as this is true throughout the thrust sheet. However, a significant number of strain measurements indicate that oblate-like strain ellipsoids exist in the area. There is a direct connection between Lode’s number and deformation fabric; rocks with negative values of $\nu$ tend to be l-tectonites, and rocks with positive values of $\nu$ tend to be s-tectonites.

One of the most interesting conclusions based on our study is that strain is quite heterogeneous on a scale of 200 m. The strain ellipsoid is commonly prolate on Day Mountain (Stops 4, 5, 6, 7, 8, and 13), but in less than 500 m the strain pattern changes to oblate (Stops 9, 10, and 11). Even more dramatic strain gradients over distances of 200 m are easily recognized between Stops (12, 13, and 14). These variations in strain can be discerned by inspection without detailed measurements.

<table>
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<th>S1 Plunge</th>
<th>S2 Trend</th>
<th>S2 Plunge</th>
<th>S3 Trend</th>
<th>S3 Plunge</th>
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Table 1. Strain data from outcrop measurements. For prolate ellipsoids, Lode’s number = -1. For oblate ellipsoids, Lode’s number = 1.
**Interpretations** - If a thrust sheet were emplaced by simple shear under plane strain conditions, there would be no horizontal strain perpendicular to the transport direction, elongation would occur parallel to the transport direction and the angle between the transport vector and maximum elongation would become progressively smaller with increasing strain, and the shortening direction would, of course, be steeply plunging and perpendicular to elongation. The prolate shape of strain ellipsoids in the northwest part of the thrust sheet, visible at Stops 4, 5, 6, 7, and 8, indicates that horizontal and vertical shortening occurred perpendicular to the transport direction. The strong stretching lineation in these rocks that records this strain pattern. It is as if this part of the thrust sheet was extruded through a narrowing channel.

Oblate strain ellipsoids indicate that even more complex ductile flow patterns existed within the thrust sheet. At Stops 10 and 11 the maximum shortening direction is oriented east-west, suggesting that flow was somehow “backed up” in the transport direction. In contrast, the oblate strain ellipsoids at Stops 12 and 14 have horizontal short axes oriented approximately north-south, indicating north-south contraction along with east-west and vertical elongation during ductile flow.

At this time we do not have a clear explanation for these complex deformation patterns. Reorientation of the strain ellipsoids by folding cannot be the dominant factor because the orientation of the principal directions is relatively constant, whereas the shape of the ellipsoids varies dramatically. The lack of strong deformation fabric in basement gneisses suggests to us that some of the heterogeneity in strain may reflect strain partitioning into the more ductile Dalton Formation that forced the more micaceous rocks of this unit to flow around the more rigid basement gneisses during deformation. Some of the erratic flow may reflect irregular topography of the unconformity surface on which the conglomerate was deposited, which could have resulted in significant variations in stratigraphic thickness over short distances. The existence of small normal faults in the basement gneisses, perhaps relicts of Neoproterozoic rifting, could help explain changes in thickness of the conglomerate, and local reactivation on such faults may account for some abrupt changes in strain recorded by the Dalton Formation.

**ACKNOWLEDGEMENTS**

This work was supported by the Sperry Family Fund for the Geosciences.
TRIP LOG

The starting point for this trip is the intersection of Grange Hall Road with the Appalachian Trail (AT) in Dalton, Massachusetts (42° 27’ 41” and 73° 09’ 74”). Please note that the route of the AT on the U.S.G.S. topographic map is wildly inaccurate. We will be on the AT for some of the trip, but much of the 5 km route is off-trail. Table 1 shows the latitude and longitude for each of the fourteen designated stops described below. There are many diverting outcrops along the way. Figure 3 shows the stops and traverse plotted on part of the Pittsfield East 7.5’ x 15’ quadrangle.

Table 2: Field trip stop locations. NAD 83 datum.

<table>
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</table>

Walk north, downhill on the AT about 250 m to the bridge. Just upstream is the first stop.

STOP 1- Typical outcrop of basement gneiss in this area. Ratcliffe (1984) mapped this as Ybh, biotite-hornblende gneiss. Some mafic layers are present, but in much of the area on Day Mountain the rocks mapped as YBH are composed of quartz, feldspar, and biotite and resemble meta-graywacke. The gneissic fabric strikes 110° and dips 86° (all strike and dip descriptions use the right hand rule). Most outcrops in the Day Mountain thrust sheet contain an east-west striking, steeply-dipping gneissic fabric. Comparison with deformation fabrics in the Dalton Formation suggests to us that the basement rocks are almost unaffected by Paleozoic deformation. The dramatic difference in deformation between the basement rocks and the unconformably overlying conglomerate unit in the Dalton Formation is an important aspect of this trip because we think it may help explain the steep strain gradients recorded by the conglomerate.

Continue north on the AT until it crosses an old logging road. Turn left on the road and follow it parallel to the stream to Stop 2.

STOP 2- Quartz-pebble conglomerate beds in stream (Fig. 4). The matrix is composed of quartz, feldspar, muscovite, and biotite. The pebbles appear to be only slightly deformed in these beds, which strike 175° and dip 40°.

For those interested, there is an outcrop of basement gneiss 80 m upstream, but we will see more gneiss upslope on our traverse.

Return to dirt road and head back uphill to the east about 50 m until you see large outcrops upslope to the north. Walk up to them and continue upslope following the string of good outcrops to Stop 3.
Figure 3. Map of field trip stops (black octagons with numbers) and traverse (dashed line). The lower conglomerate unit of the Dalton Formation (Ratcliffe, 1984) is shown as cross hachured area; the upper conglomerate unit is shown as stippled area.
STOP 3- Quartz-pebble conglomerate in large outcrop. Again, the pebbles here are not very deformed. They have some angular edges, and none of the joint faces shows very strong preferred orientation of long axes.

Continue upslope following abundant outcrops. There are some exposures of steeply dipping gneiss along the way. After less than 100 m is a very large, continuous, cliffy outcrop of quartz-pebble conglomerate above basement gneiss. The unconformity between these units is spectacularly exposed in several places in the very large outcrop.

STOP 4- Large outcrop just west of the very long cliff (Fig. 5). The quartz-pebble conglomerate is well exposed in three nearly orthogonal joint faces. Notice the dramatic increase in strain recorded by pebbles in this outcrop compared to the exposures down slope. The pebbles are prolate-shaped ellipsoids, and the long to short axial ratio is approximately 3.5 to 1. The east-west and horizontal joint faces show the stretching direction clearly. The north-south joint face shows irregular pebble shapes lacking a strong preferred orientation of long axes. Careful examination of this face also reveals mutual indentation of pebbles, evidence that pressure solution was a significant mechanism during deformation. The long axis trends 275° and plunges 5°. Bedding is visible in the outcrop and strikes 240° and dips 36°. A strong lineation is present, but there is no strong planar deformation fabric, in accord with the strain inferred from the pebbles. Upslope are some beds with much smaller pebbles only 1 to 3 cm in longest dimension, and some beds have very few pebbles.
Figure 5. Photographs of quartz-pebble conglomerate from Stop 4. A. East-west oriented joint face showing strong preferred orientation of pebble long axes. B. North-south oriented joint face lacking strong preferred orientation of pebble long axes.
Walk along the base of the cliff to the east. Notice the excellent exposures of basement gneiss below the conglomerate. Steeply dipping gneissic foliation strikes east-west. Notice a variably developed shallow cleavage in the gneiss. In one north-south striking joint face the unconformity is folded and the fold axis is parallel to the stretching lineation. Pegmatitic layers 5 to 10 cm thick are locally visible in the gneiss.

Approximately 60 m east of Stop 4 is an enormous joint face above large blocks of conglomerate that is visible if you are facing west.

STOP 5- Amazing exposure of the unconformity between the Dalton Formation and the basement gneiss (Fig. 6). Foliation in the quartz, feldspar, biotite gneiss is nearly vertical and is truncated at the contact with the quartz-pebble conglomerate. Beds in the conglomerate are approximately 1 to 2 m thick and defined by the variable density of pebbles.

Continue walking east to the end of the outcrop and head down slope to the AT. Once you reach the trail hike north (at this point you will really be heading east) through abundant outcrops of basement gneiss. Some of the outcrops look like miniature hogbacks. The gneissic foliation strikes consistently east-west and dips steeply to the south (strike 90°, dip 60° to 70°). After walking east for 200 m on the trail, head straight upslope (to the north) 80 m through abundant outcrops of gneiss. A short covered interval separates the last basement outcrop from the first outcrop of conglomerate with shallowly dipping bedding.

Stop 6- Outcrop of quartz-pebble conglomerate (Fig 7). Shallow bedding is clearly visible in the outcrop on east-west joint faces, as is very strong stretching lineation. Pebbles are very elongate in the east-west direction and on horizontal surfaces. On north-south striking joint faces, however, the pebble outlines are irregular to nearly circular and lack a strong preferred orientation.

Continue upslope to the top of Day Mountain and proceed northeast until you intersect the AT. Turn left and hike north on the AT approximately 125 m (at this point you will be heading northwest) to a large outcrop on the uphill side of the trail.

STOP 7- Large outcrop of quartz-pebble conglomerate with stretched pebbles. The stretching direction is 275°. The strain here is similar to that seen at Stops 4, 5, & 6. The point is that on this part of Day Mountain the strain in pebbles is quite consistent. They are prolate-shaped ellipsoids (negative Lode’s number, Table 1) that plunge gently to the west.

Turn around and hike south on the AT over the east shoulder of Day Mountain. When the trail swings around sharply and heads west, keep going southeast through the woods approximately 600 m to Stop 8, which is a large cliff outcrop on the steep northeast facing slope of the ridge.

STOP 8- A large outcrop with three nearly perpendicular joint faces of quartz-pebble conglomerate. The stretched pebbles are up to 10 cm long and the matrix is quartz-rich. On north-south joint faces, the pebble sections do not show a strong preferred orientation of long axes, and indentation of pebbles is easy to recognize. On east-west joint faces, the long axis of the pebbles plunges gently to the east. On horizontal planes the long axes of pebbles trend 80°.

The rocks here are shown by Ratcliffe (1984) as part of the lower conglomerate unit. The next three outcrops are in Ratcliffe’s upper conglomerate unit, but they do not look very different to us. As noted in the Geologic Setting, we were unable to confirm the existence of two separated conglomerate units in this area, and suggest that there is a single unit.

Walk 400 m southeast to a low outcrop of conglomerate.

STOP 9- The quartz pebbles in the conglomerate are much smaller here, only about 2 to 3 cm in longest dimension. Some of the beds have a quartz-rich matrix, but the rocks do not appear substantially different from other conglomerate outcrops already visited. What is different is the
shape of the pebbles. Here the pebbles are flattened parallel to the planar foliation, which is close to bedding (strike 300°, dip 40°). The maximum stretching direction is 300°.

Walk about 75 m southeast to a dirt road. Walk southwest along the road 300 m, and walk 75 m southeast into the woods to Stop 10.

STOP 10- Outcrop of quartz-pebble conglomerate. Some of the beds have a quartz-rich matrix, similar to the outcrop at Stop 8. Beds strike 350° and dip 25°. The stretching direction is 345°, and pebbles are flattened parallel to the foliation. The short axis of the approximately oblate ellipsoids plunges steeply at 255°.

Walk southeast 20 m to another outcrop of quartz-pebble conglomerate in the power line.

STOP 11- Power line outcrop of conglomerate. Maximum elongation direction is 350°, and pebbles are flattened parallel to the foliation, which strikes 350° and dips 60°. The short axis of the nearly oblate ellipsoids plunges moderately at 260°. The matrix is quartz-rich here and at Stop 10; both are mapped in the upper conglomerate unit of Ratcliffe (1984). However, the matrix here resembles the matrix seen at stop 8, which is mapped in the lower conglomerate unit by Ratcliffe (1984).

We were anxious to measure strain in two stratigraphically separate conglomerate units, to look for deformation gradients within the thrust sheet, and devoted considerable effort to distinguishing two conglomerate units in the Dalton Formation, as mapped by Ratcliffe (1984). We
Figure 7. Photographs of quartz-pebble conglomerate from Stop 6. A. East-west oriented joint face shows strong preferred orientation of pebble long axes (solid line). Bedding (dashed line) defined by variations in pebble density. B. North-south oriented joint face show weak preferred orientation of pebble long axes.
were, however, unable to distinguish two units based on composition or map distribution, and believe that there is only one major conglomerate horizon at the base of the Dalton Formation. As seen best at Stops 4, 5, and 8, pebble density in conglomerate layers is variable, pebble-rich beds alternate with beds lacking pebbles, and matrix composition varies significantly. We believe that there is a single conglomerate unit of variable thickness and composition that locally contains some relatively thick layers lacking pebbles.

Return northwest through the woods to the dirt road. Walk downhill to the southwest to Grange Hall Road, turn right, and walk on the paved road all the way back to the parking area for the AT. Hike 150 m south on the AT until the trail goes over a low outcrop.

STOP 12- Low pavement outcrop of quartz-pebble conglomerate. The quartz pebbles are flattened into more oblate ellipsoidal shapes here. The plane of flattening strikes 290° and is nearly vertical. Pebble elongation is greater in the horizontal direction than it is in the vertical direction, but not by much. This outcrop is only 1 km from Stops 10 & 11 (oblate ellipsoids with elongation direction at 350°), and less than 500 m from Stops 4 & 5 on Day Mountain (prolate ellipsoids with elongation at 270°). Further, the pebbles at Stops 2 & 3, which are less than 500 m away, were not very deformed. Clearly deformation is quite inhomogeneous.

Walk southeast through the woods a little over 200 m to another quartz-pebble conglomerate.

STOP 13- Mossy outcrop of conglomerate. This outcrop is only 200 m from Stop 12, yet the deformation recorded by the pebbles is quite different. The maximum elongation direction trends 110° and plunges 15°, so the maximum elongation direction is similar to Stop 12, but the ellipsoids are essentially prolate here (Table 1).

Walk southeast through the woods another 200 m. Go past the dirt road to an outcrop of quartz-pebble conglomerate.

STOP 14- Outcrop of quartz-pebble conglomerate (Fig. 8). Again, we are only 200 m from the last outcrop, but the pebble shapes are again quite different. The pebbles are flattened again (foliation strikes 325° and dips 75°), but the maximum elongation direction plunges steeply at 145°.

Walk back northwest through the woods to the dirt road. Turn right, down hill on the road for a short cut back to Grange Hall road, or continue northwest back to the AT.
Figure 8. Photograph of quartz-pebble conglomerate from Stop 14. The pebbles are flattened parallel to the foliations. Maximum elongation direction plunges steeply at 145°.
REFERENCES CITED


Ratcliffe, N.M. and Hatch, N.L. Jr., 1979, A traverse across the Taconide zone in the area of the Berkshire massif, in Skehan and Osberg, eds., The Caledonides in the USA, contributions to the IGCP Project 27, p.175-224.


