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Reconnaissance Bedrock Geologic Map of the rocks northwest of the Monroe fault, Concord Quadrangle, Vermont

by

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RECONNAISSANCE BEDROCK GEOLOGIC MAP OF THE ROCKS NORTHWEST OF THE MONROE FAULT, CONCORD QUADRANGLE, VERMONT

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The Concord 7-1/2 minute quadrangle is in east-central Vermont; it forms the northwest quarter of the Littleton, New Hampshire-Vermont 15 minute quadrangle, and includes the boundary between rocks of the "Vermont sequence" and the "New Hampshire sequence" (White and Jahns, 1950). This boundary was originally named and briefly described as the Monroe fault (Eric, White and Hadley, 1941), but Doll and others (1961) reinterpreted it as an unconformity and the boundary became known as the Monroe line. In 1988 Hatch (1988a) presented evidence for at least two periods of faulting (Acadian thrusting(?) and Mesozoic normal faulting) along the boundary, and the original name Monroe fault was reinstated.

The area of the Concord quadrangle was included in early reconnaissance mapping by Adams (1845), Edward Hitchcock (1861), Richardson (1902, 1906), and Dale (1910, 1915). More recently, the New Hampshire part of the Littleton 15-minute quadrangle was mapped by Billings (1937), and the Vermont part of the quadrangle was mapped by Eric (1942; Eric and Dennis, 1958). In the mid 1980's the author began a project to restudy and remap the metasedimentary rocks of the Connecticut valley-Gaspe synclinorium in Vermont between 43°30' north latitude and the Canadian border. Because of modifications to the stratigraphic sequence, as well as the structure, Hatch (1988b) renamed the U.S. part of the "synclinorium" the Connecticut valley <u>trough</u>. Objectives of the project included subdividing the then-recognized formations, and better understanding their depositional environment and the structural/tectonic history during the Acadian orogeny. The project area was bounded on the west by the "R.M.C." (Richardson memorial contact) (now the Dog River fault zone of Westerman (1987)) and on the east by the Monroe fault, forming an area of nearly 5,000 square kilometers. On the present map the geology is shown only west of the Monroe fault; the geology east of the Monroe fault was most recently shown by Eric and Dennis (1958).

The age of the rocks of the trough has long been controversial. Most recently, Hueber and others (1990) determined an Early Devonian (probably Emsian) age for the Gile Mountain Formation in southern Quebec and northernmost New Hampshire. They also reported a zircon age from southeastern Vermont that strongly suggests a Silurian or older age for the Waits River Formation. For a number of reasons discussed by Hueber and others (1990), I have chosen to assign an Early Devonian age to all of the strata on the present map.

For the reader particularly interested in the Monroe fault, the large new cuts made in the mid 1980's for Interstate I-93 expose the fault zone and clearly show many important features. Shear zones in the Meetinghouse slates, especially near the east end of the sequence of cuts, and intercalated lenses of sheared New Hampshire sequence schists and greenschists are interpreted as imbricate slices formed during Acadian compression. The westward extent of these shear zones and slices cannot be determined from the presently available data, but I estimate that the width of the Monroe fault zone during Acadian thrusting was locally as much as a kilometer. The fault line drawn on the map is interpreted to be the east margin of the fault zone. Kink bands and 15-30 cm wide zones of crushed and powdered rock are particularly conspicuous in the western part of the major cut, but are present throughout the length of the cut. These kink bands and crush zones are interpreted as having formed during normal faulting at the time of the Mesozoic break-up of eastern North America. These tensional structures have been traced at least as far south as Plainfield, New Hampshire, where the Monroe fault is cut off by, or coalesces with, another Mesozoic normal fault, the Ammonoosuc fault (Billings, 1937; Lyons, 1955). Similar tensional structures are common along the faults bounding the Mesozoic basins in Massachusetts (Peter Robinson, oral commun., 1987).

Two fabrics, schistosity and cleavage, are mapped in the area. The most widespread is schistosity which most commonly results from the parallel arrangement of micas, particularly muscovite. A strongly developed schistosity forms an axial-plane cleavage to early isoclinal folds, and thus, except near the axes of these folds, the schistosity is generally essentially parallel to bedding. Cleavage is a structure which, in the present map area, is closely spaced parallel cracks or joints. It can commonly be seen to be parallel to the axial surfaces of more open folds, and in most exposures it cuts an older schistosity. However, this cleavage locally becomes so strongly developed that it becomes a schistosity indistinguishable, except for orientation, from the earlier schistosity. On the map, although schistosity is generally parallel to the axial surfaces of early isoclinal folds and cleavage is generally parallel to the axial surfaces of later more open folds, schistosity and cleavage are shown as observed rather than as interpreted.

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EXPLANATION

"Kirby quartz monzonite" (Dbg)

Exposed in the northeast corner of the quadrangle, and mapped (Eric and Dennis, 1958) in a small body at Stiles Pond. The rock is a light-gray, medium-grained quartz monzonite or granite. It consists of microcline, plagioclase, quartz, biotite and minor muscovite. It is similar to and here correlated with the Barre Granite at the quarries in Graniteville to the southwest.

Gile Mountain Formation

Gray micaceous quartzite, quartz-mica schist, mica-quartz schist, and, particularly in the separately mapped Meetinghouse Slate Member, dark-gray slate/phyllite.

Meetinghouse Slate Member (Dgm)

Underlies a N 40 E trending belt across the quadrangle. Primarily dark-gray slate or phyllite with local thin (1 mm to 2 cm) beds of light-gray to nearly white fine-grained quartzite. Many of the quartzites are gradational into the adjoining slate, and thus form interpretable graded beds. Intercalated with the slates, particularly near the Monroe fault at the east margin of the belt, are a few bodies 3-5 m thick (not shown on map) of greenstone or greenish quartz-mica granulite and schist. Because their contacts with the slate are commonly sheared, these greenstones and greenish granulites are here interpreted as tectonic slivers of New Hampshire sequence rocks rather than beds within the Meetinghouse. The west contact of the Meetinghouse with unit Dg of the Gile Mountain is gradational and is drawn rather arbitrarily at the point where light-gray micaceous quartzite is more abundant than dark-gray slate.

Quartzite and gray phyllite member (Dg)

Underlies about 75% of the area northwest of the Monroe fault. The predominant rock is light-gray to gray, fine-grained micaceous quartzite composed of quartz and minor amounts of biotite, muscovite, garnet and chlorite. Interbedded with this quartzite is dark-gray to black quartz-muscovite-graphite slate or phyllite. Beds are generally 10 to 25 cm thick; many are graded.

Thick-bedded micaceous quartzite member (Dgq)

Occurs in lens-shaped bodies within unit Dg which are interpreted as stratigraphic lenses. The rock forms beds (0.5-5 meters thick) of gray-brown to medium-gray, medium-grained micaceous (biotite) quartz granofels and gray-brown quartz-biotite schist. Schists are distinguished from the metapelites of unit Dg by their conspicuously brown color, paucity or absence of graphite, and coarser grain size.

Devonian metavolcanic rocks (Dv)

Occurs as three lensoid bodies within the metasedimentary rocks of the Gile Mountain Formation in the northwest part of the map area. The rocks are chiefly medium-grained, dark- to very dark-green, moderately foliated to schistose hornblende-plagioclase amphibolites. Minor amounts of feldspar-biotite rock are also present.

Waits River Formation (Dw)

Underlies an area of a few square kilometers in the northwest corner of the quadrangle. The rocks are interbedded dark-gray phyllite indistinguishable from that in the Gile Mountain Formation and medium- to light-gray, fine- to medium-grained calcite-quartz-mica granofels. Beds range from 10 cm to as much as 5 m in thickness. The most distinctive and readily recognizable feature of the formation is the thick, dark, punky-weathering rind on the beds of calcite-quartz-mica granofels. Thus the common field term "the punky brown". Distinguished from the Gile Mountain Formation by the abundance of "punky brown", the near absence of non-calcareous granulite, and the rustier overall aspect of outcrops.

Undifferentiated Paleozoic igneous and metamorphic rocks of the "New Hampshire sequence" (White and Jahns, 1950) (Pznh)

Previously mapped (Eric and Dennis, 1958) as Albee Formation, Ammonoosuc Volcanics, and Highlandcroft granodiorite.

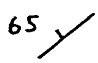
MAP SYMBOLS

Contact, approximately located

Fault, approximately located

PLANAR FEATURES

Where two or more symbols for planar or linear features are combined, their intersection marks the point of observation. Where two symbols for planar features are combined with a symbol for a linear feature, the point of observation is the intersection of the symbols for planar features.



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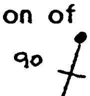

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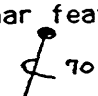
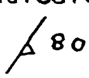


Overturned

Strike and dip of bedding

Ball indicates top of beds known from sedimentary structures. Position of 90 on vertical beds indicates top

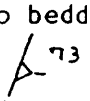


Inclined

Vertical

Strike and dip of schistosity

Relation to bedding not apparent in outcrop



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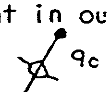

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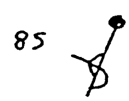
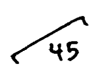


Overturned

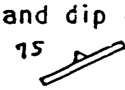
Strike and dip of parallel bedding and schistosity

Ball indicates top of bedding known from sedimentary structures. Position of 90 on vertical bedding indicates top

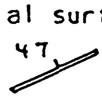


Inclined

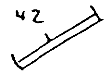
Strike and dip of cleavage



Strike and dip of axial surface of small fold that folds bedding; schistosity is parallel to the axial surface



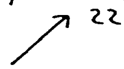
Strike and dip of axial surface of fold that folds schistosity (bedding either parallel to schistosity or not apparent in outcrop); no cleavage observed



Strike and dip of axial surface of fold that folds schistosity (bedding either parallel to schistosity or not apparent in outcrop); cleavage is parallel to axial surface

LINEAR FEATURES

May be combined with any of the above planar features



Bearing and plunge of axis of small fold or crinkle. Where combined with the symbol for the axial surface of a fold, indicates the bearing and plunge of the axis of that fold

OTHER FEATURES

Zone of strongly sheared rock

CORRELATION OF MAP UNITS