Structural Controls on Geomorphology:
Brodie Mountain, Massachusetts

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INTRODUCTION:

Our project was located in Berkshire County, Massachusetts, in the Taconic Mountains. The Ordovician Taconian Orogeny formed these mountains of western New England. The purpose of the project was to assess possible structural controls on the geomorphology of the area.

The Cambrian and Ordovician rock units as mapped by Zen et al. (1983) are composed of the Stockbridge Formation--an alternating dolomitic and calcitic marble, of variably gray colors. It is overlain by the Walloomsac Formation, a dark, graphitic phyllite. This stratigraphic sequence is in fault contact with the Late Proterozic to Cambrian Nassau Formation which consists of three members in our area. The lowest member is dark gray. The intermediate member a light, greenish to gray, non-graphitic phyllite. The uppermost member is a lustrous silver phyllite with pyrite crystals up to three centimeters in size.

The Taconic range in western New England consists of a series of ridges and valleys, mostly oriented 010° north-south. The exposed rocks in the valleys are dominantly Stockbridge and Walloomsac Formations, while the ridges are underlain by phyllite of the Nassau Formation. We investigated the controls of the orientations and the locations of these landscape elements. Our whole group addressed the same problems over an extended range of ridges and valleys. Our area of study concerned Brodie Mountain--792 meters in elevation, located on portions of the Stephentown Center, New York, Massachusetts and the Cheshire, Massachusetts 7.5 x 15 minute quadrangles. It is bounded to the west by Route 43, to the south by Brodie Mountain Road, and Route 7 forms the eastern boundary.

GOALS:

- To determine whether there are structural controls on the orientation and location of the major ridges and valleys of the area.
- To determine what is controlling tributary stream orientations.

METHODS:

- We collected data on traverses in the streams draining Brodie Mountain and used a Brunton compass to determine orientations of foliations, joints, lineations and fold axes. We estimate the error to be ± 2°.
- We noted the lithology and mineralogy at each outcrop.
- We plotted joint sets, foliations, and stream orientations on rose diagrams and stereograms to evaluate the possibility of structural controls on geomorphology.
- To determine stream orientation, we divided the streams on a 1:25,000 quadrangle map 125 m. Each interval was measured for orientation and plotted on rose diagrams.

DATA:

The western slope of the Brodie Mountain is thick glacial till from 390m to approximately 500 m in elevation and then thin till from 500 m to 690 m. The eastern side is covered of till, though many of the streams expose bedrock. While traversing up the steep western slope, we observed a line of groundwater springs more than halfway up the mountain between elevations of 510 m and 540 m. These springs helped up to pinpoint the phyllite-marble contact. Recent studies by Altschuller (1994) and LaFleur and DeSimone (1992) place this line of springs between 341 m and 396 m in an area 3 km to the north.

Joints: When the 182 measured joints are plotted, two prominent directions are apparent. One has an average strike of 290° dipping 88° to the northeast, and the other has an average strike of 015° dipping 84° to the northwest (Fig. 1).

Foliations: The average trend of the foliations is fairly consistent throughout the entire field area (Fig. 2). The average strike and dip is 014° and 27° to the southeast.

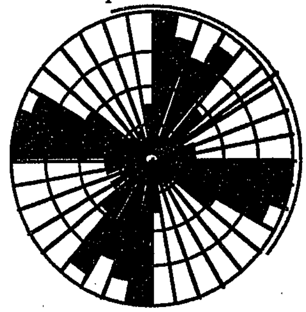

Figure 1. Rose Diagram of all Brodie Mountain Joints N=182

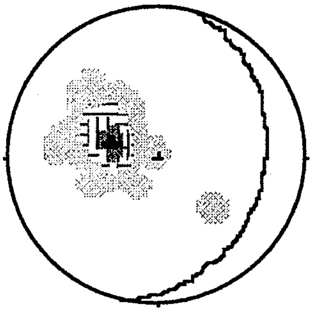

Figure 2. Equal Area Stereonet Contour Plot of all poles to Foliation on Brodie Mt.. N=134 (Darkest area is highest density of poles to foliation planes)

***Stream Orientations*:** Because the ridge axis of Brodie Mountain and the adjacent valleys are oriented at about 15°, the regional gradient must be oriented at approximately 105° on the east, and 285° on the west side of the mountain. The streams on the west and east side of the mountain have different average orientations (Fig. 3a and 3b). The orientation of the gradient of the glacial till deposits on the eastern slope of the mountain is 154°. The west slope is steep and till depostis are thin, so the till gradient is parallel to the regional gradient.

EAST

- The average stream orientation is 114°, which is 9° southeast of the regional gradient (Fig. 3a).
- The streams flow over bedrock, especially in the higher elevations nearer to the ridge.
- The majority of stream segments in the lower elevations, below 570m, are flowing at 095°, though there is a significant number that flow more southeasterly (Fig. 4a).
- The joints in the lower elevations are mostly trending 015°, with another set trending 095° (Fig. 4b).
- At upper elevations, the streams are flowing mainly in the directions of 105° and 125° (Fig. 5a).
- The joints in the upper elevations are trending at 095°, and other scattered directions (Fig. 5b).

WEST

- The average stream orientation is 280°.
- They are flowing through till.

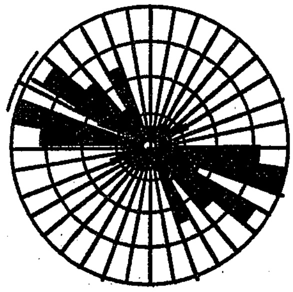

Figure 3a. Eastern Stream Orientations N=52 Vector Mean=297

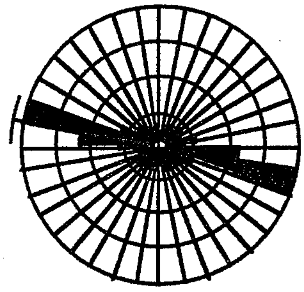

Figure 3b. Western Stream Orientations N=15 Vector Mean=280

East Brodie below 570 m

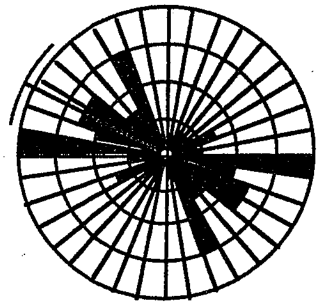

Figure 4a. Streams
N=40 Vector Mean=297

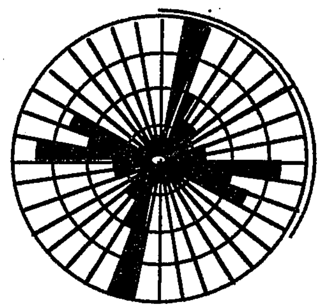

Figure 4b. Joints
N=33 Vector Mean=60

East Brodie above 570 m

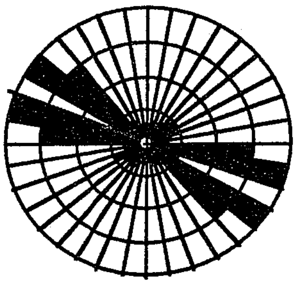

Figure 5a. Streams
N=16 Vector Mean=291

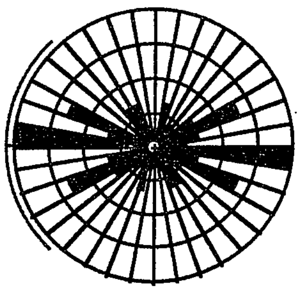

Figure 5b. Joints
N=13 Vector Mean=270

DISCUSSION AND CONCLUSIONS:

According to Cadwell (1986), the Wisconsinan ice sheet advanced across the Williamstown area approximately 24,000 years ago. The ice were moving in a southeasterly direction, depositing thick till on the eastern leeward side of Brodie Mountain. We investigated this till deposition as a possible controller of stream orientation. The streams on the west side of the mountain were almost completely in till with little to no outcrop. The western streams have not yet reached the bedrock surface, and therefore flow down the regional gradient.

The eastern streams were also in till at lower elevations, but there was abundant outcrop exposed. Due to the scarcity of till in higher elevations, eastern stream directions were influenced by bedrock joints and foliations. In the lower elevations, the stream segment orientations correlate directly with the east-west joint set. Many stream segments, however, trend at 150°-160°. This is parallel to the till gradient at 154°.

We discovered what we believe to be a thrust fault on the west flank of Brodie Mountain. Since the marble-phyllite contact on the western slope of the mountain is found at approximately 480 m, and is not visible on the eastern slope, we inferred that the original fault surface was most likely an eastward dipping contact. The variation in the groundwater spring elevations on the west side, hence the fault contact, pointed to the fact that the original fault surface had been deformed (Fig. 6).

There is a striking correlation between the orientation of ridges and valleys and the average strike of foliations and a prominent joint set in the Brodie Mountain area (Fig 7). The faults found in the area thrusted the less resistant Stockbridge Formation over the more resistant Nassau Formation. Because the marble was exposed to erosion at higher structural levels, valleys were formed. Thus, the present-day ridges are composed of the Nassau Formation phyllite.

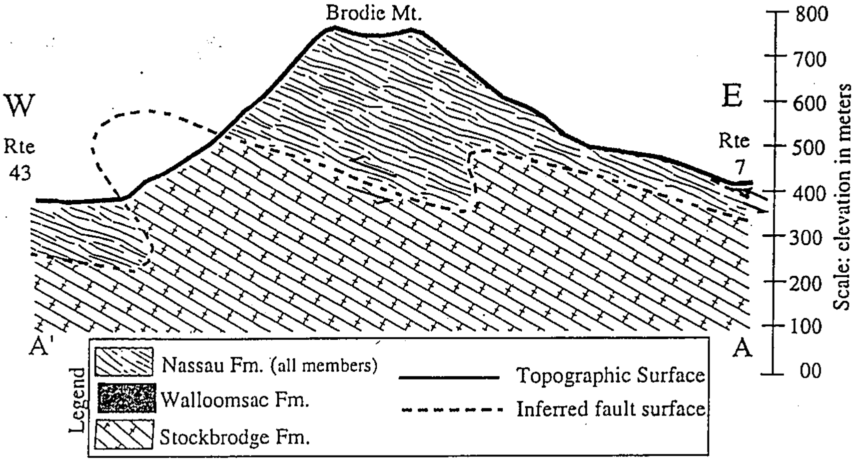

Figure 6. East-West Cross Section of Brodie Mountain

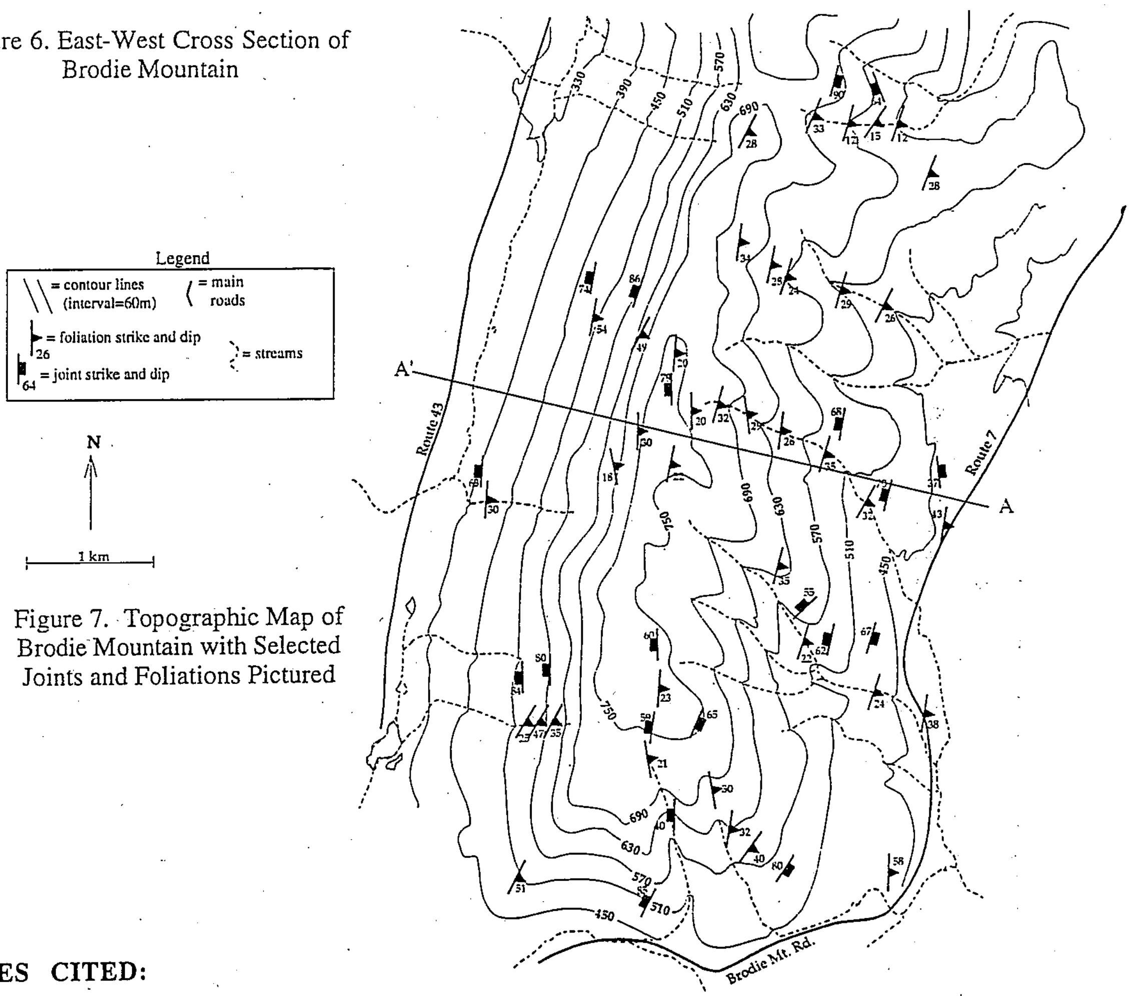

Figure 7. Topographic Map of Brodie Mountain with Selected Joints and Foliations Pictured

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