1998 NYSGA FIELD TRIP A2
Carthage-Colton Zone Transect
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OVERVIEW
This is a trip emphasizing contacts, rock fabrics, and regional structure. It examines rocks of the lowlands/highlands boundary zone spaced along Rt 812 over a distance of about 6.5 miles starting 2.5 mi. NE of Harrisville and ending 4 mi. SW of Harrisville. This trip examines structures, fabrics, and lithologies of Adirondack lowlands rocks and of the Diana complex adjacent to their mutual boundary near Harrisville, NY[1]. The trip starts at the Route 3 bridge over the Oswegatchie River in Harrisville, NY. It proceeds E to where Rt 812 branches N from Rt 3, about 1.1 mi E of Harrisville and continues on Rt 812 to where Stone Road intersects Rt 812, about 1.1 mi N of the Rt 812 / Rt 3 junction. It follows Stone Rd to the north 0.3 mi to stop 1.

Locations and brief characterizations of Field Trip Stops.

Stop 1 - metagabbro/marble contact; on east side of Stone Road, 0.3 miles north of the junction of Stone Road with Rt 812; location: 44° 10.42' N, 075° 20.07' W.

Stop 2 - meta-quartz-syenite/marble contact; on east side of Rt 812, 1.1 mi north of the junction of Rt 812 with Rt 3 NE of Harrisville; location 44° 10.22' N, 075° 19.73' W.

Stop 3 - rusty-calcsilicate gneiss, diopsidic marble contact with Diana syenite gneiss; on the east side of Rt 3, 0.5 mi N of the bridge where Rt 3 crosses the Oswegatchie River in Harrisville; location 44° 09.45' N, 075° 19.02' W.

Stop 4 - Diana syenitic gneiss with abundant mylonitic veins; on the north side of Rt 3, 0.8 mi west from the Rt 3 bridge over the Oswegatchie River in Harrisville; location 44° 08.73' N, 075° 19.94' W.

Stop 5 - Diana syenitic augeniferous gneiss; on both sides of Rt 812, 0.7 mi. south of its junction with Rt 3.

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[1]There is a muncipal parking lot, with three picnic tables, about 100 m SE of the bridge in Harrisville next to Scanlon's bakery and coffee shop. Possible lunch and rest-stops in Harrisville on Main St. are: Hunter's View Restaurant; Scanlon's bakery and coffee shop; the Village Inn; and Pastamore Restaurant (for pizzas). There is also Greg's grocery-deli store for soft-drinks and fixings for sandwiches.

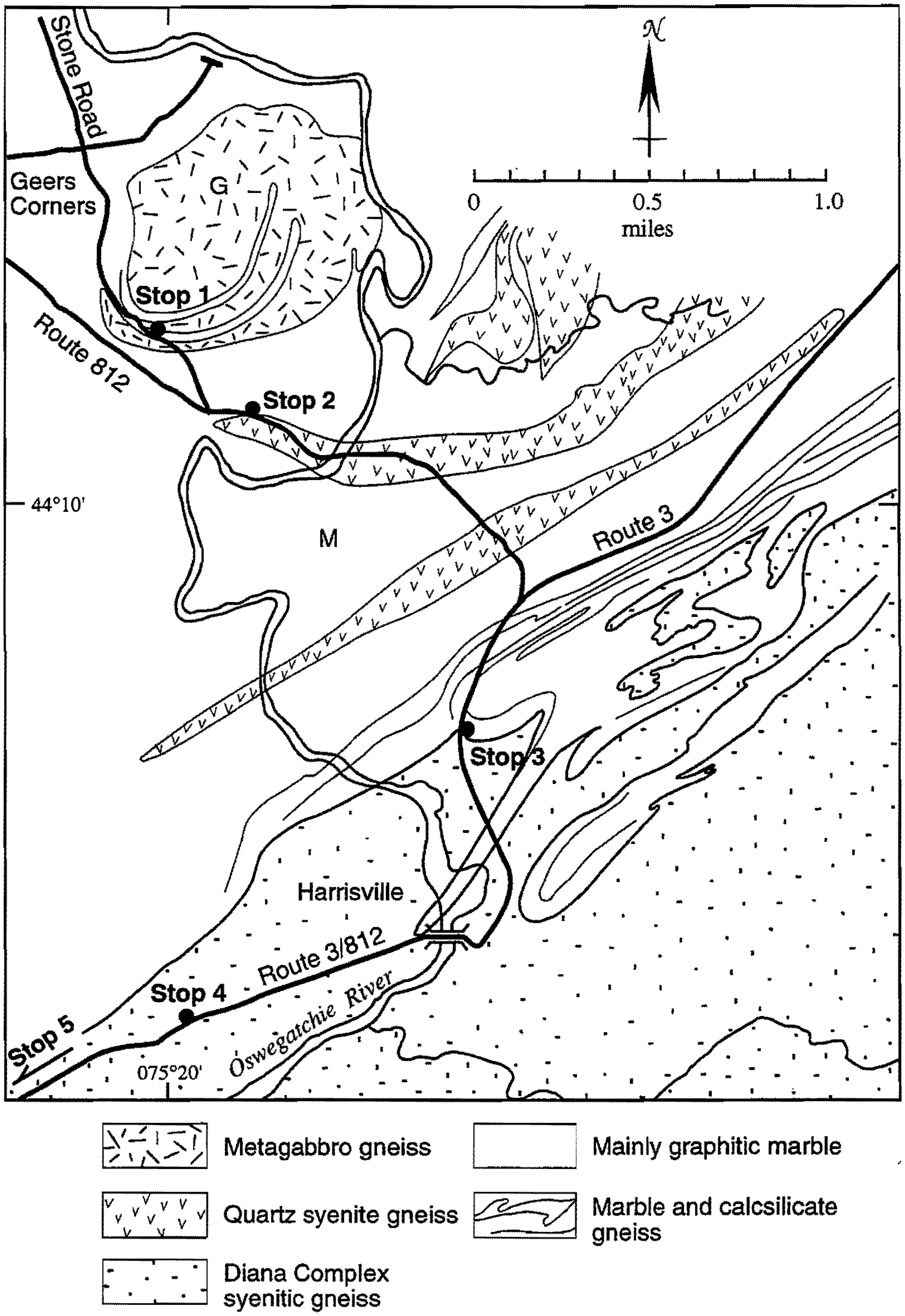

Figure 1. Location of stops for this field trip are distributed along 6.5 miles of Rt. 812 in the vicinity of Harrisville, NY. Geologic sketch map after Wiener (1983).

INTRODUCTION

Regional setting

The focus of this trip is on the contact zone of the Grenville marble and paragneiss with the Diana Syenite Complex in the NW Adirondack Mts. This contact zone extends from Carthage NY to Colton NY, perhaps extending as far as 500 km or more (Lamb, 1993). The trip follows an approximately N-S track along Rt 812 through Harrisville NY, about mid-way between Carthage and Colton (Fig.1). The excellent detailed map and report of Wiener (1983) describes the local geology.

Major lithological subdivisions

Lowlands paragneisses and orthogneisses. The Grenville meta-sedimentary rocks of this area include garnet-quartz-plagioclase-biotite gneiss, biotitic granitic gneiss, calc-silicate gneiss, and related rocks (Smyth and Buddington, 1926; Wiener, 1983). These are intruded by metamorphosed and deformed sills of gabbro and quartz-syenite. This trip will examine gabbro, quartz-syenite and marble, and their contact relations.

'Highlands' orthogneisses. The principal meta-igneous rock of interest SE of the boundary is the Diana syenite (Buddington, 1939; Buddington and Leonard, 1962; Hargraves, 1968; Wiener, 1983). Buddington (1939) interpreted the Diana Quartz Syenitic Complex as a major differentiated sill, over 6 km thick, isoclinally folded with Grenville meta-sediments which it intrudes, and overturned to the SE in the Harrisville vicinity. This trip examines the syenite at three localities, and its contact with the metasedimentary rocks at one locality.

Structural aspects

Much of the syenite is mylonitic to varying degrees, and is cut by fine mylonite veins of variable development. The zone of mylonite development is broad, and extends into the paragneisses to the NW, leading Geraghty et al. (1981) to map a broad zone of Diana Complex and adjacent paragneisses/marbles as the Carthage-Colton mylonite zone.

Major and minor structures. Wiener (1983) mapped numerous major folds and minor cross-cutting folds in this region (see his Fig. 6 for the overall fold pattern and his numerous other figures detailing individual fold structures). He distinguishes four major phases of folding in the Harrisville vicinity, characterized as follows:

First phase folds: NE trending isoclinal folds; overturned to SE; limited to Grenville paragneisses/marbles of the lowlands region; minor folds are reclined, hinges plunge N to NW.

Second phase folds: NE trending isoclinal folds; overturned to SE; this is the generation represented by an abundance of minor folds and by the development of mylonitic foliation especially evident in the Diana complex; minor fold hinges plunge N to NE and SW to W.

Third phase folds: NE trending, overturned to SE; more open in the NW and tighter to the SE (includes Harrisville anticline/syncline and Baldface Hill syncline of this trip); minor fold hinges trend N to NE in the east, N to W in the SW, and SW to W in the NW parts of the Harrisville area.

Fourth phase folds: NW trending open and upright folds (includes Meadow Brook syncline of this trip); minor fold hinges plunge mainly NW.

Interpretations of the highlands/lowlands boundary

Several interpretations have been offered on the nature and origin of the Highlands (orthogneisses) / Lowlands (paragneisses) boundary. In some interpretations, the Diana syenitic complex is part of the highlands association, in others it is part of the lowlands assembly, and in others it is the boundary zone or straddles the boundary between the two major assemblages. Explanations for this boundary include the following:

- *trace of a fold-thrust nappe* (Geraghty et al., 1981)
- *intrusive boundary*, isoclinally folded and overturned to SE (Wiener, 1983; Buddington 1939; Buddington and Leonard, 1962)
- *major suture* (Mezger et al., 1992; Martignole, 1986)
- variations on *faults, fault reversals, detachment faults* (e.g. Mezger et al., 1992; Isachsen and Geraghty, 1986)

DESCRIPTIONS OF THE GEOLOGICAL STOPS

STOP 1 - Gabbro/Marble Contact

This locality is characterized by multiple sills of gabbro, intruding marble, subsequently metamorphosed and multiply folded.

Meta-gabbro lies along the east side of the road, both north and south of this outcrop. Here at Stop 1 we find gabbro in the central upper region of the outcrop. The gabbro-marble contact rises both north and south from near road-level in the middle of the exposure. Marble foliations trend approximately N70E, 30 N at both ends of the outcrop. Near the south end of the outcrop erosional relief shows excellent internal details of the marble structure. Here there are isoclinal folds of both large (meter) and small (centimeter) scale, with mainly *easterly* plunges in the plane of the foliation. Marble foliations also envelope boudins of more competent marble and of calc-silicates. A more open *north* -plunging fold can be found in the marble near the north end of the outcrop. The gabbro-marble contact is obscured somewhat by surface obstructions and by shearing but can generally be located within a meter or so, defining a gentle basin in the N-S profile along the outcrop. The meta-gabbro has a moderately well-developed foliation. A few hundred meters south near the pipeline clearing it contains large (1 cm.) subequant hornblende porphyroclasts.

According to Wiener (1983) this meta-gabbro lies in a structural basin east of Geers Corners at the intersection of the NE-trending Baldface Hill syncline (third-order fold) and the NW-trending Meadow Brook syncline (fourth-order fold); he (ibid.) interprets the gabbro as having been intruded after the first regional folding phase and mainly before the second phase.

STOP 2 - Marble/Quartz-syenite Contact

This exposure clearly displays the contact between a sill of quartz-syenite and the graphitic marble. A sketch (Fig. 2) shows the view east at this locality. The marble is discordantly and isoclinally folded adjacent to the more gently folded quartz - syenitic gneiss. The intrusive contact shows several prominences and re-entrants; foliation in the

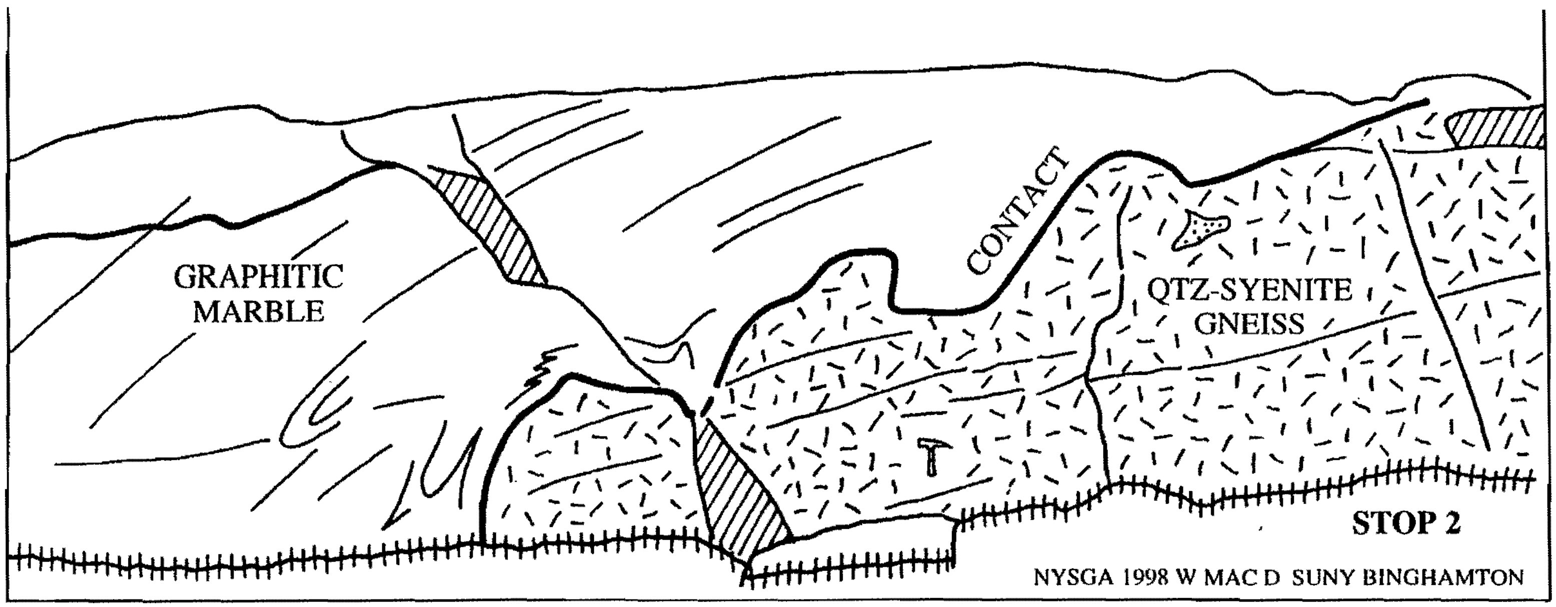

Figure 2. Stop 2, view east. Sketch of contact relations between graphitic marble and quartz-syenite.

marble generally follows the irregular syenite contact. Glacial grooves and striae of approx. N-S trend can be found all along the top of the outcrop, but are better preserved in the marble.

This outcrop is at the west end of a large sill of quartz syenite gneiss, one of several which crop out west of Baldface Hill (Wiener, 1983). The marble/syenite contact is quite irregular and is consistent with an intrusive boundary. The fabric of the syenitic gneiss is quite subtle relative to that of the marble. Some graphite crystallization has occurred along fractures in the gneiss. Disseminated sulfides are also found in the marble, contributing to rusty stains. Marble foliation here is defined by color banding, silicate-rich bands, and erosional relief on weathered surfaces. The foliation dips about 45 northwesterly.

These sills of quartz syenite are believed to be genetically related to the Diana syenite complex (Buddington and Leonard, 1962). They were intruded during the second phase of regional folding. These sills appear to be less intensely deformed than the Diana Complex syenite, possibly because they are enveloped by less competent marbles which flowed around them during regional deformations.

STOP 3 - Marble/Diana Syenite Contact

This site reveals isoclinal meta-carbonates and related rocks now down- folded into the Diana syenite. The location is approximately in the common limb between the Harrisville syncline (to the NW) and the Harrisville anticline (to the SE) (Wiener, 1983). The structures here dip NW and are overturned to the SE.

The exposure has three main parts of equal width, from N to S: 1) a zone of rusty calc-silicate gneisses grading into white marbles, 2) diopsidic marble, and 3) Diana syenite. Faults and shear zones of WNW trend and steep NE dip separate these three units. The foliation within the diopsidic marble and Diana syenitic gneiss on either side of the 2-3 shear zone trend NE and dip steeply NW.

Zone 1) The foliation of the rusty calc-silicates is approximately conformable with that of adjacent marbles. Transition across this zone from rusty calc-silicates at the north end of the outcrop to white marble near the contact with diopsidic marble is gradual. The zone 1 - zone 2 contact between light-colored marbles and grey diopsidic marble is quite abrupt and probably is a fault or shear zone .

Zone 2) Adjacent to its north limit, the diopsidic marble shows strongly isoclinal folding (streaks of light grey bands in dark grey marble). Isolated diopsidite clusters and masses, some of which resemble metamorphosed thin-bedded limestone fragments, 'float' in a more massive dark grey matrix of calcite with abundantly scattered dark green granular diopside grains. Some of the light-green diopsidic masses have a darker green 'halo'. Numerous small faults of variable trends cut through the diopsidic marble; some have calcite slickenfibres and others are plated with serpentine (antigorite?).

Zone 3) A fault or shear zone at the S limit of the diopsidic marble separates it from zone 3 which is dominantly Diana syenite. This shear zone (approx. 105, 70N) is strongly discordant to the foliation of the adjacent diopsidic marble which trends approx. 035 and dips 65NW. However, on south side of that shear zone are brown to rusty brown well-foliated gneiss with foliation approx parallel to the shear zone. The contact of these light-brown weathering gneisses with the darker greenish grey massive Diana syenite is transitional over a meter or so. This contact appears to be the intrusive contact between the paragneisses of the lowlands and the orthogneisses of the Diana complex. A very weak foliation in the Diana syenite (defined by sub-parallel lenticular grains of K feldspar) here is about 035, 70 NW, consistent with that in the adjacent diopsidic marble

STOP 4 - Mylonitic Diana Syenite
Diana syenite is the dominating lithologic unit in the roadcuts on both sides of the road. The outcrop on the north side of the road is emphasized here. It is cut by numerous thin mylonite veins, the 'late ductile shear zones' of Wiener (1983). There are also a few small faults and larger shear zones, and some thin meta-dikes(?) of 10 to 20 cm thickness. In the eastern quarter of the outcrop is a tightly folded meta-dike(?). Abundant glacial grooves and striae at the top of the outcrop trend approximately along azimuth 175. The principal features to examine here are the Diana syenite, the mylonites, and the meta-dikes(?).

Diana Syenite
The Diana syenite here is weakly foliated, dark greenish-grey and relatively uniform in appearance. The weak foliation in the Diana syenitic gneiss here is defined by parallel lenticular grains of K feldspar up to about 1 cm long and up to a few mm thick. This foliation is most clearly seen in the weathered rinds along the drill-holes (drill-holes used for blasting the roadcut). The Diana syenitic gneiss foliations trend approximately N50E and dip somewhat variably but approx N50 to 60 NW. A little further south (e.g. stop 5) the foliation becomes more strongly developed and augeniferous. The Diana syenite was intruded early in the second phase of regional deformation and folding, and its protomylonitic foliation developed during the second phase of regional deformation (Wiener, 1983).

Mylonites
This is an excellent outcrop to examine the development of mylonitic zones in the Diana syenite. Mylonitic bands are of several different types:
a) thin, planar, of significant extent (to 5 m or more) mainly 1 to 3 cm thick
b) curved and branching, of irregular thickness and relatively limited extent
c) broad banded zones (to 20 cm) less abundant and typically of limited extent
The mylonites terminate by pinchout, by truncating at high-angle junctions with other mylonites, or by branching from other mylonites at more acute angles. Although the mylonites are clearly later than the foliation in the syenite, there is relatively little offset of the syenite foliation by the mylonites. Internally, the mylonites have a well-developed foliation, with abundant porphyroclasts of rounded subequant sphene and occasional elongate pyroxene. Sulfides occur along the margins of some mylonites. In the syenite

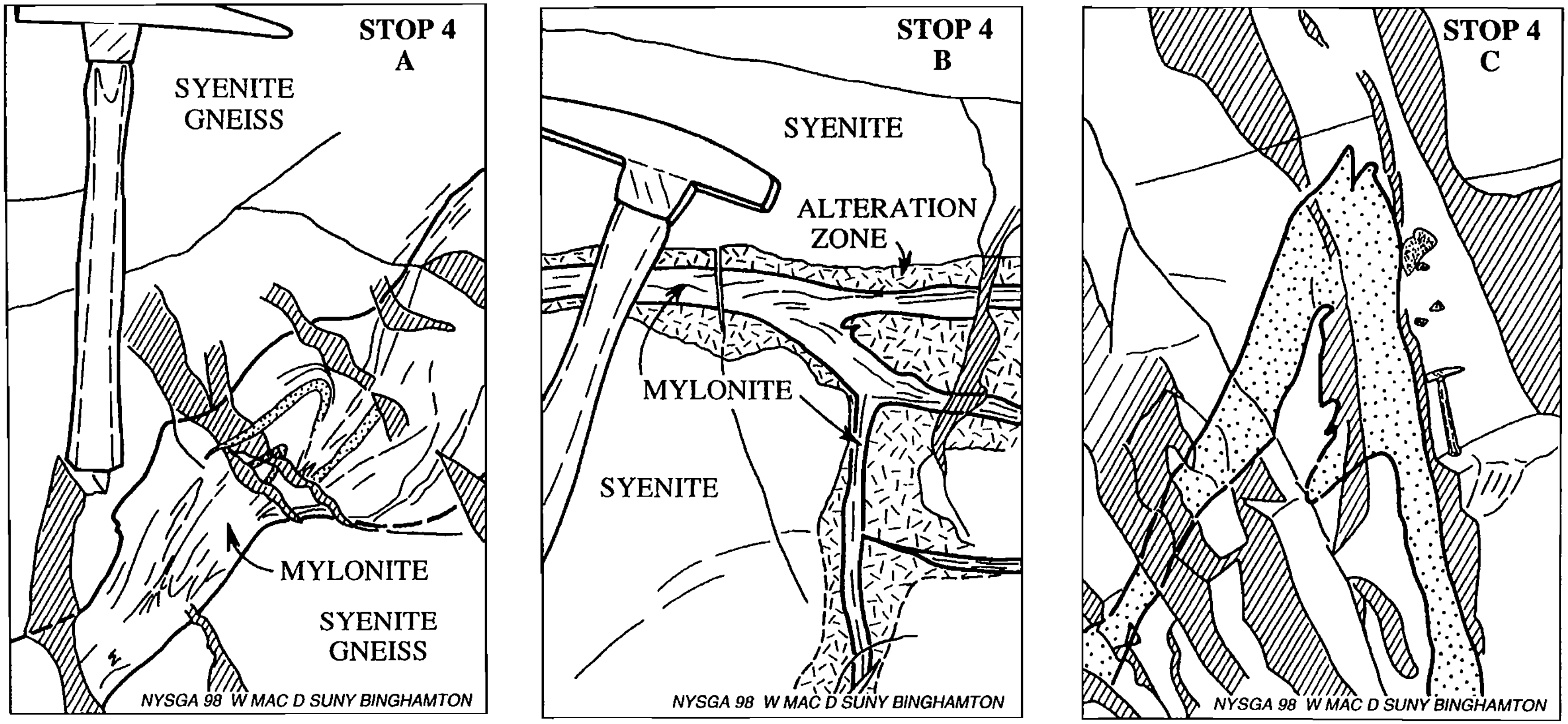

Figure 3. Stop 4, north side of road. Sketch A shows small-scale folds within a mylonite zone. Sketch B shows branching and termination of mylonite veins in Diana syenite. Sketch C shows tight fold in meta-dike(?).

adjacent to many mylonites are marginal alteration zones of variable width in which pinkish K feldspar dominates, and mafics are less abundant. Some of the alteration zones are several times as wide as the associated mylonite vein. In some alteration zones, prominent alignment of pyroxene grains or clusters can be seen, plunging moderately to steeply N to NNW.

The mylonites do not appear to have been folded. However, their distribution is symmetric with respect to the regional fold axis of the second phase of regional folding (see Fig. 4 and discussion). A small z-fold is evident about 200 m east of the west end of the outcrop. This small isoclinal fold pair (anticline/syncline) occurs in the fabric of the mylonite; the mylonite zone here is about 10 to 15 cm wide and its boundaries have not been folded. The sense of shear indicates W side up. Such folds in the mylonite are scarce.

Meta-dikes(?)

Several meta-dikes(?) now largely altered to pyroxene cut the syenite. They are mostly relatively thin, 10 to 30 cm thick. A tight fold has developed in one of these, in the eastern third of the outcrop. This kind of fold is not common. The theoretical axial surface plane of this fold trends about N10W and dips 75 W, and lies at a high angle to the foliation of the Diana syenite. The theoretical hinge (found by interpolating the intersection of the limbs) plunges steeply N. As a mylonite adjacent to this fold is not itself folded, it is thought that the mylonites post-date deformation of these 'meta-dikes'.

Discussion

Some structural relationships at this outcrop are summarized in Fig. 4. Here we see that the foliation ('protomylonitic' foliation) of the Diana syenite dips moderately NW. The mylonite veins appear to have a common axis of orientation which plunges 62 toward 347. According to Wiener (1983), this is the common direction of lineations for the second phase of regional deformation. That pole and the associated 95% confidence oval (Bingham statistics) represent the direction of the eigenvector corresponding to the minimum eigenvalue for the distribution of about 30 axes or normals to the mylonite veins. These are for measurements in the western third of this outcrop only. Both pyroxene lineations and the theoretical axis of the tightly folded 'meta-dike' also lie close to this direction. This suggests that although the mylonites are of greatly variable orientations, they are mainly coaxial about an axis near the foliation plane of the Diana syenite and plunging NNW.The pyroxene lineations adjacent to mylonites are therefore near the intersections of the mylonite foliations with the Diana syenite foliation, as might be expected.

STOP 5 - Augeniferous Diana Syenite

Augeniferous well-foliated syenite gneiss is exposed in low outcrops on both sides of the road. A few thin mylonites are visible here. The foliation, wrapping around centimeter-sized feldspar augen, trends approximately N45E and dips 45NW. Dark-cored feldspar augen (greenish) with lighter tan rims and curved cleavage are abundant.

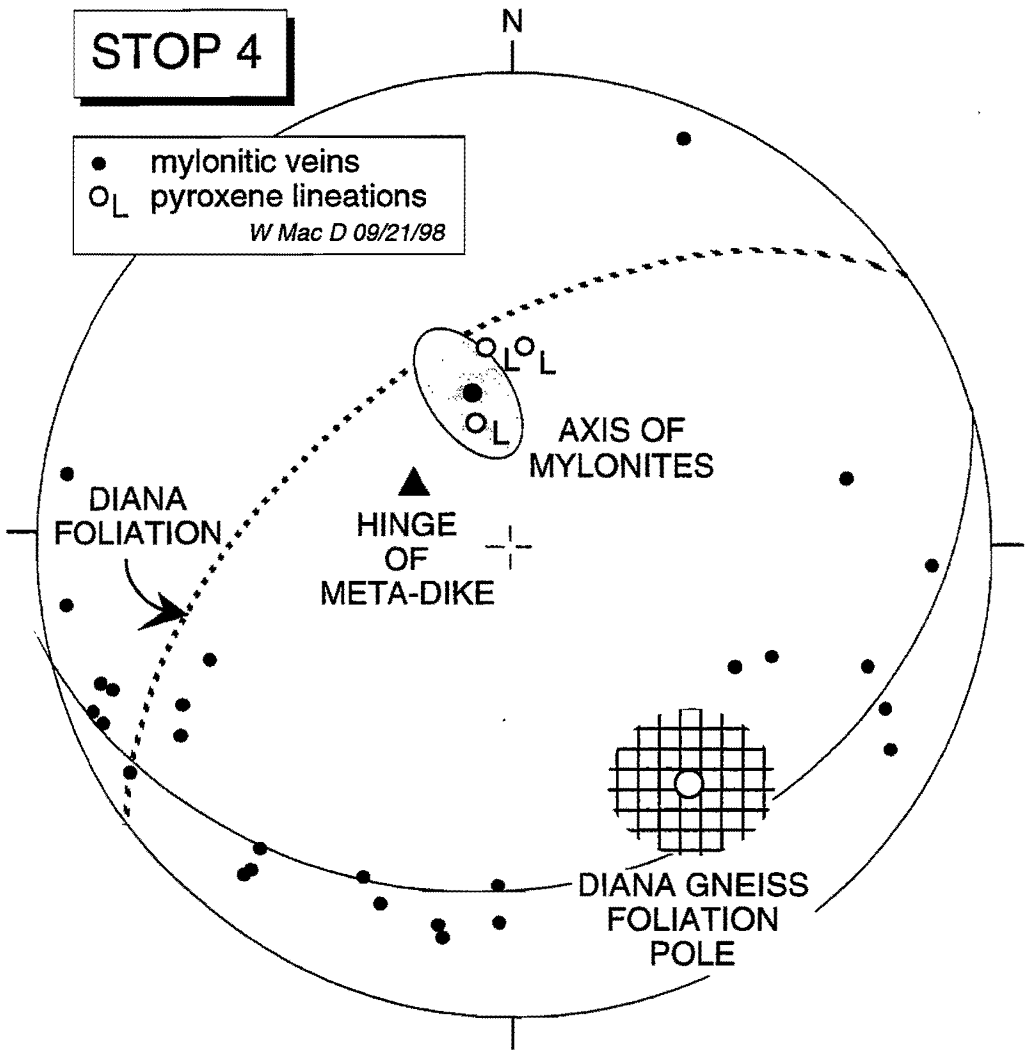

Figure 4. Stop 4. Structural relations here are summarized in this stereographic diagram. The foliation of the Diana syenite dips moderately northwesterly. Cross-cutting mylonites intersect along a common axis plunging 62 toward 347. This is close to the lineations defined by pyroxene lineations, and to the theoretical hinge of the isoclinally folded meta-dike (?).

Foliation in the Diana syenite is best seen in the drill-holes used for blasting, where the syenite weathers to a light brown color. The rock is quite uniform here, and there is no indication of interlayering with other lithologies.

Southward from this outcrop the foliation becomes better developed approaching flaser gneiss, and layers of other rocks, such as shonkinites, develop. Still further south, hornblende granite appears. This apparent regional zonation led Buddington and Leonard (1962) to conclude that the Diana complex is essentially a large isoclinally folded and metamorphosed differentiated sill complex, overturned to the SE such that higher levels of the sill lie to the SE.

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