U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Preliminary Bedrock Geologic Map of the Mount Holly Quadrangle and portions of the Ludlow Quadrangle, Rutland and Windsor Counties, Vermont

By
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Open-File Report 92-282-A

Prepared in cooperation with the State of Vermont

NOTE: Open-file report 92-282-B, which can be ordered separately, consists of five color film transparencies (slides) of a colored version of the geologic map. The first slide shows the correlation of map units (in color), and the other slides show the map in four slightly overlapping sections.

[1] Reston, Va.

Correlation of map units
(Arrow indicates age range, queried where uncertain)

Cretaceous

Devonian

Cambrian

Late Proterozoic

Middle Proterozoic

Intrusive and Metasomatic Rocks

Kd

Dg

Zd

Yp

Yta

Ygg

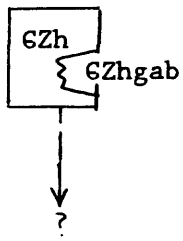
Yap

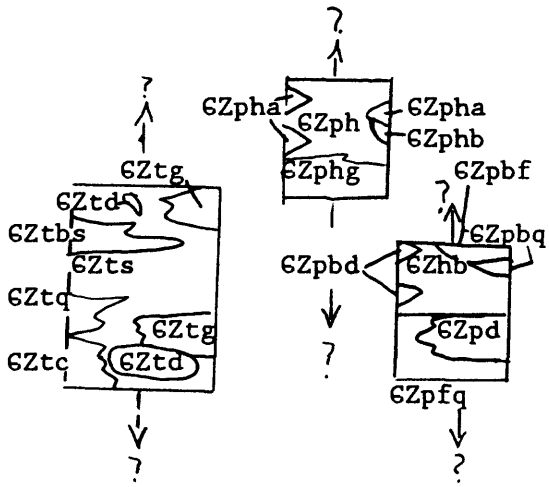
Yphg

Yhd

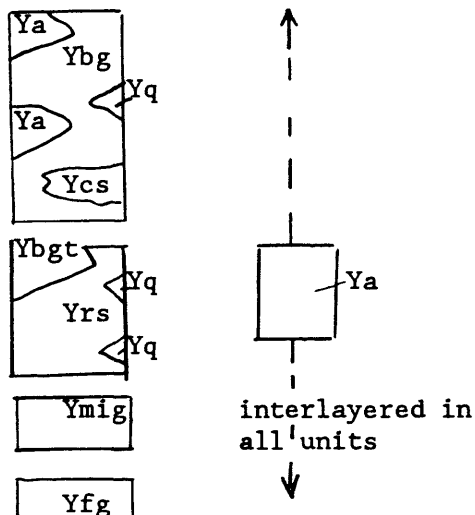
Yt

Stratified Rocks



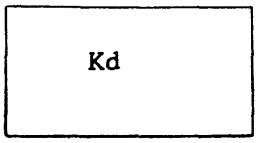


simplified relations

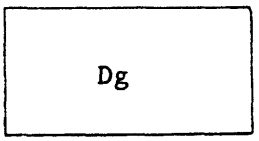


Mount Holly Quadrangle, Vt.

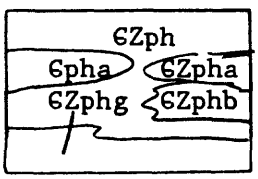
Description of map units



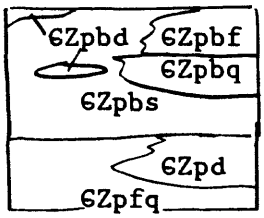
Camptonite dikes (Cretaceous)--fine- to coarse-grained dark grey to black porphyritic camptonite; commonly 1-2 m thick contain phenocrysts of yellow golden brown to red brown kaersutite(?), augite and olivine set in a groundmass of fine-grained labradorite, kaersutite, augite and analcime. Dikes 1 to 2 m thick are unfoliated but highly jointed



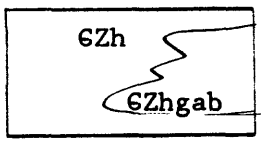
Rhyodacite dike (Devonian)--light purplish grey, biotite-albite porphyritic rhyodacite dike, contains phenocrysts of albite as much as 3 mm long in fine-grained matrix of albite-quartz- microcline and minor chlorite and muscovite, rock cross- cuts prominent fault-fabric foliation (S_2) and lineation in Dry Hill fault but is weakly foliated. Dike is as much as 3 m thick



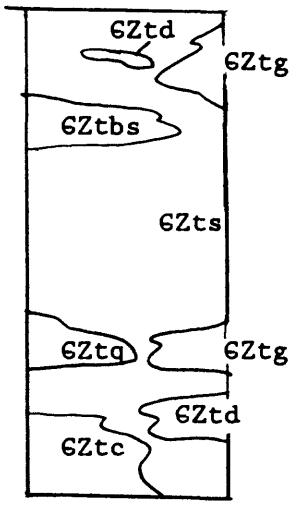
Pinney Hollow Formation (Late Proterozoic? and Cambrian)--€Zph, light-green, lustrous, magnetite-chlorite-quartz-muscovite±chloritoid phyllite and quartz-knotted phyllite; €phg, garnetiferous schist member; €Zpha, amphibolite and greenstone member, dark-green hornblende-epidote amphibolite or lighter green ankerite-albite-hornblende-chlorite greenstone, interpreted as metabasalt and basaltic volcaniclastic rocks; €Zphb, dark grey, sulfidic carbonaceous schist spatially associated with greenstone and amphibolite



Plymouth Formation (Late Proterozoic? and Cambrian)--€Zpbs, black schist member, dark grey to black thinly layered graphite-biotite-muscovite-quartz schist that contains thin beds of blue-grey quartzite, dolomite quartzite, and blue-grey ribbon dolostone all in layers 1-5 cm thick, black schist member contains mappable layers of deep orange-brown to beige-weathering dolostone as much as 2 meters thick (€Zpbd), grey-tan biotite feldspathic quartzite (€Zpbf) and minor beds of grey vitreous quartzite (€Zpbq). Black schist member resembles dark colored schists mapped as the Granville Formation of Osberg (1952) in the Rochester area, Vermont, which underlies the Pinney Hollow Formation in that area; €Zpd, dolostone member, beige weathering dark blue-grey and white mottled dolostone, white dolostone and quartzite correlated with Plymouth Formation dolostone at Plymouth Village in the Plymouth Quadrangle; €Zpfq, feldspathic quartz-schist member, light grey to dark tan-grey, pinstriped, muscovite-biotite-microcline-plagioclase-quartz schist, phyllonite and quartzite, unit strongly tectonically laminated in laminae 2 to 4 mm thick;



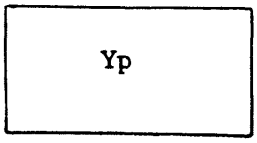
Hoosac Formation (Late Proterozoic? and Cambrian)--Dark grey to grey-green, white albite-studded, biotite-muscovite quartz schist and granofels, contains lens of magnetite-rich albitic granofels and light green lustrous quartz phyllite



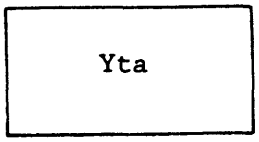
Tyson Formation schist (Late Proterozoic? and Lower Cambrian)--light grey-green to dark grey lustrous biotite-muscovite or magnetite chlorite-muscovite-quartz albite± schist albite; varies from fine-grained and lustrous chlorite schist to a medium-grained dull-weathering biotite albite schist; €Ztbs, black schist--dark grey to black, dull grey weathering, carbonaceous muscovite-biotite-quartz schist; €Ztbs, chlorite schist--light green to yellowish green, lustrous, magnetite-chlorite-quartz-muscovite schist occurs as lenses near base and near top of the Tyson Formation; €Ztq, quartzite white vitreous muscovite-tourmaline quartzite; €Ztd, dolomite beige weathering, fine-grained, white dolomite occurs as lens as much as 3 m thick in Tyson conglomerate, and albitic schist (€Zts); €Ztc, conglomerate white to grey, quartz-pebble and gneiss-pebble conglomerate containing beds of flaggy tan-weathering muscovite-biotite quartzite. Beds northwest of Tiny Pond contain rock fragments of Ygg, and Yphg as well as abundant pebbles of microcline. On Dry Hill coarse quartz- and gneiss-boulder conglomerate occurs near the base, this passes upwards into finer grained quartz-conglomerate that contain rods of quartz aligned down the dip of the prominent S_2 foliation

Zd

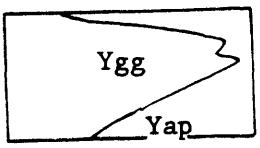
Metadiabase dikes (late Proterozoic?)--dark-green fine-grained well-foliated metadiabase consisting of epidote-chorite-actinolite-albite-titanomagnetite and sphene



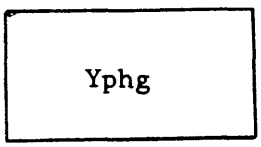
Pegmatite (Middle Proterozoic)--pink- to grey-white biotite granite pegmatite contains metamorphic muscovite and epidote



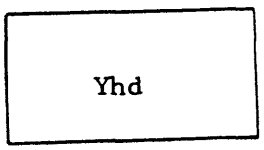
Tourmaline aplite (Middle Proterozoic)--white to yellowish grey, fine-grained rock consisting of abundant blue-green pleochroic tourmaline, microcline, oligoclase and quartz and minor biotite, contains metamorphic muscovite



Biotite granite gneiss (Middle Proterozoic)--light pinkish grey coarse-grained gneissic granite and granodiorite containing phenocryst of plagioclase mantled by microcline and brown pleochroic biotite. Unit passes into white fine-grained plagioclase or microcline-rich aplite (Yap) and gneissic aplite especially near amphibolites or calc-silicate rocks where it pervasively intrudes them; may in part be metasomatic reaction product of Ygg and other units



Proctor Hill gneiss (Middle Proterozoic)--medium-grey to light-pinkish grey, biotite-rich, coarse-grained granodiorite gneiss containing large megacrysts or augen of plagioclase; rock is highly gneissic and rich in biotite (20%) and plagioclase (50%) and commonly contain less than 20% microcline. Interpreted as an intrusive granodiorite



Hornblende-[± diopside]-plagioclase gneiss (Middle Proterozoic)--light-greenish grey, finely foliated, medium- to coarse-grained diopside-hornblende-biotite-plagioclase gneiss containing little quartz; marked by greenish irregular clots and clumps of hornblende and diopside 2 to 5 mm in diameter which impart a spotted appearance;

plagioclase component weathers chalky white. Interpreted as a metasomatic reaction product produced by intrusion of Proctor Hill gneiss into amphibolitic gneisses (Ya) into which unit may grade

Ybg

Biotite-quartz-plagioclase gneiss (Middle Proterozoic)--heterogeneous assemblage of biotite- and quartz-rich plagioclase gneisses; commonly dark- to medium-grey, biotite-rich well-foliated gneiss or schistose gneiss that weathers dull grey; contains layers of epidote- and quartz-rich gneiss or metaquartzite, amphibolite, and hornblende-biotite-quartz plagioclase gneiss. Unit contains mappable belts of calc-silicate rocks (Ycs), quartzite (Yq)

Ycs

Ym

Yd

Calc-silicate rocks (Middle Proterozoic)--consists of one or more of the following rock types intimately interlayered; light-green coarse-grained diopside rock, dark-grey to black, coarse-grained knotted hornblende-diopside rock, white vitreous diopside quartzite; tremolite-phlogopite-calcite marble; white to grey idocrase-calcite marble; greenish talc-calcite marble or calcite marble (Ym); locally calc-silicate rocks pass into hornblende and diopside spotted plagioclase gneiss (Yhg) where infiltrated by abundant white aplite (Yap). Small pods of orangish brown- to beige-weathering, light-grey scapolite-dolomite marble or phlogopite-dolomite marble (Yd) are shown separately by symbols on map

Ya

Amphibolite (Middle Proterozoic)--two kinds of amphibolite are present both shown by the symbol Ya; they are either medium-grained, well-layered, hornblende-plagioclase amphibolite, or a dense, very fine-grained, massive amphibolite consisting of actinolite, chlorite, zoisite or clinozoisite, albite and sphene. These fine-grained varieties consist almost wholly of greenschist facies minerals except for relict hornblende and garnet. Pseudomorphs after garnet consist of chlorite and epidote. Amphibolite is present at various stratigraphic positions as Ybg or interlayered with Ycs and Yrs

Yrs

Rusty aluminous schist (Middle Proterozoic)--commonly a lustrous to rusty brown weathering, steel grey to light yellowish grey schist, or quartz schist; contains chlorite pseudomorphs after garnet, muscovite, chloritized biotite and/or plagioclase. Locally rock contains distinctive ribs of quartzite 1-3 cm thick, and beds of garnet-biotite-quartz-plagioclase schist or gneiss (Ybgt) without extensive alteration. Chloritoid is present as a late retrogressive mineral in highly altered rocks. Garnets include sillimanite and/or kyanite. Very aluminous, silvery white magnetite muscovite-kyanite-garnet quartz schist on the east slope of Ludlow Mountain contains late chloritoid and relict (Proterozoic kyanite) and is interbedded with massive quartzite. Chlorite-muscovite rich schists locally contain relict Proterozoic garnet up to 7 cm in diameter

Ybgt

Garnet-biotite-quartz-plagioclase schist or gneiss (Middle Proterozoic)--dark-grey- to steel-grey-weathering, medium grey, garnet-biotite-quartz-plagioclase (muscovite) schist or gneiss, marked by distinctive grey to dark-green deformed areas of garnet largely altered to chlorite; abundant muscovite in highly altered rocks

Yq

Quartzite (Middle Proterozoic)--white, vitreous garnet-muscovite-quartzite or chlorite-muscovite quartzite. A particularly pure and thick quartzite is found on Ludlow Mountain where it is interlayered with magnetite-muscovite-chlorite-quartz schist

Ymig

Migmatite gneiss (Middle Proterozoic)--coarse grained pinkish grey, epidote-biotite-plagioclase-quartz-microcline gneiss; massive in outcrop but well-foliated and marked by distinct clots, stringers, and lenses of microcline-rich granite. Interpreted as a metamorphosed and anatectic rock produced by partial melting of a felsic volcanic or intrusive rock

Yfg

Felsic magnetite gneiss (Middle Proterozoic)--pinkish grey green to white fine-grained, finely foliated, granular magnetite-plagioclase-microcline-quartz gneiss, irregularly distributed in Ymig, possibly the protolith to Ymig

Yt

Trondhjemite gneiss (Middle Proterozoic)--coarse-grained pinkish-grey to chalky white-weathering, medium grey epidote-biotite-quartz-plagioclase gneiss, marked by large anhedral patches of quartz 3 to 5 mm in diameter spaced regularly throughout rock and intergrown with large deformed plagioclase crystals now highly altered to sericite and epidote. Unit interpreted as a metatrondhjemite

Mount Holly Quadrangle

Explanation

 approximate outline of outcrop or area of abundant closely-spaced outcrops examined

 Contact accurately located

 Contact approximately located

 Contact concealed by water

 Thrust fault accurately located; teeth on upper plate

 Thrust fault approximately located; teeth on upper plate

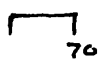
 Strike and dip of inclined right-side up bedding

 Strike and dip of inclined gneissic layering of Proterozoic age

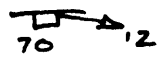
 Strike and dip of vertical gneissic layering of Proterozoic age

 Strike and dip of inclined schistosity in Late Proterozoic and Lower Cambrian rocks and of penetrative retrogressive foliation imposed on Middle Proterozoic rocks, probably Late Ordovician (Taconian). Expressed in Proterozoic rocsk by crystallization of muscovite, chlorite, epidote, tremolite-actinolite from relict Proterozoic feldspar, biotite, garnet, plagioclase, and calc-silicate minerals

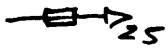
 Generalized strike and dip of highly plicated schistosity or gneissosity

 Strike and dip of inclined crenulation cleavage developed on schistosity in Late Proterozoic to Cambrian rock or on a retrogressive foliation in middle Proterozoic rocks

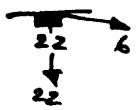
 Strike and dip of vertical crenulation cleavage



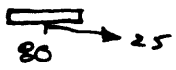
Strike and dip of inclined axial surface of minor fold of Middle Proterozoic age, arrow shows bearing and plunge of hinge line of fold



Strike and dip of vertical axial surface of minor fold of Middle Proterozoic age, arrow show bearing and plunge of hinge line of fold



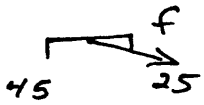
Strike and dip of inclined axial surface of minor fold or gneissosity in Proterozoic rocks formed in Ordovician (Taconian) retrogressive event, arrow show bearing and plunge of hinge lines of folds



Strike and dip of axial surface late upright fold, arrow shows azimuth and plunge of hinge line, probable Late Devonian (Acadian) folds

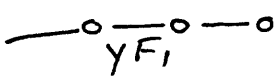
Strike and dip of inclined joints

Strike and dip of vertical joints



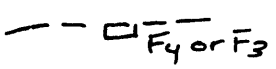
Strike and dip of fault or brittle fracture, arrow shows bearing and plunge of slickenlines where present

Axial Traces of Major Folds

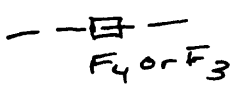


Axial trace of axial surface of major Proterozoic fold; YF_1 and YF_2 denote generation. Dip of axial surfaces are largely subvertical and plunges are generally gentle to east or to the west

Axial trace of Taconian (Late Ordovician) fold of F_2 generation. Structure correlates with second generation structures in late Proterozoic to Cambrian rocks which are associated regionally with major thrust faults in cover rocks east of the Green Mountain massif, and with ductile shear zones within the massif



Axial trace of late open fold, inclined axial surface; F_3 or F_4 (Acadian) folds



Axial trace of late open fold, vertical axial surface; F_3 or F_4 (Acadian) folds

Note regarding use of the terms Tyson Formation, Hoosac Formation, and Plymouth Formation

Rocks in the Ludlow area which lie between the Mount Holly Complex and the base of the Pinney Hollow Formation have been referred to by various names. The usage adopted in this open-file map differs from usage shown on Doll and others (1961) and from that of Thompson (1950). The following correlation chart summarizes past and present usages. The excellent work of Perry (1928, 1929) stands as the best of the early descriptions of these rocks in the Plymouth area immediately north of the Ludlow quadrangle. In Thompson's (1950) study of the Ludlow area, he applied the name Tyson Formation to conglomerates, arkoses, and greywackes resting on the older gneisses of the Green Mountains.

In the Ludlow 15-minute quadrangle he shows Tyson resting unconformably on basement from the base of Ludlow Mountain (south of Rt. 130) to near the southern border of the sheet. Another belt of Tyson is shown overlying Proterozoic gneisses at Dry Hill and near Tiny Pond near the northern border of the map. Between Ludlow Mountain and Dry Hill Thompson shows albitic schists of the Grahamville Formation resting directly on the basement. Therefore, Tyson in his original usage (Thompson, 1950) had a very restricted extent.

In preparation of the State map of Vermont (Doll and others, 1961) the name Tyson was extended to refer to all rocks included in Brace's (1953), Saltash Formation and as well as rocks mapped by Perry (1928, 1929) beneath his albitic mica schist of his Older Cambrian Group. Thus the Tyson in the area north of Ludlow as used by Doll and others (1961) contains rocks mapped by

Perry as Mendon Series and those in the lower part of Perry's Older Cambrian Group. Doll and others (1961) abandoned the term Grahamville and replaced this with Hoosac Formation claiming that rocks previously assigned to the Grahamville were the same as rocks mapped as Hoosac Formation in southern Vermont by Skehan (1957). The name Hoosac is therefore applied by them to all cover rocks above the expanded Tyson and below the Pinney Hollow.

Because the sequence of rocks and rock types contained in the Hoosac Formation north of Ludlow as mapped by Doll and others (1961) really do not resemble those found in the type Hoosac of Hoosac Mountain (Ratcliffe and others, in press) or in southern Vermont (Ratcliffe, in press), the author believes the term Hoosac should not be extended to apply to many of the rocks in the Ludlow and Plymouth area. The rocks present here are sufficiently distinct that they deserve their own terminology.

Therefore, in this map the term Tyson is expanded to include some rocks previously mapped by Thompson (1950) as Grahamville or as Hoosac by Doll and others (1961). The name Plymouth Formation is used to refer to rocks above the Hoosac and the Tyson Formation but beneath the Pinney Hollow; rocks here included in the Plymouth Formation are strikingly different from any rocks known in the Hoosac Formation. As amended the name Hoosac is retained to refer only to the green, grey or black albitic rocks west of Dry Hill, and in the Black River Valley near the northern end of the map.

Because the series of grey, green, and black schists lying above the conglomerates of the Tyson on Dry Hill and at the base of Ludlow Mountain resemble rocks found in the lower part of the Tyson as mapped by Brace (1953)

and Perry (1928) in the Plymouth area, the name Tyson is extended to include rocks up to the thrust fault which carries rocks of the Plymouth Formation over the Tyson near Ludlow. To the north of Ludlow, along the Black River Valley a thickening section of Tyson and Hoosac appears in the footwall of this thrust.

References

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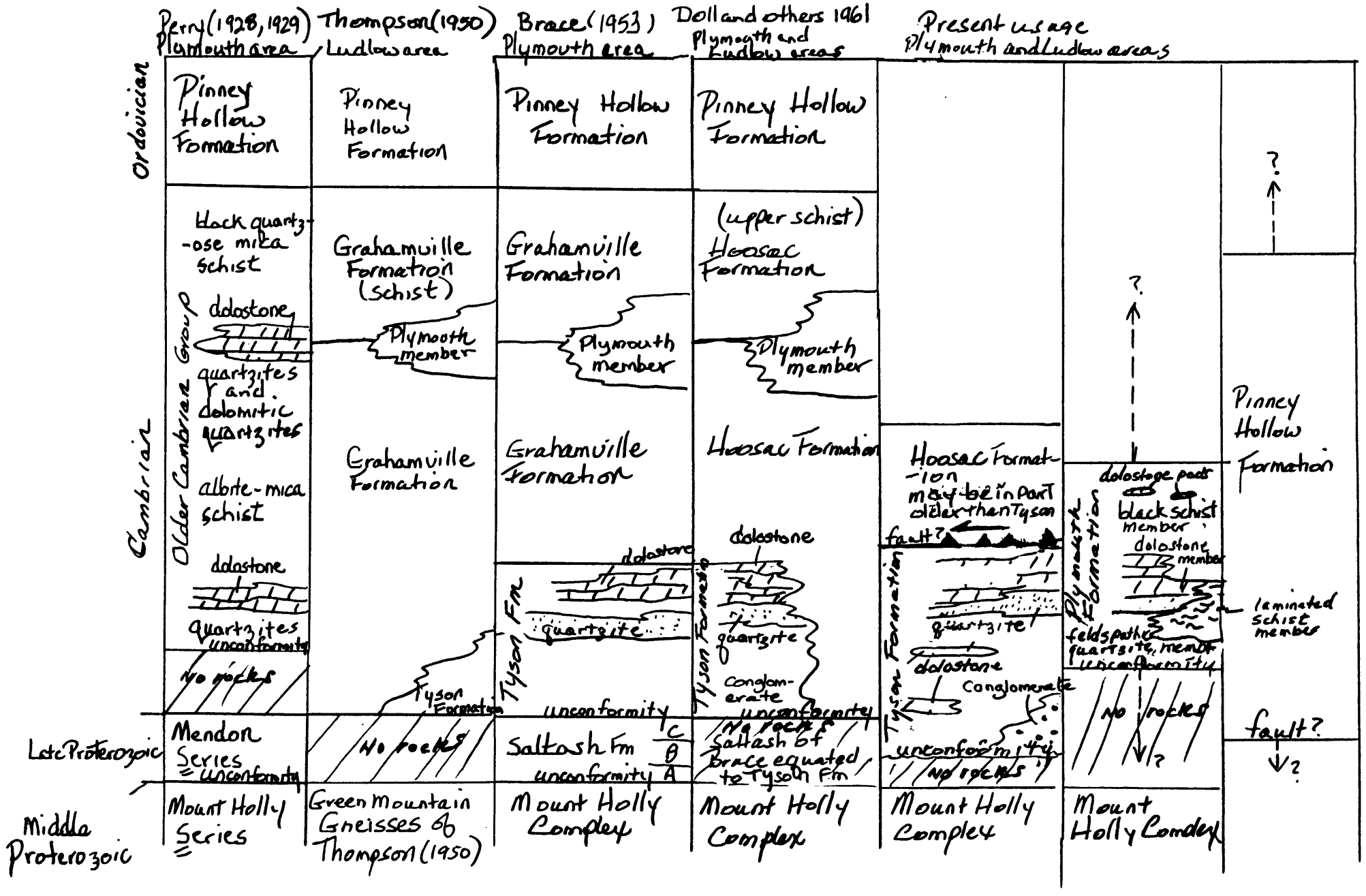

Fig 1 Correlation chart showing cover sequence rocks in the Plymouth and Ludlow areas east of the Green Mountains