STRUCTURAL GEOMORPHOLOGY OF NORTHERN BERKSHIRE COUNTY, MASSACHUSETTS

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Carbonate Fault Slivers Control the Orientation and Location of Valleys on the Greylock Massif, Berkshire County, Massachusetts

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INTRODUCTION

Mount Greylock is the highest point in Massachusetts at 1063 m (3487 ft) and together with several other separately named peaks it forms the Greylock massif. The dominant lithology is the Greylock Schist, a Late Proterozoic to Early Cambrian argillite deposited on the continental slope of Laurentia. The Greylock Schist structurally overlies Cambrian and Ordovician marbles and quartzites of the Stockbridge Formation and Ordovician flysch (now phyllite to schist) and marble of the Walloomsac Formation that were deposited on the continental shelf of Laurentia. Westward thrusting during the Ordovician Taconian orogeny carried the Greylock Schist over the Stockbridge and Walloomsac Formations.

Ridges and valleys on and surrounding the Greylock massif trend consistenly at 20°, parallel to regional strike. Marbles of the Stockbridge Formation are much more susceptible to chemical weathering than the aluminum rich rocks of the Greylock Schist. Rapid chemical weathering promotes extensive erosion of the marble layers compared to the schist on the Greylock massif. The long linear valleys commonly coincide with narrow bands of marble not only near the base of the massif, but also at higher elevations. We examined, in detail, the contacts between schist and marble near the valleys to understand the kinematic development of the marble layers on the Greylock massif.

DATA

The study area is located in northwestern Massachusetts. Major NNE-SSW trending valleys border the Greylock massif to the west and east. The Green Mountain massif, which extends from Vermont into northernmost Massachusetts, and the Greylock massif are separated by an unusual east-west trending valley that coincides with the position of a major lateral ramp in the Taconian thrust system.

Lithologic Layering and Cleavage. Outcrops at higher elevations on the Greylock massif are mostly composed of Greylock Schist, part of the Taconic sequence. The dominant fabric in the rock is a strongly developed crenulation cleavage; bedding is rarely recognizable. In schist on the easternmost ridges of the Greylock massif, the strong crenulation cleavage is tightly folded and a more weakly developed crenulation cleavage is axial-planar to these folds. Both crenulation cleavages strike between 350° and 30° and dip moderately to steeply to the east. The strike of the cleavage and lithologic layering is approximately parallel to the trend of the ridges. Within outcrops of quartzite and marble of the Stockbridge and Walloomsac Formations bedding is well preserved and the regional cleavage is developed only in micaceous beds.

Thrusting. East-dipping linear belts of the Stockbridge and/or Walloomsac Formation are commonly structurally overlain and underlain by Greylock schist. Structural evidence suggests that these east-dipping belts are not the cores of recumbent folds. Rather, they are large slivers of shelf sequence rocks bounded above and below by thrust faults. The interleaving of the Stockbridge and Walloomsac Formations withing rocks of the Greylock Schist occurs at a wide range of scales from approximately 1 m to 1 km.

Jointing. Two steeply-dipping prominent joint sets are present. One set is approximately parallel to the crenulation cleavages. The other strikes between 80° and 130°. This second joint set is approximately parallel to the orientation of many tributary streams that flow down the gradient of the ridges to the major valleys.

STRUCTURAL CONTROL OF TOPOGRAPHY

Thrusting. NNE-SSW striking and east-dipping belts of marble coincide with the major valleys flanking the Greylock massif as well as numerous minor valleys on the massif, even at higher elevations (approximately 800 m). The fault-bounded marble slivers formed when Taconic sequence rocks overrode the carbonate shelf rocks and large portions of the foot-wall became accreted to the hanging-wall. The present location of these slivers between thrust sheets of the Taconic sequence rocks indicates that the imbricate faults were active during westward transport along the basal sole thrust. The carbonate slivers were carried into their present positions along the imbricate splays which separated Taconic sequence rocks. The marked contrast in resistance to chemical weathering and erosion between the schist and the thin marble layers present on the Greylock massif explains the long, narrow, deeply incised valleys.

Jointing. The NNE-SSW striking prominent joint set and crenulation cleavages are closely parallel to the major ridges and valleys and exert an enormous influence on the topographic development of the area. The WNW-ESE striking prominent joint set is approximatley parallel to many of the tributary streams. Many tributary streams are influenced by both joint sets and follow a roughly rectilinear path down the sides of ridges to the major valleys. This pattern is especially pronounced in deeply incised valleys where surficial cover is thin or absent.

Structural controls on stream geomorphology in the Savage Hill area, Northern Berkshire County, Massachusetts

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Introduction

During the Taconian Orogeny, (470-450 Ma) west-directed thrusting emplaced slope and rise deposits of the Greylock Schist over shallow water deposits of the Stockbridge Formation and flysch of the Walloomsac Formation. Northeast trending ridges and valleys in the area are oriented parallel to the regional flow direction of the major streams. Our study focuses on the effects structural features in the bedrock have on local stream geomorphology.

Geologic Setting

The study area is located in the 7.5' by 15' Cheshire Quadrangle in the Taconic-Berkshire zone (Zen and others., 1983), and includes several north-south trending ridges and valleys. The elevation ranges from 300 to 630 meters. The exposed lithologies include units of the Late Precambrian to Cambrian Greylock Schist, the Cambrian to Ordovician Stockbridge and the Ordovician Walloomsac Formations. The Greylock Schist is a dark greenish-gray ilmenite, chloritoid, quartz, muscovite schist containing some albite granofels. It originated as argillaceous deposits on the continental slope and rise of ancient North America (Ratcliffe and others, 1993). The members of the Stockbridge Formation that we see in our area are light, blue, gray, weathered calcite and dolomitic marbles representing continental shelf deposits (Ratcliffe and others, 1993). The Walloomsac Formation is a dull gray weathered, black to sooty-gray, carbonaceous, biotite, muscovite, plagioclase, quartz schist. It contains a calcitic schistose marble member and originated as a syn-orogenic flysch.

During the Taconian Orogeny, Laurentia collided with the Shelburne Falls arc. During collision the slope and rise deposits were thrust westward over the shelf deposits and the Walloomsac Formation. A prominent and consistent northeast trending, easterly dipping foliation is parallel to lithologic contacts and to the regional trend of valleys and ridges.

Methods

Data were collected over eleven days. Traverses were concentrated along streams and valleys where outcrop was relatively abundant. We took measurements on foliations, joints, lineations and fold axes. Stream trend direction was obtained using 7.5' by 15' quadrangles. The trend was measured in 5 millimeter increments on the map which corresponds to a distance of 125 meters in the field. Stream data were divided into two groups, an upper and lower. These groups were separated by the break in slope created by lithologic differences between the marble and the schist. We entered all our data into a Excel database which we used to create our figures.

Data

We observed that the lithologies of the valleys were different than that of the ridges (Figure 1). The Stockbridge Formation, consisting of both calcitic and dolomitic members is found in the valley floors. It is not present above 400 meters. The Walloomsac Formation was found on both the east and west slopes of ridges above 400 meters. With one exception, we found Greylock Schist on top of every prominent ridge in our area at elevations above 420 meters.

The foliations we measured throughout our area were consistent and showed little scatter (Figure 2a and 2b). The prominent foliation strikes 026° and dips 40° southeast. There were some foliations found in the eastern part of our study area which strike 200° and dip 70° northwest. These made up less then 5% of our data set. The marbles in our area showed compositional layering parallel to the regional foliation (Figure 3). Although there are several distinct groups of fold axes orientations, the dominant set trends 025° and plunges 10° to the northeast (Figure 4). The folds we measured indicate top to the west sense of