U.S. DEPARTMENT OF THE INTERIOR
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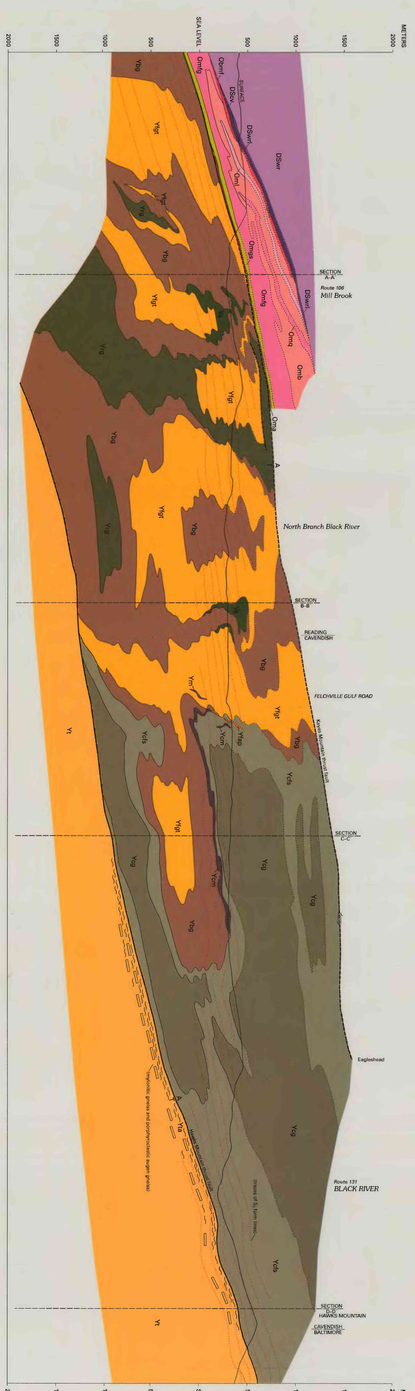
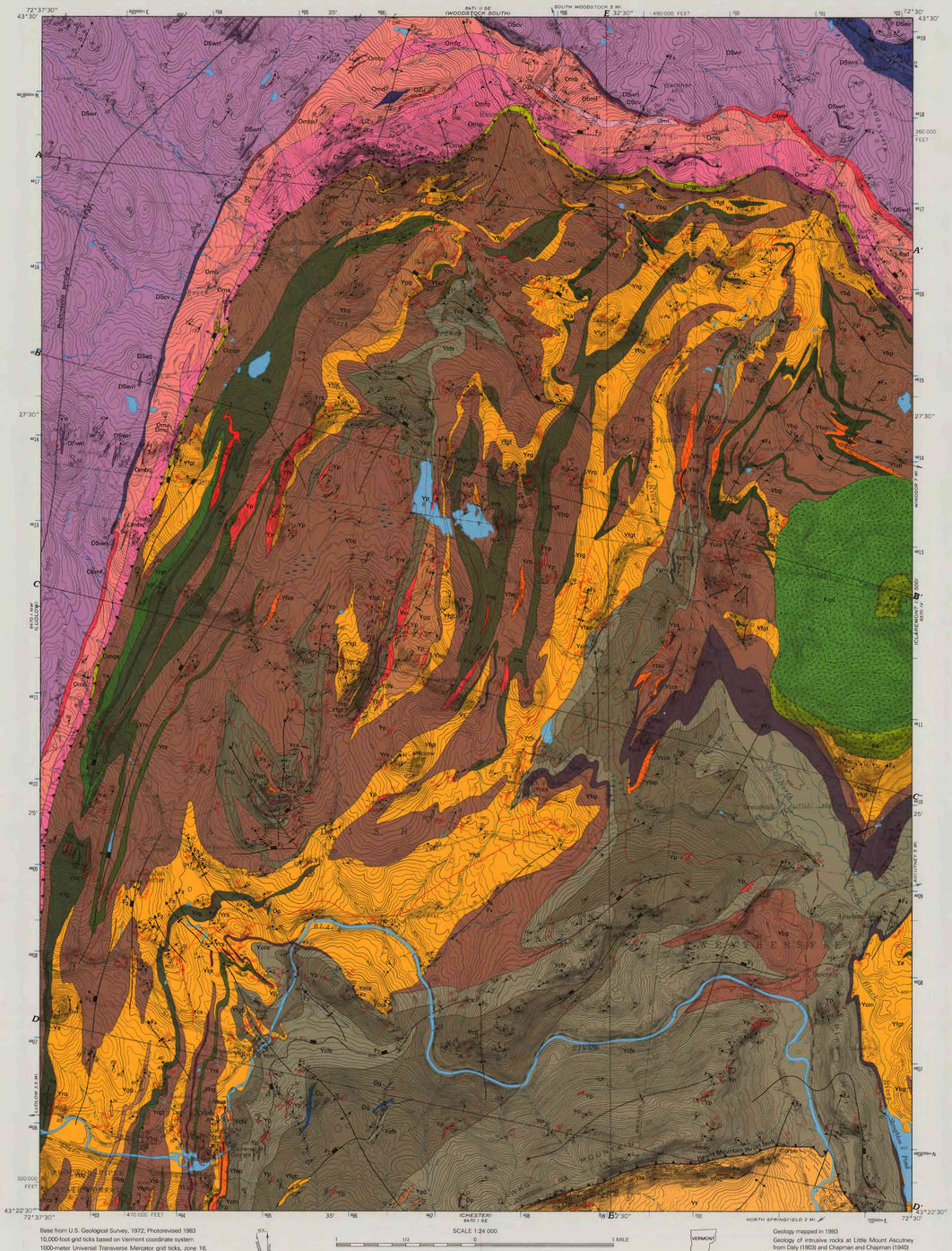
VERMONT GEOLOGICAL SURVEY

GEOLOGIC QUADRANGLE SERIES
CAVENDISH QUADRANGLE, WINDSOR COUNTY, VERMONT
MAP GQ–1773

Explanatory pamphlet accompanies map





CORRELATION OF MAP UNITS

INTRUSIVE ROCKS OF COVER AND CORE OF THE CHESTER DOME

CRETACEOUS

DEVONIAN

COVER ROCKS OF THE CHESTER DOME

Igneous rocks

LOWER DEVONIAN AND SILURIAN

Unconformity

Disconformity?

ORDOVICIAN

LATE PROTEROZOIC

CORE ROCKS OF THE CHESTER DOME
(Mount Holly Complex)

Layered paragneiss and metavolcanic(?) rocks

Intrusive rocks

Cavendish Formation (Age uncertain, interpreted as correlative with units Yca, Ycg, Ycs, and Ym)

MIDDLE PROTEROZOIC

Gneiss rocks beneath the Hawks Mountain thrust fault

DESCRIPTION OF MAP UNITS

[Major minerals listed in order of increasing abundance]

INTRUSIVE ROCKS OF COVER AND CORE OF THE CHESTER DOME

Syenite (Cretaceous)—Coarse-grained, well-jointed hornblende-biotite syenite

Gabbro-diorite (Cretaceous)—Coarse-grained, highly jointed hornblende-biotite gabbro and lighter colored, crosscutting, coarse-grained biotite-hornblende diorite

Mafic dikes (Cretaceous)—Nonfoliated, blocky jointed, medium- to fine-grained camptonite or diabase dikes

Felsic dikes (Cretaceous)—Light-gray to tan-weathering, very fine grained dikes and sills of felsite; consists of microcrystalline felsite and interspersed spheruilitic patches or rare microphenocrysts of alkali feldspar. Dikes are similar to those described by Balk and Krieger (1936). Shown as unit where thick enough, otherwise only by symbol

Pegmatite (Devonian)—Massive, nonfoliated muscovite-biotite pegmatite. Shown only by symbol where too small to map as unit

Granite (Devonian)—Massive to weakly foliated muscovite-biotite-microcline-plagioclase-quartz granite to granodiorite dikes and sills that crosscut highly foliated country rocks. Shown only by symbol where too small to map as unit

COVER ROCKS OF THE CHESTER DOME

Waits River Formation (Lower Devonian and Silurian)

Amphibolite—Dark-green, medium- to coarse-grained, warty textured hornblende-plagioclase±large garnet amphibolite. Unit varies from massive and very coarse grained to well-layered gneissic amphibolite

Felsic gneiss—Light-gray to tan-weathering biotite-quartz-plagioclase gneiss, medium-gray, feldspathic biotite quartzite, or volcaniclastic rock interpreted as interbedded with unit DSwra. Units DSwra and DSwrf were previously mapped by Chang and others (1965) as Standing Pond Volcanics

Schist—Dark-gray to silvery-gray-weathering, fine-grained, carbonaceous biotite-muscovite-plagioclase-quartz schist and phyllite and small-garnet phyllite. Unit contains abundant thin pods and beds of pasty-brown-weathering, fine-grained biotite-quartz-calcite marble commonly less than 0.5 m thick. Locally thicker beds, as much as 10 m thick, are mapped separately as unit DSwr. Overall, unit is poorly exposed and deeply weathered

Unnamed calcareous volcaniclastic and feldspathic granofels (Lower Devonian? and Upper Silurian)—Calcareous greenstone, marble, and hornblende-plagioclase granofels. A thin, less than 20 m thick, discontinuous, heterogeneous unit of interbedded actinolitic, calcareous greenstone and chloritic marble, whitish-gray hornblende-biotite-plagioclase-quartz granofels, calcareous epidote-hornblende-plagioclase amphibolite, and feldspathic quartzite interlayered on a 1 to 10 cm scale. Unit contains beds of lustrous, carbonaceous, silvery-gray, small-garnet, biotite-muscovite-quartz schist or beds of sulfidic, rusty-weathering biotite-plagioclase-quartz schist, coticule, pasty, rusty-brown-weathering amphibolite, and gray, thin-bedded quartzite (DSaq) near the top. Locally, the unit grades from schistose, feldspathic, and calcareous greenstones to the basal limestone (DSwrl) of the Waits River Formation. Unit is interpreted as reworked, diluted volcaniclastic detritus from the underlying Barnard Gneiss from which it may be separated by a nonconformity or disconformity

Barnard Gneiss (Ordovician)—Layered felsic and mafic gneiss. Heterogeneous unit of light-gray magnetite-hornblende-biotite-plagioclase-quartz granofels, hornblende lasciole schist, or dark-gray to greenish-gray-weathering biotite-hornblende-plagioclase amphibolite; layers 1 cm to as much as 1 m thick. Unit passes laterally into rusty-weathering amphibolite (Ombа?); upper and lower contacts and relation to underlying rusty-weathering sulfidic schist of the Moretown Formation are uncertain. Unit may be, in part, a heterogeneous interbedded assemblage of metasedimentary rocks derived by erosion of felsic and mafic intrusive rocks of the Barrard Gneiss or may be, in part, primarily volcaniclastic or volcanic rock

Moretown Formation (Ordovician)

Rusty plagioclase schist—Dark-gray to dull-gray-brown-weathering, carbonaceous, sulfidic, slabby biotite-muscovite-plagioclase-quartz schist. Contains dark, very rusty weathering layers rich in garnet or garnet-rich quartzite and beds of dull-gray-weathering to steel-gray- to bluish-gray-weathering vitreous quartzite (Omba) in beds as much as 2 m thick, but commonly less than 0.5 m thick. Locally quartzite grades into beds of feldspathic grit. Unit is correlated with the Cram Hill Formation of Currier and Jahns (1941). Unit Omba? is an amphibolite, possibly belonging to the Barnard Gneiss, mapped at one locality near DSwr contact

Dioritic amphibolite—Dull-gray-green-weathering, blocky, well-jointed, medium-grained hornblende-plagioclase amphibolite consisting of subequal amounts of subhedral plagioclase and hornblende 3 to 5 mm in diameter and looking like either a distinctive dioritic rock or a fine-grained, well-foliated hornblende-epidote-plagioclase amphibolite. Unit confined to one occurrence on north slope of Keyes Mountain

Amphibolite—Dark-green to dull-gray-green- or rusty-weathering, slabby, well-foliated hornblende-plagioclase amphibolite; occurs as small lenses throughout units Omb and Omfg and as a nearly continuous, very thin and highly mylonitic epidote-hornblende-plagioclase amphibolite associated with Omg along the sole of the Keyes Mountain thrust fault

Felsic gneiss—Light-gray to rusty-gray-green-weathering, well-layered garnet-chlorite-biotite-plagioclase quartz granofels or schist containing alternating light-gray to yellow-tan feldspathic quartzite in layers 1 to 3 cm thick in more feldspathic granofels. Granofels contains distinctive large sprays and irregular clots up to 4 cm in length of actinolite altered to chlorite and distinctive medium-sized 3- to 5-mm flakes of biotite that cut across the foliation. Unit is distinctly feldspathic throughout, contains distinctive 1- to 3-cm-thick discontinuous, irregular layers of pinkish-gray-weathering minute-garnet quartzite (coticule) at or near the contact with Omgs or Oma along the Keyes Mountain thrust fault. Outcrops of coticule are indicated by c

Pinstripe quartzite—Light-gray-weathering, biotite-muscovite-plagioclase quartzite having distinctive 0.5- to 1-cm-thick feldspathic layers separated by thin layers of concentrated muscovite 1 to 2 mm thick that give the rock a pinstriped, laminated texture

Feldspathic quartzite—Light-yellow-tan-weathered, slightly porous and brown-pitted biotite-plagioclase quartzite commonly internally layered on a mm scale but grades laterally into more massive vitreous quartzite. Unit is associated locally with unmapped light-yellowish-tan, lustrous, garnet-bearing, fine-grained muscovite schist or darker gray, small-garnet, lustrous, highly laminated phyllite, similar to phyllite in the Whetstone Hill Member of the Moretown Formation of Doll and others (1961). May occur as lenses in Omfg

Rusty schist—Dark-gray to rusty-brown-weathering, carbonaceous biotite-quartz-muscovite-garnet schist or phyllite occurring as thin lenses within Omq at or near contact with Omgs

Green phyllonitic schist—Light-gray-green-weathered, lustrous, fine-grained chlorite-biotite-muscovite-quartz schist or phyllonite having a distinctive flaser foliation. Unit locally contains magnetite and small garnets, as well as coarse sprays or clots of chlorite, perhaps derived from originally large crosscutting biotite or hornblende. A highly mylonitic rock, perhaps derived from Omq by shearing. Although this rock is approximately stratigraphically equivalent to the Pinney Hollow Formation as shown by Thompson and others (1993), it does not have coarse hornblende or biotite sprays that are characteristic of the Pinney Hollow. Unit appears to be interbedded with the Moretown Formation. Outcrops of coticule are indicated by c

Coarse garnet-plagioclase granofels—Light-gray to slightly rusty brown to gray-weathering, very coarse grained large-garnet biotite-plagioclase-quartz granofels containing individual garnets as much as 3 cm in diameter. Unit occurs as a discontinuous unit, interlayered tectonically(?) with Omgs or Oma at two localities along the Keyes Mountain thrust fault. Float elsewhere indicates that Omg is more widespread than indicated along the thrust. Age, origin, and correlation of this unit are uncertain

Ultramafic rocks (Ordovician to Late Proterozoic)—Talc schist. Light-silvery-green, lustrous talc schist, actinolite-talc schist, and chlorite-talc schist locally quarried at Hammondsville and occurring as small, discontinuous, poorly exposed lenses on the north slope of Keyes Mountain. It is associated with Omb and Omf and probably marks the location of important but unmapped faults within or between Omb and other units of the Moretown Formation. These ultramafic rocks occur in the same position as the main ultramafic belt in the Moretown that extends from Townshend Reservoir in the Townshend quadrangle (Ratcliffe, 1992, 1997) northeastward to Proctorsville in the Ludlow quadrangle; the ultramafic belt occurs at or near the contact between Omb (equivalent to the Cram Hill Formation) and other units of the Moretown Formation

CORE ROCKS OF THE CHESTER DOME
Mount Holly Complex (Middle Proterozoic)

INTRUSIVE ROCKS

Pegmatite—Highly deformed, well-foliated, light-gray to pinkish-gray biotite-hornblende(?)-muscovite pegmatite commonly altered to chlorite, epidote, albite, and sericite and containing large plates of ilmenite. Forms small 1- to 2-m-thick pods to masses as long as 1 km. Most abundant in or near rusty-weathering schist and quartzite units (Yrg, Yrs, Yrq) and in the Cavendish Formation, but occurs throughout the Mount Holly Complex as thin pods, stringers, or layers too small to be mapped

Granitic and migmatitic gneiss—Light-gray to pinkish-tan-weathering, fine-grained, ropy to well-foliated biotite-quartz-microcline-plagioclase granite gneiss commonly having indistinct layers and augen of microcline and intergrown plagioclase as much as 2 cm in diameter. Unit resembles Ygt but contains abundant fine-grained 1- to 2-mm microcline grains subequal in abundance to plagioclase grains, which are commonly 3 to 5 mm in diameter. Accessory amounts of metamorphic muscovite and epidote common. Finer grained varieties may contain abundant scattered magnetite. Unit interpreted as feldspathic volcanic rock that was migmatized in the Middle Proterozoic. Unit may correlate with the Yfg unit of the Mount Holly Complex mapped in the Mount Holly area (Ratcliffe, 1992)

Felchville Gneiss—Light-gray to whitish-gray-weathering, medium- to medium-coarse-grained magnetite-biotite-microcline-quartz-plagioclase gneiss that has indistinct layering near contacts with adjacent units but is massive elsewhere. Large conspicuous augen of well-twinned plagioclase as much as 1 cm in diameter are common, whereas matrix feldspar is less than 1 mm in diameter and consists of microcline in sparing amounts to as much as 25 percent. Overall unit is granodiorite to trondhjemite. Unit intrudes all units of the Mount Holly Complex, including the Cavendish Formation. U-Pb zircon data suggest an age of 1,379±23 Ma (J.N. Aleinikoff, written commun., 1995; Ratcliffe, Armstrong, and Aleinikoff, 1997)

Aplitic facies—White-weathering, fine-grained equivalent of Yfgt consisting of magnetite, quartz, plagioclase, and only trace amounts of microcline; unit contains xenoliths of more biotitic gneiss and amphibolite. Commonly associated with contact zones of Yfgt and calc-silicate gneiss (Yca), amphibolite (Ya), or marble (Ycm) associated with the Cavendish Formation. Both Yfgt and Yfap units resemble similar rocks mapped as Yph and Yfap in the Mount Holly quadrangle (Ratcliffe, 1992), where they intrude lustrous schist and rusty quartzose gneiss of the Mount Holly Complex. U-Pb zircon data suggest an age of 1,424±22 Ma (J.N. Aleinikoff, written commun., 1995; Ratcliffe, Armstrong, and Aleinikoff, 1997)

LAYERED PARAGNEISS AND METAVOLCANIC(?) ROCKS

Biotite-quartz-plagioclase gneiss—Heterogeneous assemblage of dark- to medium-gray, non-rusty-weathering quartz-rich biotite gneiss characterized by abundant plagioclase and epidote and little or no microcline. Other distinctive rock types include light-gray-weathering magnetite-muscovite-biotite-plagioclase-quartz gneiss containing thin layers of hornblende-spotted gneiss; very dark gray, biotite-rich plagioclase-quartz gneiss commonly associated with epidote-bearing quartzite; and medium- to dark-gray, white-albite-spotted biotite-quartz gneiss. Muscovite is a common accessory and small garnets may be present. The biotite-quartz-plagioclase gneiss unit contains numerous layers of other distinctive rocks interlayered throughout; where thick enough to map, these rocks are mapped separately as listed below

Albite-biotite granofels—Light-gray, non-rusty-weathering, white-albite-studded magnetite-biotite-muscovite-epidote-albite-granofels and gneiss. Locally between contact of Ycfs and Ybg and as a lens in Ybg between Bowen Hill and Keyes Mountain

Amphibolite—Dark-green to dull-gray-weathering, fine- to coarse-grained hornblende and hornblende-garnet-plagioclase amphibolite. Locally very coarse grained and contains garnets as large as 2 cm in diameter

Garnet-biotite gneiss—Dark-gray- to rusty-gray-brown-weathering, sulfidic muscovite-biotite-magnetite gneiss or schist marked by abundant small garnets, biotite, and fine laminae of quartz and plagioclase. Unit occurs interbedded with other rusty schist and gneiss units (Yrs and Yrg) and is commonly associated with thin belts of rusty-weathering amphibolite and thin beds of calc-silicate gneiss too thin to map

Rusty muscovite-chlorite schist—Light-silvery- to greenish-gray, rusty-weathering, lustrous biotite-muscovite-chlorite-quartz schist marked by irregular plates and clots of chlorite. Locally contains garnet. Unit is spatially related to contact of pegmatites with other rusty gneiss units, Yrg or Yrgt. Yrs closely resembles the aluminous schist of the Gassetts Schist Member (Yrq) and the feldspathic schist (Ycfs), both of the Cavendish Formation

Rusty muscovite-biotite-plagioclase-quartz gneiss—Dark-brown to gray, rusty-weathering gneiss and schist containing abundant layers of schistose quartzite, biotite-garnet quartzite, and rusty sulfidic amphibolite. The distinction between Yrg and Yrs is slight, but, generally, Yrg is less muscovitic, more gneissic, and more uniformly biotitic. Yrg grades laterally into Yrs and, locally, contains lenses of Yrs too small to map

Quartzite—Forms zones within the rusty gneiss unit (Yrg) that contain numerous closely spaced beds of yellow-brown-weathering, vitreous muscovite and garnet quartzite in beds less than 1 m thick

Calc-silicate gneiss—Commonly coarse-grained hornblende-plagioclase-calcite±diopside±actinolite calc-silicate knotted rock that forms pods, stringers, or lenses in other rock types. Commonly is interlayered with beds of coarse-grained calcite, calcite-diopside-actinolite marble, or amphibolite. Many thin bands of calc-silicate gneiss occur with the Ytg unit west of Cavendish Gorge, on Star Hill, and along the contact between the Cavendish Formation and Ytg in the area east of Felchville

Marble—Small pods and lenses of white, very coarse grained calcite-phlogopite marble and gray, medium-grained calcite-dolomite marble resembling the marble in the Cavendish Formation (Ycm). Many pods occur within the Ytg unit bordering the Cavendish. A large belt of marble within granodiorite gneiss (Ytg) was quarried east of Felchville

Cavendish Formation (Age uncertain, interpreted as correlative with units Yrs, Yrg, Ycs, and Ycm)

Gassetts Schist Member—Yellowish-green to gray-green, rusty-weathering, lustrous, large-garnet chlorite-biotite-muscovite-(paragonite)-quartz-±plagioclase schist marked by large irregular sprays, clots, and patches of iron-rich chlorite and large irregular shredded plates of muscovite. May contain large conspicuous crystals of black staurolite as much as 4 cm long and smaller, 1-cm crystals of faintly blue-gray kyanite. Dark-reddish-brown garnet, as much as 2 cm in diameter, commonly is highly altered to chlorite, whereas smaller garnet, 2 to 3 mm in diameter, in the matrix is unaltered. Unit grades into gray-green, more feldspathic schist lacking abundant silky muscovite but still containing small garnets and abundant sprays, clots, and patches of chlorite

Feldspathic schist or granofels—Either a rusty-weathering, light- to medium-dark gray, white-plagioclase-spotted biotite-quartz granofels or a biotite-rich porphyroclastic schist having isolated plagioclase augen as much as 1 cm in diameter set in a phyllonitic matrix of biotite, muscovite, epidote, and quartz. The latter variety is widely distributed on Hawks Mountain and on Pine Hill

Marble—Consists of a variety of marbles associated with calc-silicate gneiss and beds of actinolitic quartzite. Marbles include whitish-gray-weathering, medium- to coarse-grained, quartz-knotted phlogopite-calcite dolomitic marble; greenish actinolite-rich dolomitic marble; and fine-grained yellow-gray-weathering, highly foliated phlogopite-talc(?)-tremolite dolomitic marble. The purer varieties of the marble were quarried in Cavendish south of the quadrangle, at the south end of Pine Hill, in Amsden, in the Albert Lord State Forest northwest of Greenbush, and east of Felchville. The beds of marble grade laterally into very coarse grained calc-silicate rocks (Yca). Equant subrounded to faceted and equant zircon from a 0.5-m-thick quartzite and calc-silicate layer at Cavendish Gorge yield $^{207}Pb/^{206}Pb$ ages between 1,290 and 943 Ma (Karabinos and others, 1998). If these ages of zircon are interpreted as the true age of zircon of detrital origin, the sampled quartzite must be younger than 943 Ma, thus suggesting that some parts of the Cavendish Formation may be younger than the Mount Holly Complex. Multiaged overgrowths on zircon are common in all of the Mount Holly Complex and range from 1,200 to 950 Ma in rocks whose original age is older

Calc-silicate gneiss and marble—Dark-green hornblende-actinolite-diopside-microcline gneiss, diopside-calcite-hornblende gneiss, and dull-gray-weathering phlogopite-scapolite-calcite marble commonly intruded by Yfap and Yfgt. The calc-silicate rocks (Yca) and associated marbles (Ycm) are included as members of the Cavendish Formation because they are in contact with schistose or feldspathic members (Yrg and Yrfs) of the Cavendish. These calc-silicate rocks and associated marbles are otherwise similar to calc-silicate (Yca) and marble (Ym) units elsewhere in the Mount Holly Complex

Gneiss beneath the Hawks Mountain thrust fault

Tonalitic gneiss—Coarse-biotite-flecked, light-gray to whitish-gray-weathering, medium-grained biotite-quartz-plagioclase gneiss having a distinct igneous appearance in less sheared rocks. Rock closely resembles tonalitic and trondhjemitic gneisses within the core of the Green Mountain massif that have been dated at 1,300 Ma (Ratcliffe and others, 1992)

Tonalitic augen gneiss—Very well foliated, mylonitic biotite gneiss containing porphyroclastic eyes of plagioclase as long as 5 mm set in a mylonitic matrix rich in biotite; rock gradually grades into mylonite gneiss or schist (Ytm) that may be equivalent to the dark-gray biotite-feldspar schist of the Cavendish Formation (Yefs) on Hawks Mountain and Pine Hill

EXPLANATION OF MAP SYMBOLS

Contact—Dotted where concealed by water

Thrust fault or ductile shear zone—Dashed where approximately located, dotted where concealed by water. Teeth on upper plate. In cross section relative movement indicated by arrows or T, toward observer; A, away from observer

Normal fault—Bar and ball on downthrown side

FOLDS

[Approximate axial trace and general plunge direction of major fold. Rectangle shows dip direction of axial surface. Relative age identified by color and subscript; the greater the subscript number the younger the fold. Axial trace of Acadian F_3, F_4, and F_5 folds was located by deflection of older Taconian surface as determined from form line map of S_2 surface shown in figure 8]

Vertical to subvertical pre-Acadian fold—Age uncertain, possibly Middle Proterozoic or Taconian F_1 folds of text

Before domal-stage fold

F_2 fold—Inclined. Acadian or possibly Taconian

Acadian F_1 overturned syncline—Not described in text but observed

Domal-stage Acadian fold—Relative age (F_3, F_4, F_5) indicated where known

Upright antiform

Upright synform

PLANAR FEATURES

[May be combined with linear or other planar features; symbols joined at point of observation]

Strike and dip of vertical bedding

Strike and dip of gneissosity or coarse schistosity in Middle Proterozoic rocks—Possibly a relict Proterozoic structure

Inclined

Vertical

Strike and dip of schistosity—Possibly Taconian in Ordovician rocks; Acadian in Silurian and Devonian rocks

Inclined

Vertical

Strike and dip of schistosity and parallel beds

Inclined

Vertical

Strike and dip of S_2 foliation in Middle Proterozoic and Ordovician rocks—Feature overprints older gneissosity or schistosity; second or later generation structure. Used to construct form line map, fig. 8

Inclined

Vertical

Strike and dip of inclined, highly plicated schistosity or gneissosity

Strike and dip of crenulation cleavage—May be combined

Inclined

Vertical

Strike and dip of axial surface of minor folds

Middle Proterozoic fold

Inclined

Vertical

Second or later generation fold of schistosity or gneissosity

Inclined

Vertical

Fold of bedding—Possibly Taconian in Ordovician rocks; Acadian in Silurian and Devonian rocks

Inclined

Vertical

Late Acadian fold

Inclined

Vertical

Strike and dip of brittle fault or fracture—Where known, U denotes side that moved up; D denotes side that moved down, single arrow shows plunge of slickensides; opposing half arrows show direction of relative lateral movement

Inclined

Vertical

LINEAR FEATURES

Azimuth and plunge of hinge line of minor fold—Where observed, small arc shows apparent sense of rotation of fold as viewed down plunge

Bedding

Schistosity or foliation—Relative age shown by combination with planar symbol

Inclined

Horizontal

Strike and dip of dike or vein—Identified by unit designation

Inclined

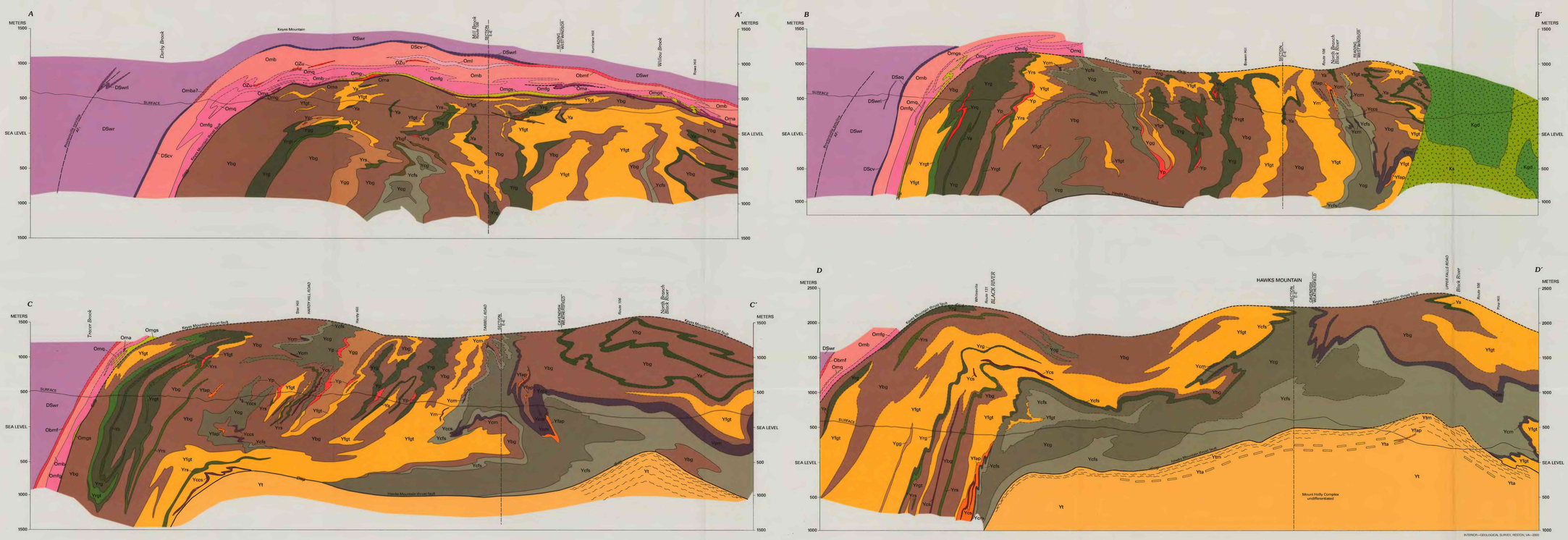
Vertical

OTHER SYMBOLS

Abandoned quarry—m, marble

Approximate boundary of outcrop—Additional areas shown by attitude symbol

Location of zircon sample used for U-Pb dating of the Felchville Gneiss



BEDROCK GEOLOGIC MAP OF THE CAVENDISH QUADRANGLE, WINDSOR COUNTY, VERMONT

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