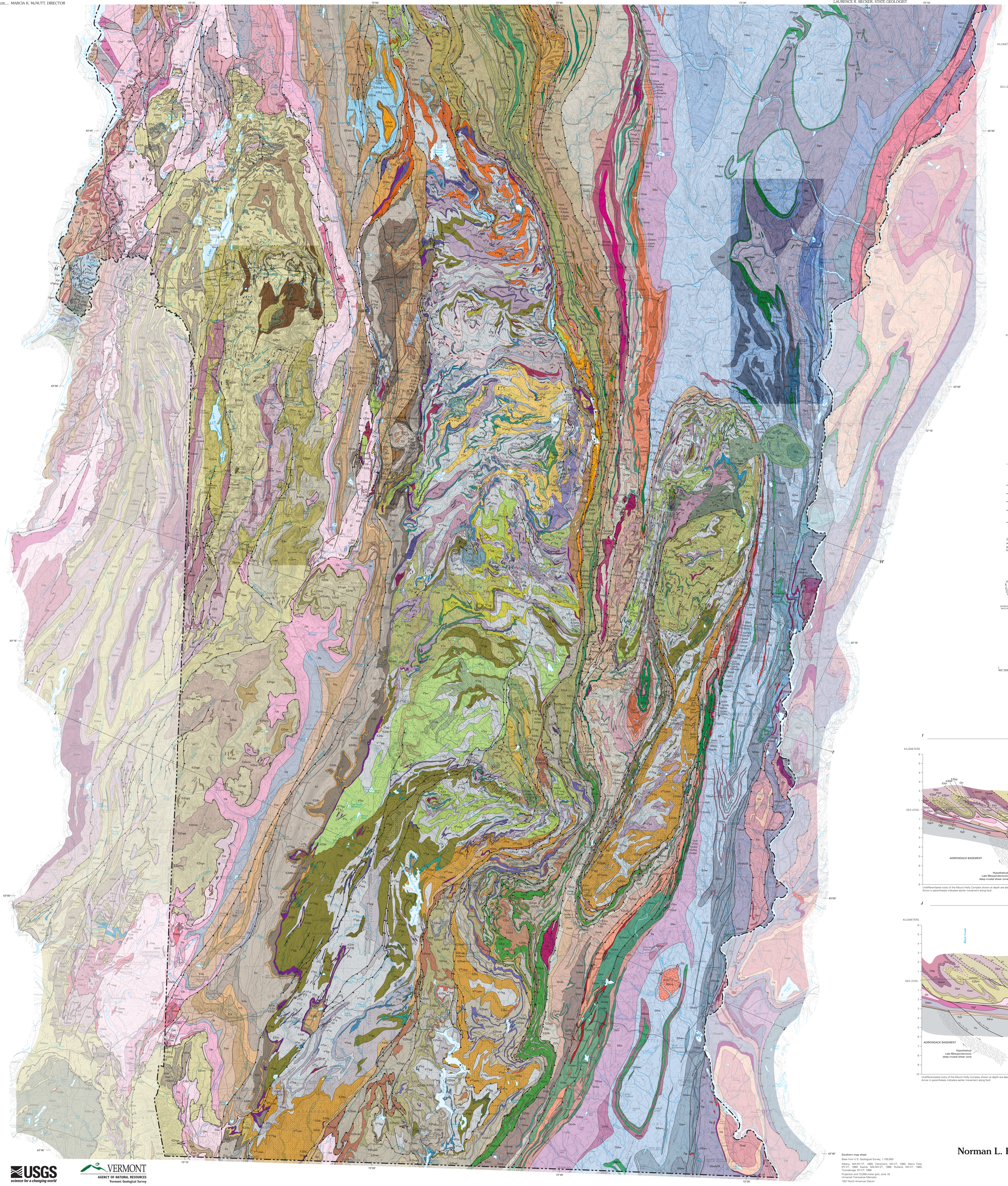
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
MARCIA K. McNUTT, DIRECTOR

Prepared in cooperation with the
STATE OF VERMONT, VERMONT AGENCY OF NATURAL RESOURCES,
VERMONT GEOLOGICAL SURVEY
LAURENCE R. BECKER, STATE GEOLOGIST


73°15′
73°00′
72°30′
72°15′
43°30′
42°45′

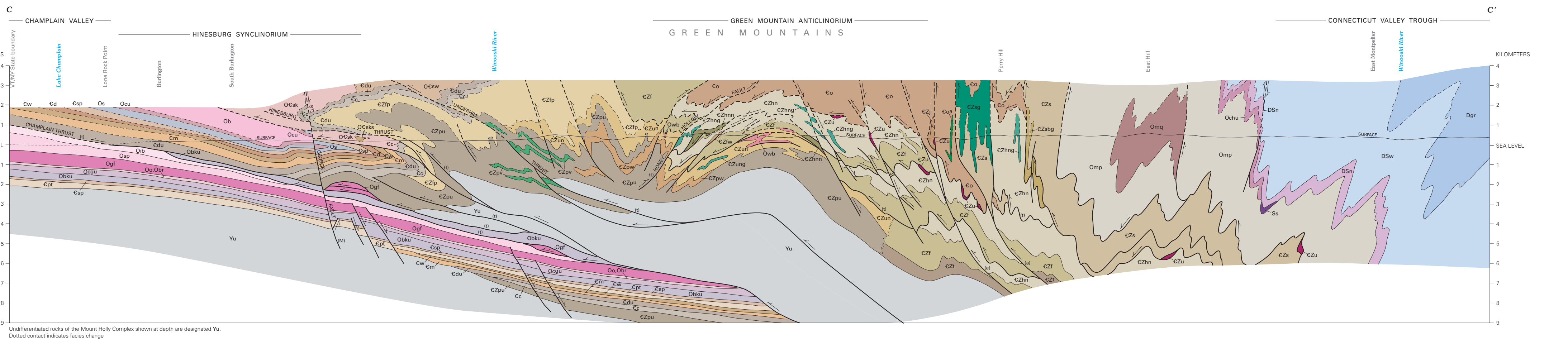
Southern map sheet

Base from U.S. Geological Survey, 1:100,000

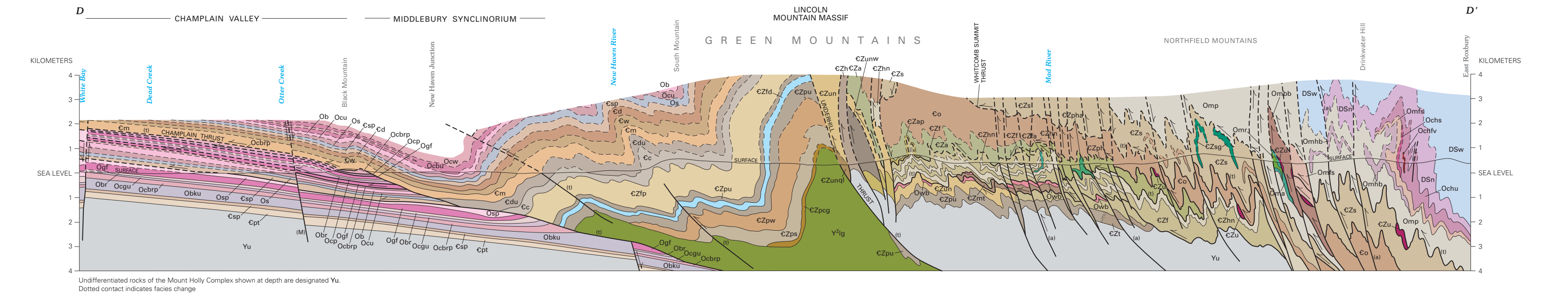
Albany, MA-NY-VT, 1989; Claremont, NH-VT, 1985; Glens Falls, NY-VT, 1989; Keene, MA-NH-VT, 1986; Rutland, NH-VT, 1985; Ticonderoga, NY-VT, 1989

Projection and 10,000-meter grid, zone 18, Universal Transverse Mercator

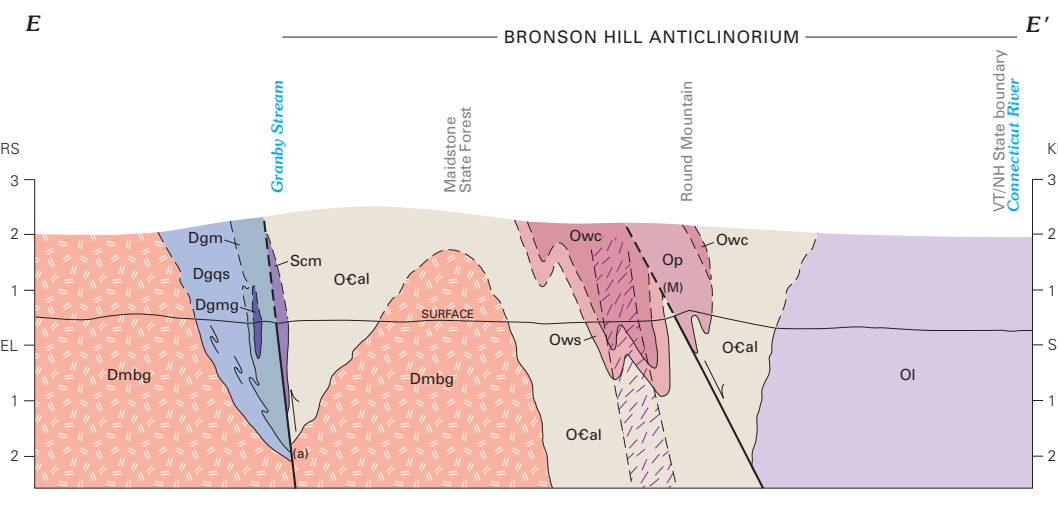
1927 North American Datum

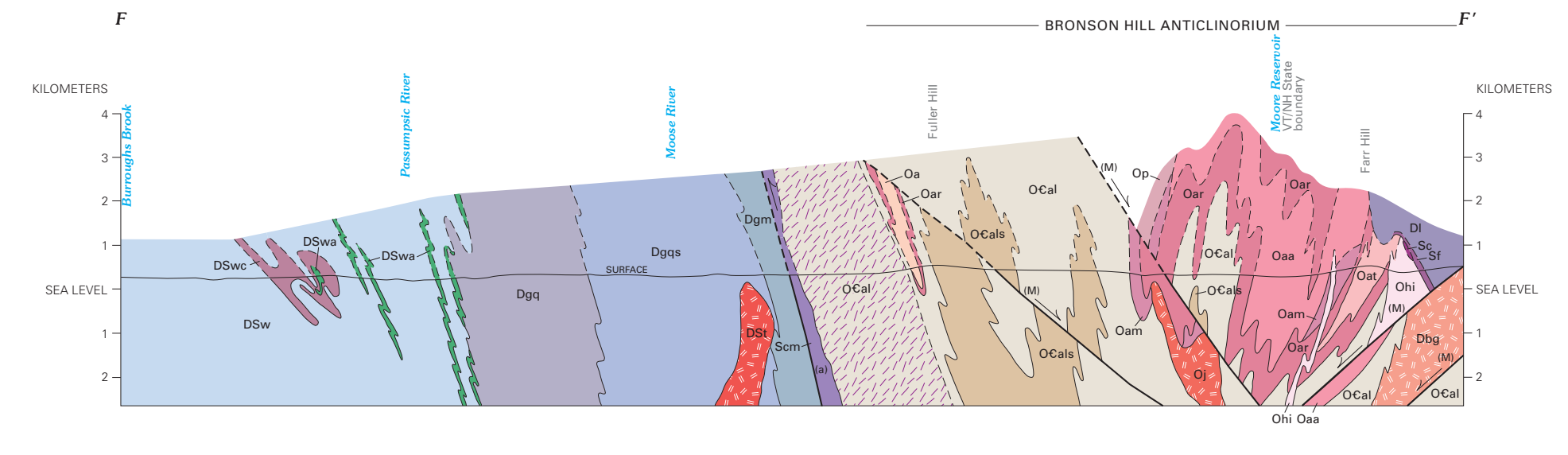

C
C′
CHAMPLAIN VALLEY
HINESBURG SYNCLINORIUM
GREEN MOUNTAIN ANTICLINORIUM
GREEN MOUNTAINS
CONNECTICUT VALLEY TROUGH
KILOMETERS
SEA LEVEL

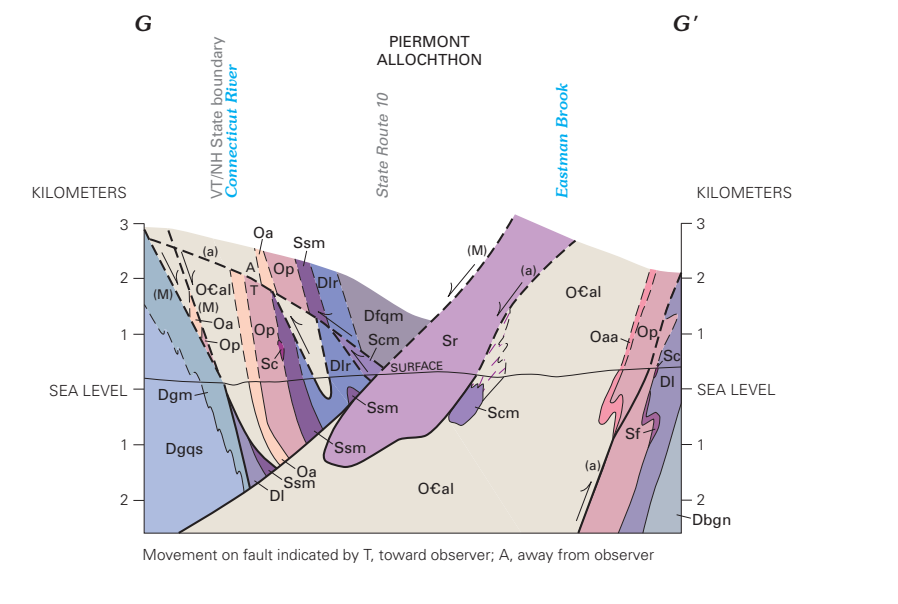
Undifferentiated rocks of the Mount Holly Complex shown at depth are designated **Yu**.
Dotted contact indicates facies change


D
D′
CHAMPLAIN VALLEY
MIDDLEBURY SYNCLINORIUM
LINCOLN MOUNTAIN MASSIF
GREEN MOUNTAINS
NORTHFIELD MOUNTAINS
CHAMPLAIN THRUST
KILOMETERS
SEA LEVEL

Undifferentiated rocks of the Mount Holly Complex shown at depth are designated **Yu**.
Dotted contact indicates facies change


E
E′
BRONSON HILL ANTICLINORIUM
KILOMETERS
SEA LEVEL


F
F′
BRONSON HILL ANTICLINORIUM
KILOMETERS
SEA LEVEL


G
G′
PIERMONT ALLOCHTHON
KILOMETERS
SEA LEVEL

Movement on fault indicated by T, toward observer; A, away from observer

EXPLANATION OF MAP SYMBOLS

Contact—Approximately located; dashed where encloses overprint pattern; dotted where concealed by water

Faults—Approximately located; dashed and queried where uncertain; dotted where concealed by water. On cross sections, age of principal movement where known is shown by (t), Taconian; (a), Acadian; (M), Mesozoic

Thrust fault—Pre-metamorphic or early metamorphic; sawteeth on upper plate. Age of principal movement is considered oldest Taconian

Thrust fault—Syn-metamorphic or post-metamorphic with respect to either Taconian or Acadian metamorphism. Sawteeth on upper plate

Strike-slip fault—Arrows show sense of lateral relative movement. Age of principal movement is considered Acadian or Alleghanian

Normal fault—Ticks on downthrown side; arrows indicate sense of oblique relative movement where known. Age of principal movement is considered Acadian, Alleghanian, or Mesozoic

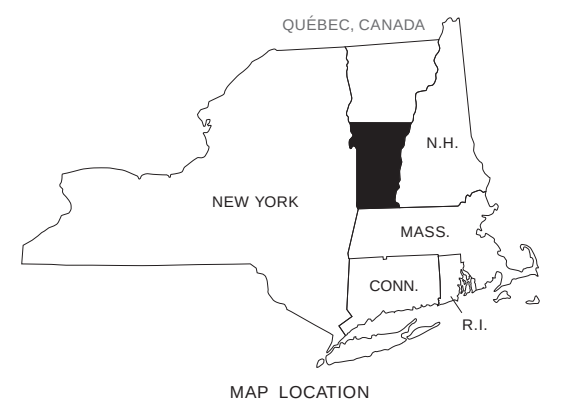
Brittle fault—Sense of movement, where known, is shown by U, upthrown side; D, downthrown side

48 ⊙ **U-Pb zircon sample site**—See table 1 on back of sheet 3

The geology portrayed in adjacent Massachusetts, New York, and New Hampshire is partly subdued to more clearly define the geographic limits of the State of Vermont. Some of the geology shown in these adjoining areas was newly surveyed for this map in order to obtain a better understanding of the rock units and structures within Vermont.

14½°
MAGNETIC NORTH
TRUE NORTH

APPROXIMATE MEAN DECLINATION, 2011


QUÉBEC, CANADA
N.H.
NEW YORK
MASS.
CONN.
R.I.

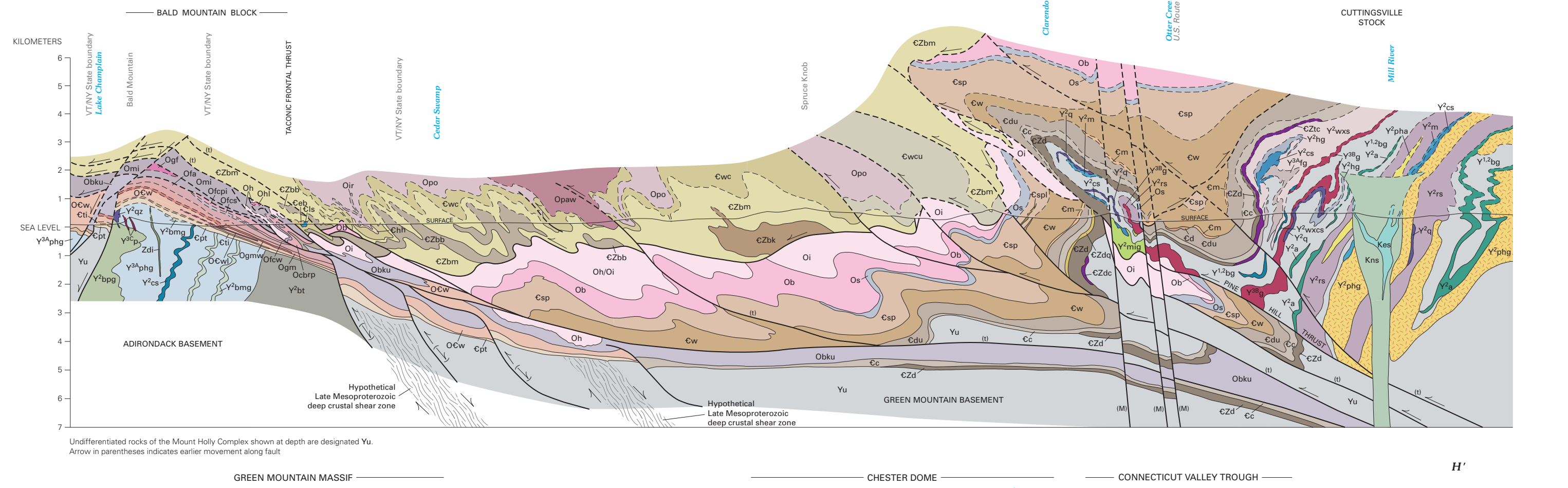
MAP LOCATION

SCALE 1:100 000

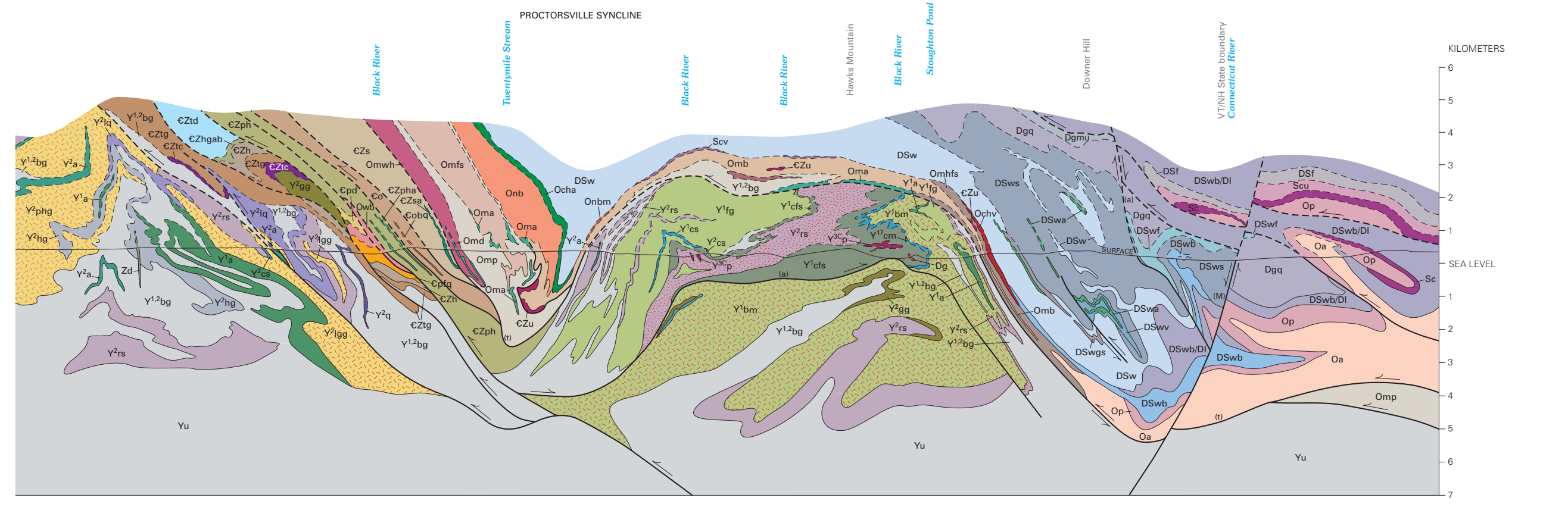
1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

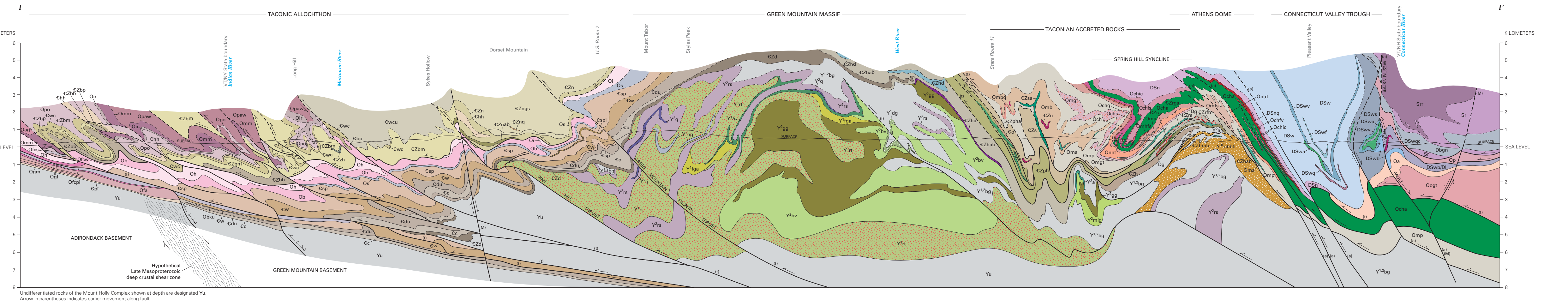
1 0 1 2 3 4 5 6 7 8 MILES

CONTOUR INTERVAL 20 METERS

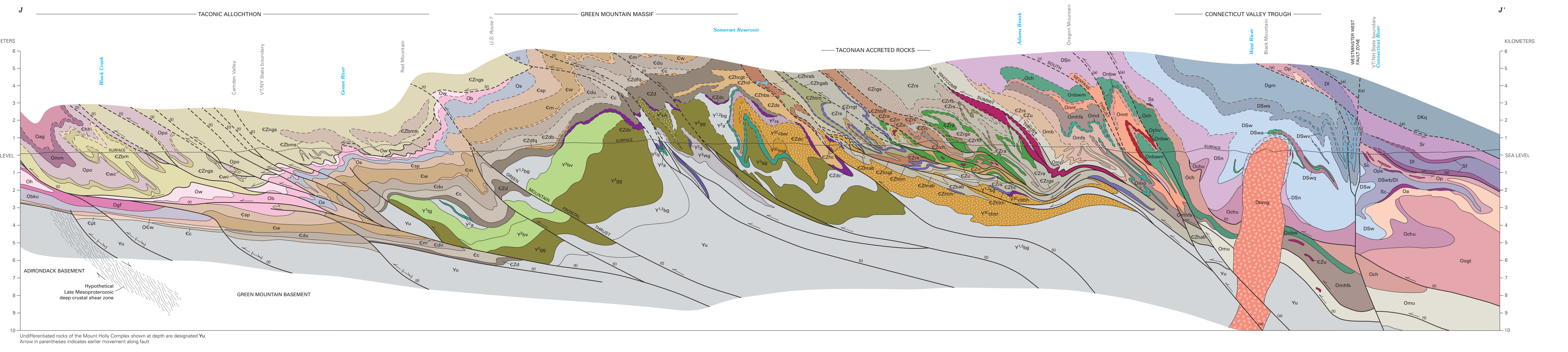

H
TACONIC ALLOCHTHON
BALD MOUNTAIN BLOCK
TACONIC FRONTAL THRUST
GREEN MOUNTAIN MASSIF
CUTTINGSVILLE STOCK
ADIRONDACK BASEMENT
Hypothetical Late Mesoproterozoic deep crustal shear zone
GREEN MOUNTAIN BASEMENT
KILOMETERS
SEA LEVEL

Undifferentiated rocks of the Mount Holly Complex shown at depth are designated **Yu**.
Arrow in parentheses indicates earlier movement along fault


H′
GREEN MOUNTAIN MASSIF
CHESTER DOME
PROCTORSVILLE SYNCLINE
CONNECTICUT VALLEY TROUGH
KILOMETERS
SEA LEVEL


I
I′
TACONIC ALLOCHTHON
GREEN MOUNTAIN MASSIF
TACONIAN ACCRETED ROCKS
ATHENS DOME
CONNECTICUT VALLEY TROUGH
SPRING HILL SYNCLINE
ADIRONDACK BASEMENT
Hypothetical Late Mesoproterozoic deep crustal shear zone
GREEN MOUNTAIN BASEMENT
KILOMETERS
SEA LEVEL

Undifferentiated rocks of the Mount Holly Complex shown at depth are designated **Yu**.
Arrow in parentheses indicates earlier movement along fault


J
J′
TACONIC ALLOCHTHON
GREEN MOUNTAIN MASSIF
TACONIAN ACCRETED ROCKS
CONNECTICUT VALLEY TROUGH
ADIRONDACK BASEMENT
Hypothetical Late Mesoproterozoic deep crustal shear zone
GREEN MOUNTAIN BASEMENT
KILOMETERS
SEA LEVEL

Undifferentiated rocks of the Mount Holly Complex shown at depth are designated **Yu**.
Arrow in parentheses indicates earlier movement along fault

BEDROCK GEOLOGIC MAP OF VERMONT

By

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With contributions by

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Cartography by Linda M. Masonic[1]

2011

USGS
science for a changing world

VERMONT
AGENCY OF NATURAL RESOURCES
Vermont Geological Survey

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GIS database compiled by Gregory J. Walsh and Marjorie H. Gale

Digital cartography by Linda M. Masonic

Edited by James R. Estabrook

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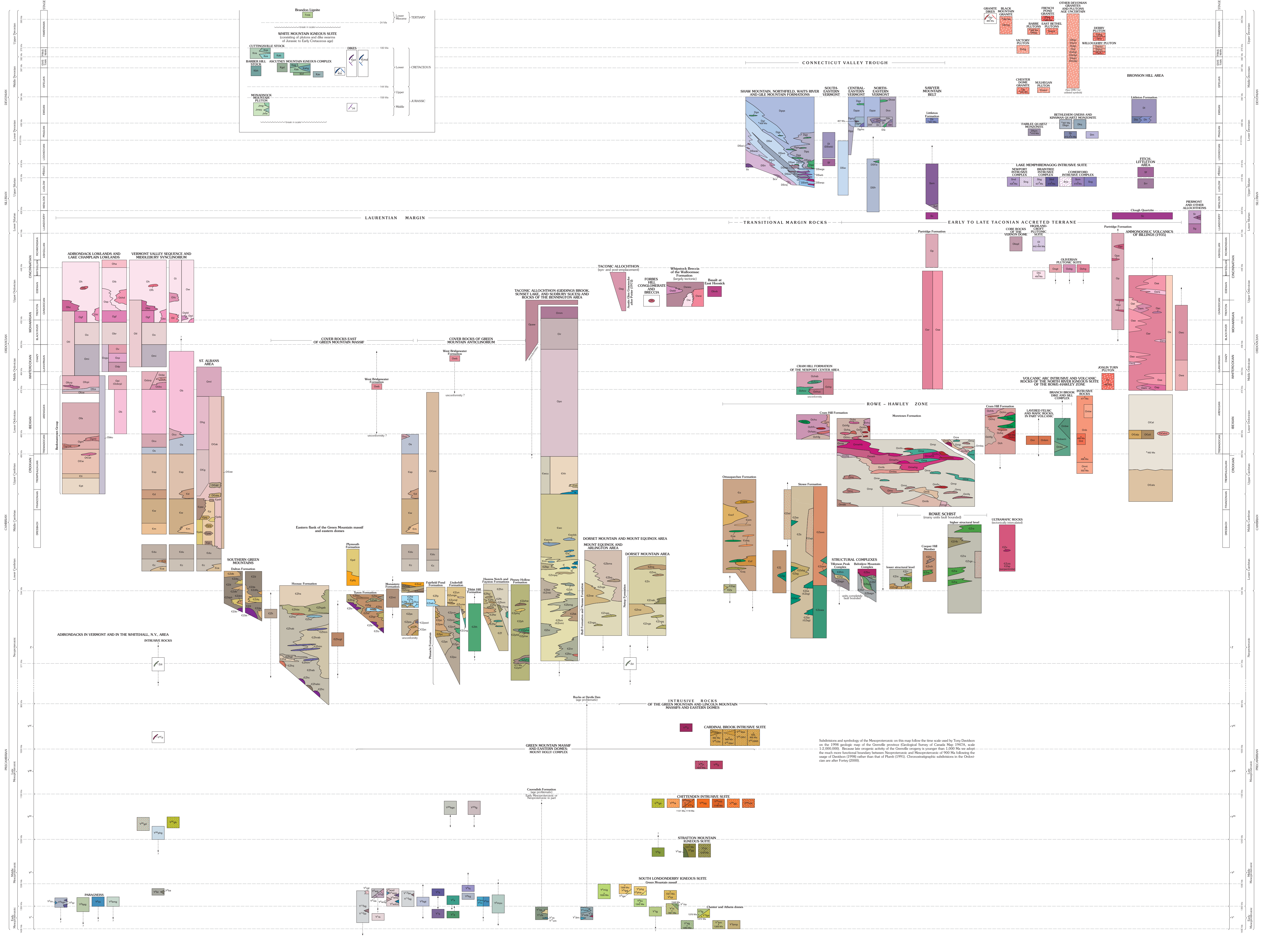
CORRELATION OF MAP UNITS

(Some lesser units listed in the Description of Map Units may not be shown here. Asterisk indicates U-Pb zircon age.)



DESCRIPTION OF MAP UNITS

[Minerals are listed in order of increasing and approximate abundance. Minerals that are variably present are shown in parentheses with ±. Nos. 1–51 refer to uranium-lead (U-Pb) zircon age samples listed in table 1 on the back of this sheet and shown on the geologic maps]

Tmb

Brandon Lignite (lower Miocene)—Organic silt, sand and gravel and slumped and dismembered lignite occurring as elongate disrupted deposits in underlying kaolin, residual hematite, and ochre deposits near Brandon. Lignite was let down into kaolin perhaps by karst collapse along a concealed west-dipping normal fault between the Dunham Dolostone on the west and the Cheshire Quartzite on the east. Deposit largely concealed but known from historic underground workings for kaolin, hematite ochre, and lignite

White Mountain Igneous Suite (Early Cretaceous and Jurassic)

Cuttingsville stock (Early Cretaceous)—Composite stock and intrusive breccia dikes consisting of augite and hastingsite syenite, nepheline and sodalite syenite, essexite, and monzodiorite. Associated dikes of monchiquite, camptonite, bostonite, and spessartite. Average of five K-Ar ages 101 Ma; ages range between 103±4 and 99±2 Ma (Armstrong and Stump, 1971)

Kns

Nepheline and sodalite syenite, hornblende syenite

Kqs

Quartz syenite

Kes

Essexite (alkali gabbro)

Kab

Andesite breccia containing xenoliths of Mesoproterozoic gneiss and autoclasts of felsic alkalic and fine-grained mafic rocks

Ascutney Mountain igneous complex (Early Cretaceous)—Consists of two plutons, a partial ring dike, and screens of volcanic rocks. K-Ar ages of 122 to 120 Ma (Foland and Faul, 1977)

Ascutney Mountain stock

Kag

Medium- to coarse-grained biotite-microperthite-orthoclase-albite granite

Kahg

Hornblende granite occurring as small intrusive masses in Kas

Kas

Syenite-porphyrite to sericite-perthite-hornblende-biotite syenite; contains minor fayalite, augite, and quartz; occurs as a partial ring dike in the Little Ascutney stock

Kav

Trachytic to rhyolitic tuffs, and breccias containing fragments of volcanic rocks having trachytic flow structure and layering. Interpreted as volcanic rocks of the edifice

Khf

Hornfels—Dense, compact hornfels consisting of recognizable but altered schists of the country rock. Shown only around main Ascutney Mountain stock in structural continuity with rocks outside the contact aureole. Locally aluminous rocks of the Waits River Formation contain andalusite, sillimanite, cordierite, pleonaste, and corundum; calcareous pelites contain diopside, quartz-wollastonite, plagioclase, grossular garnet, and scapolite

Little Ascutney stock

A composite gabbro-diorite stock having two (eastern and western) intrusive centers defined by weakly developed igneous foliation. Gabbro is intruded by abundant, poorly defined areas of diorite. Includes two areas of syenite (Kas)

Kgd

Gabbro and diorite—Medium- to coarse-grained augite-hornblende-biotite gabbro infiltrated by hornblende and biotite diorite

Kpd

Paisanite dike—Fine-grained syenitic dike similar to spherulitic dikes found within the plutons and in the adjacent country rocks. One paisanite dike occurs well outside the Ascutney Mountain stocks in the saddle between the Chester and Athens domes

Barber Hill stock (Early Cretaceous)

Kbh
Kfd

A small, 0.5-km-long, northwest-trending stock consisting of a coarse-grained alkali syenite core, a fine-grained quartz syenite border, and associated trachyte dikes (Kfd). K-Ar biotite age of 114±2 Ma (Armstrong and Stump, 1971) and Rb/Sr whole-rock isochron on trachyte dikes of 125±5 Ma (McHone and Corneille, 1980)

Monadnock Mountain pluton (Middle Jurassic)

Composite stock of quartz syenite, syenite granite, and essexite. K-Ar age of 175±4 Ma (Foland and Faul, 1977)

Jmsy

Quartz syenite—Greenish-gray to pink hornblende-biotite quartz syenite

Jmg

Granite—Hornblende-biotite-microperthite granite, gradational into quartz syenite

Jme

Essexite—Pyroxene-biotite-hornblende andesine gabbroic rock grading into quartz syenite

Jd

Dikes associated with Monadnock Mountain pluton—Granite, syenite, quartz bostonite, camptonite, aplite, and pegmatite

Kmd

Dikes of White Mountain Igneous Suite—Largely Early Cretaceous, but some may be Middle Jurassic (McHone, 1992)

Predominantly mafic and intermediate dikes of diabase, <1 m to 3 m thick, consisting of olivine-augite diabase, lamprophyre, calcite amygdaloidal mafic dikes; alkali basalt, monchiquite and granitic, rhyolite, trachyte and foidal felsic dikes; and spherulitic trachyte dikes. Only felsic dikes near intrusive centers are distinguished as Kfd; elsewhere, felsic dikes are not shown separately. Orientation gives strike of dikes measured; spot locations from literature without strikes are not shown. Distribution uneven owing to nonuniform reporting; however, three general areas contain dike swarms: (1) probable Middle Jurassic dikes of syenite diabase, and lamprophyre associated with Monadnock Mountain pluton; (2) Early Cretaceous swarms associated with Barber Hill stock near Lake Champlain and extending eastward to swarm of lamprophyre at western margin of Connecticut Valley trough; and (3) a southern Early Cretaceous swarm of foidal felsic, mafic, and lamprophyre dikes associated with plutons at Mount Ascutney and Cuttingsville and extending westward into the Taconic Range. Commonly dikes are nondeformed and chilled, but locally they are offset by minor faults that are either northeast-trending normal or strike-slip. Notable faulted dikes occur on the east side of Monadnock Mountain, 3.2 km west of Little Ascutney Mountain, along U.S. Route 4 southwest of Proctor, and immediately west of the Cuttingsville stock

New Hampshire Plutonic Suite

Devonian intrusive rocks
(four general designators are used: Dbg, binary and biotite granite and granodiorite, undifferentiated; Dqm, quartz monzonite; Ddg, diorite and gabbro; and Dg, small dikes. Only Dbg and Dg are shown in the Description of Map Units)

Dbg

Binary and biotite granite and granodiorite, undifferentiated—Includes small dikes labelled Dg

Igneous rocks of the Northeast Kingdom batholith of Ayuso and Arth (1992)—Plutons identified on map

Ddbg
Ddrz

Derby pluton—Light-gray, medium- to coarse-grained, massive, epidote-biotite-muscovite porphyritic granodiorite and minor tonalite (Ddbg), with a rim zone of granodiorite (Ddrz). Rb/Sr whole-rock isochron age of 370±17 Ma (Ayuso and Arth, 1992)

Debg
Dedg
Degr

Echo Pond pluton—Light-gray to pink, medium- to coarse-grained, massive, seriate to porphyritic granodiorite and granite (Debg) and outer zone of quartz gabbro and quartz diorite (Dedg), and inner zone of granite (Degr)

Dwdg

West Charleston pluton—Dark-gray, medium- to coarse-grained, massive, quartz-biotite-hornblende (±pyroxene) gabbro and diorite

Dnwz
Dniz
Dnqm

Nulhegan pluton—Light-gray to dark-gray, medium- to coarse-grained, massive, biotite-clotted, hornblende-quartz monzodiorite, minor granodiorite, and granite divided into a western zone (Dnwz), inner zone (Dniz), and core of quartz monzonite (Dnqm). Rb/Sr whole-rock age of 390±14 Ma (Ayuso and Arth, 1992)

Dwmz
Dwwz
Dwhz

Willoughby pluton—Light-gray to pink, medium- to very coarse grained, massive, miarolitic garnet-muscovite peraluminous leucogranite. Varies from a pegmatitic main zone (Dwmz) to biotitic granodioritic western zone (Dwwz), to inner hydrothermally altered zone (Dwhz). Rb/Sr whole-rock age of 376±9 Ma (Ayuso and Arth, 1992)

Dabg

Averill pluton—Gray to pink, medium- to coarse-grained garnet-muscovite-biotite granite and pegmatite, undifferentiated

Dnbg

Newark pluton—Pinkish-gray to cream-colored, medium- to coarse-grained magnetite-microcline-perthite-biotite granite

Dvbg

Victory pluton—A western zone of medium- to fine-grained biotite-muscovite granite and minor hornblende-biotite tonalite and an eastern, more melanocratic zone of biotite-hornblende quartz monzonite like that in the Nulhegan pluton, as well as biotite granodiorite

Dmbg

Maidstone pluton—Almost-white to dark-gray, locally pink, medium- to coarse-grained hypidiomorphic, granular, biotite-muscovite-microcline-plagioclase granite; accessories include apatite, sphene, pyrite, and magnetite

Overprint pattern—Shows areas of intricately mixed country rock, hornfels, and abundant dikes and sills of granite. Underlying color and symbol identify country rock unit

Other plutons of the New Hampshire Plutonic Suite

Dkbg

Knox Mountain pluton—Light-gray, medium-grained, quartz-rich biotite-muscovite granite. Has distinctly more potassium feldspar and is lighter gray than rocks of the East Barre plutons

Dbbg

East Barre plutons—Gray, homogeneous, fine- to medium-grained muscovite-biotite granodiorite. U-Pb zircon Sensitive High Resolution Ion Microprobe (SHRIMP) age of 368±4 Ma, no. 47 (Aleinikoff and others, 2011)

Dbqm

East Bethel plutons—Very light-bluish-gray to white, medium-grained, muscovite-biotite quartz monzonite, locally orbicular; commercially known as "Bethel white" and similar to the predominantly lighter-colored granitic rocks of southern Vermont

Dst

Stiles Pond pluton—Gray, medium-grained, nonfoliated biotite-muscovite tonalite

Dhg

Porphyritic, light-gray, hypabyssal biotite granite and tonalite in sill-like bodies—Contains phenocrysts of euhedral and embayed quartz, euhedral microcline with Carlsbad twinning (in granite), plagioclase, and euhedral biotite (±muscovite)

Dd

Biotite metadiorite in unit Dgq northeast of St. Johnsbury—Medium-light-bluish-gray, fine-grained, foliated and lineated

Devonian granitic rocks of southern Vermont

Dbmg

Black Mountain pluton of the Guilford dome—Weakly foliated, light-gray to whitish-gray, garnet-biotite-muscovite granite, minor pegmatite, and aplite dikes (Dg). Rb/Sr muscovite age of 383±7 Ma (Naylor, 1971) and a U-Pb zircon upper-intercept age of 364±4 Ma, no. 48 (Aleinikoff and others, 2011)

Dg

Granite and trondhjemite dikes of Chester and Athens domes and west of the Connecticut Valley trough—Light-gray to white, garnet-muscovite-biotite granodiorite at Gassetts quarry, having a U-Pb zircon SHRIMP age of 392±6 Ma, no. 46 (Aleinikoff and others, 2011), from rims on Proterozoic-age cores (J.N. Aleinikoff, USGS, written commun., 2002); and whitish-gray muscovite-rich quartz monzonite and granodiorite, granite pegmatite, and aplite which occur as crosscutting nonfoliated dikes within the core of the domes and as folded and well-foliated dikes on the east and west flanks of the domes; also granite dikes and small stocks of very light gray to white, muscovite-rich, locally garnet-bearing, fine- to medium-grained biotite-muscovite quartz monzonite and granodiorite, locally orbicular, that intrude cover rocks east of the Green Mountain massif from Jamaica to Northfield, including the Liberty Hill locality and the granodiorite stock east of Plymouth. The latter contains inherited zircon with rims having an imprecise SHRIMP age of about 380 to 390 Ma (Aleinikoff and others, 2011); a similar dike south of Plymouth has a U-Pb zircon SHRIMP age of 365±5 Ma, no. 49 (Aleinikoff and others, 2011). These closely resemble undated white granodiorites of the Bethel area and dikes in the Chester and Athens domes; also resemble small dikes of granite, trondhjemite, and quartz monzonite largely west of the Connecticut Valley trough

ROCKS OF THE LAURENTIAN MARGIN

Adirondack lowlands and Lake Champlain lowlands
(west of the Orwell and Champlain thrusts)

Oha

Hathaway Formation (Upper Ordovician)—Clasts of limestone, dolostone, sandstone, and chert within beds of black shale and chert

Oib

Iberville Formation (Upper Ordovician)—Dark-gray shale with thin discontinuous beds of crossbedded and graded dolomitic siltstone

Osp

Stony Point Formation (Upper Ordovician)—Dark-gray calcareous shale with beds of bluish-gray limestone

Ochd

Cumberland Head Formation (Upper Ordovician)—Interbedded graded bioclastic limestone, bluish-gray calcareous shale, and laminated shale

Ogf

Glens Falls Limestone (Upper Ordovician)—Dark-bluish-gray-weathering, thinly bedded dark-gray to black granular limestone; locally grades upward into sooty-weathering shaly limestone beds rich in fragments of the trilobite *Cryptolithus*

Obr

Black River Group, undivided (Upper Ordovician)—Thin-bedded to massive dolostone, sandy dolostone, and light-gray limestone; vertical burrows in basal beds; upper beds fossiliferous with black chert

Oo

Orwell Limestone (Upper Ordovician)—Dove-gray-weathering, black to dark-gray, fine-grained poorly fossiliferous limestone

Chazy Group (Upper and Middle Ordovician)

Ocgu

Chazy Group, undivided (Upper and Middle Ordovician)—Dark- to light-gray, massively bedded fossiliferous limestone and calcareous sandstone

Ov

Valcour Formation (Upper Ordovician)—Dark- to light-gray fossiliferous limestone

Ocp

Crown Point Formation (Middle Ordovician)—Gray, massively bedded fossiliferous limestone

Odp

Day Point Formation (Middle Ordovician)—Gray, thin-bedded to massive sandstone and fossiliferous limestone

Beekmantown Group (Middle Ordovician to Upper Cambrian)

Obku

Beekmantown Group, undivided (Middle Ordovician to Upper Cambrian)—Gray limestones, fossiliferous limestones, and dolostones

Opi

Providence Island Dolostone (Middle and Lower Ordovician)—Light-buff-tan-weathering, massive to thick-bedded, fine-grained dark-gray dolostone; has "beeswax-scored" surfaces; contains thin layers of fossiliferous bluish-gray limestone (largely equivalent to the Bridport Member of the Chipman Formation, north of Orwell)

Ofcpi

Fort Cassin Formation (Middle and Lower Ordovician)—Shown locally from Whitehall, N.Y., to Orwell, Vt. Laterally equivalent to Providence Island Dolostone

Ofcrp

Root Pond Quartzite Member (Middle and Lower Ordovician)—Light-gray to tannish-white, well-bedded and vitreous steel-gray quartzite interbedded with orangey-tan- and beige-weathering dolostone and thin beds of fossiliferous limestone. Named for occurrences near Root Pond in the Benson quadrangle, but herein extended to include thin lenses of quartzite that occur interbedded at several positions in the Fort Cassin Formation. Interbedded limestones contain upper Ibexian conodonts southwest of Root Pond (J.E. Repetski, USGS, written commun., 2004)

Ofcs

Sciota Limestone Member (Middle and Lower Ordovician)—Light-gray, fine-grained, and dark-gray, fossiliferous, and platy bluish-gray limestone. Contains upper Ibexian to lower Whiterockian conodonts at the type locality near Sciota School House, in the Benson quadrangle (J.E. Repetski, USGS, written commun., 2004)

Ofcw

Ward Siltstone Member (Lower Ordovician)—Light-tan to gray, thinly bedded and crossbedded, calcareous and dolomitic siltstone and quartzite in beds similar to the quartzite of the Root Pond Quartzite Member (Ofcrp)

Ofa

Fort Ann Formation (Lower Ordovician) (Shown only in New York State)—Medium- to dark-gray and mottled, medium- to thick-bedded dolomitic limestone and buff-weathering dolostone

Ogm
Ogml

Great Meadows Formation (Lower Ordovician)—Light-gray, medium-grained, medium- to thick-bedded dolostone, locally cherty; contains lens of light-gray-weathering fossiliferous limestone (Ogml)

Ogmw

Winchell Creek Member—Tan-weathering, gray, well-bedded and crossbedded laminated quartzite and dolostone; sandy beds weather to a woody-grained surface texture

O€wl
O€w

Whitehall Formation (Lower Ordovician and Upper Cambrian)—Predominantly light-gray and pinkish-gray, coarse-grained dolostone and cherty dolostone, containing layers of gray limestone (Ocwl)

€ti

Ticonderoga Formation (Upper Cambrian)—Light-gray, yellowish-gray- to buff-weathering quartzose dolostone, pebbly dolomitic quartzite, and interbedded quartzite

€pt

Potsdam Sandstone (Upper Cambrian)—Light-gray, tan, and dark-gray, well-bedded pebbly quartzite, crossbedded vitreous quartzite, and local conglomerate

----------unconformity----------

Neoproterozoic and Mesoproterozoic rocks of the Adirondacks in Vermont and in the Whitehall, N.Y., area

Intrusive Rocks

Zdi

Diabase dikes (Neoproterozoic)—Dark-gray to greenish-gray, very fine grained, ocellar basaltic to medium-grained augite-plagioclase diabasic dikes, occurring as a subvertical northeast-trending discontinuous zone in the center of Bald Mountain

$Y^{3C}p$

Pegmatite dikes (Late Mesoproterozoic)—Pinkish-gray to light-gray, unfoliated, magnetite-biotite (±tourmaline) granite pegmatite, <1 m to 10 m thick. Crosscuts Ottawan foliation and locally fills narrow, northeast-trending, steeply dipping normal ductile shear zones

$Y^{3A}gb$

Metagabbro (Late Mesoproterozoic)—Garnet-hornblende (±olivine) gabbro and dioritic gneiss; similar rock mapped in the Chittenden Intrusive Suite in Vermont

$Y^{3A}gd$

Granodioritic augen gneiss and quartz monzonite gneiss (Late Mesoproterozoic)—Light-gray to pinkish-gray, garnet-biotite-plagioclase-microperthite augen granodioritic gneiss, locally massive but well foliated. Contains deformed phenocrysts (augen) aligned in old relict flow (?) foliation

$Y^{3A}phg$

Pharaoh Mountain Gneiss of Wiener and others (1984) (Late to Middle Mesoproterozoic)—Rusty-grayish-brown- to brown-weathering, knubbly coarse-grained magnetite-garnet-hornblende and pyroxene-bearing charnockitic gneiss and garnet-hornblende granite gneiss. Has large polycrystalline aggregates of plagioclase as much as 1.5 cm long, recrystallized from pre-Ottawan phenocrysts (?) of plagioclase. Contains mappable and folded screens of marble, calc-silicate rock (Y^2cs), mafic diopside-hypersthene gneiss, and interbedded sillimanite-garnet quartzite (Y^2qz). Interpreted as largely intrusive but may contain some charnockitic gneiss of uncertain origin

Y^2bt
Y^2ba

Biotite tonalite gneiss (Y^2bt) and mafic gneiss (Y^2ba) (Middle Mesoproterozoic)—Predominantly chalky-white-weathering, massive biotite tonalite gneiss having screens, dikes, or sills of more mafic gneiss. Passes laterally into white, fine-grained trondhjemitic aplite near contacts with larger screens of paragneiss. U-Pb zircon Thermal Ionization Mass Spectrometry (TIMS) age of 1329±37 Ma (McLelland and Chiarenzelli, 1990) obtained from exposure 1.5 km west of Austin Hill on the west side of South Bay, west of Whitehall, N.Y. Contains lenses and screens of rusty sulfidic garnet-biotite-feldspar-quartz schist, dark-gray garnet-feldspar quartzite, and calc-silicate gneiss on south end of Austin Hill. Unit interpreted as intrusive into some paragneiss units that are here older than 1328±32 Ma (McLelland and Chiarenzelli, 1990)

Paragneiss

Y^2hgn

Hague Gneiss of Alling (1918) (Middle Mesoproterozoic)—Yellowish-grayish-green to rusty-sulfidic-weathering, garnet (large)-sillimanite-biotite-orthoclase-plagioclase-quartz schist or gneiss, locally containing mappable and discontinuous lenses, layers or pods of quartzite, marble, or calc-silicate rock. Contains a coarse sillimanite-feldspar gneissosity older than the regional Ottawan foliation

Y^2qz

Quartzite (Middle Mesoproterozoic)—Light-tan to yellowish-gray, massive to well-layered magnetite-garnet quartzite and magnetite-biotite-garnet quartzite in beds as much as 10 m thick. Occurs in two layers, one within or attached to the Hague Gneiss and one within biotite-quartz-plagioclase gneiss (Y^2bpg) beneath the Hague Gneiss. The latter is rich in microcline and passes through interbedding into a quartzose facies of Y^2bpg

Y^2cs

Marble and calc-silicate gneiss (Middle Mesoproterozoic)—Medium-dark-gray to light-gray diopside-phlogopite-scapolite-calcite marble, phlogopite-tremolite-talc schist, and dark-gray diopside-hornblende (actinolite)-plagioclase calc-silicate gneiss

Y^2bpg

Biotite-quartz-plagioclase gneiss (Middle to Early Mesoproterozoic)—Light-greenish-gray to pinkish-gray, well-foliated and well-layered quartz-rich gneiss and more mafic biotite-hornblende-pyroxene-quartz-plagioclase gneiss irregularly distributed within unit. Unit may be in part older than the tonalitic gneiss (Y^2bt)

Y^2bmg

Mafic gneiss (Middle to Early Mesoproterozoic)—Dark-gray to black, fine-grained, magnetite-garnet-hornblende-biotite-diopside-plagioclase gneiss, commonly containing beds of dark-gray vitreous magnetite-garnet quartzite, 2 to 5 cm thick, tremolite-pyroxene gneiss, and biotite-rich, rusty-weathering garnet-quartz schist and gray sulfidic sillimanite quartzite. Occurs as screens within tonalitic gneiss and the Pharaoh Mountain Gneiss and is interpreted as paragneisses older than the tonalitic gneiss (Y^2bt)

Vermont Valley sequence and Middlebury synclinorium
(above the Orwell and Champlain thrusts)

Oh
Ohl
Ohc

Hortonville Formation (Upper Ordovician)—Dark-gray siliceous shale and phyllite containing thin beds of bluish-gray argillaceous limestone and minor beds of gray to tan quartzite. Grades into limy shales of the Stony Point Formation. Near base contains bluish-gray, granular, smooth-weathering fossiliferous limestone (Ohl) and locally a polymict limestone and dolostone-clast conglomerate (Ohc). Unit mapped west of the Taconic allochthon, and northwest of the Sudbury slice

Osp

Stony Point Formation (Upper Ordovician)—Dark-gray calcareous shale and beds of bluish-gray limestone

Oi
Oil (Owm)
Oilc

Ira Formation (Upper Ordovician)—Same description as Hortonville Formation above. Contains basal limestone (Oil), locally referred to as the Whipple Marble Member, and a polymict limestone conglomerate (Oilc). Unit mapped along east side of the Taconic allochthon south to Bennington

Ow
Owl
Owbl

Walloomsac Formation (Upper Ordovician)—Same description as the Hortonville Formation above. Contains basal limestone member (Owl) and a black carbonaceous highly graptoliferous phyllite (Owbl). Tectonically shredded, silty varieties near and on Whipstock Hill constitute the Whipstock Breccia Member of Potter (1972) (Oww)

Ogf

Glens Falls Limestone (Upper Ordovician)—Dark-bluish-gray-weathering, thinly bedded, dark-gray to black granular limestones, and gray granular limestone, grading locally upward into sooty-weathering shaly limestones containing beds rich in fragments of the trilobite *Cryptolithus*

Otl

Chazy, Black River, and Trenton Limestones, undifferentiated (Upper and Middle Ordovician)—Shown locally west of the Taconic allochthon

----------unconformity----------

Oo

Orwell Limestone (Upper Ordovician)—Dove-gray-weathering, black and dark-gray fine-grained limestone. Distinguished from the Middlebury Limestone with difficulty, especially in the area west of the Sudbury slice

Omi

Middlebury Limestone (Middle Ordovician)—Buff-streaked, dark-bluish-gray, thinly bedded and well-foliated dolomitic limestone, shown above the Champlain thrust south of Middlebury

Chazy Group (Upper and Middle Ordovician)

Ocgu

Chazy Group, undivided (Upper and Middle Ordovician)—Dark- to light-gray, massive fossiliferous limestone and calcareous sandstone

Ov

Valcour Formation (Upper Ordovician)—Dark- to light-gray fossiliferous limestone

Ocp

Crown Point Formation (Middle Ordovician)—Gray, massively bedded fossiliferous limestone

Odp

Day Point Formation (Middle Ordovician)—Gray, thinly bedded to massively bedded sandstone and fossiliferous limestone

Chipman Formation (Middle Ordovician)
(mapped south of Wings Point)

Ocbrp

Bridport Member—Thickly bedded, "beeswax-scored," orangey-beige-weathering, yellowish-gray to light-bluish-gray dolostone, dark-gray fine-grained to aphanitic dolostone, and minor beds of bluish-gray limestone. Transitions eastward into the Beldens Member with addition of limestone beds. Equivalent to Providence Island Dolostone (Ofcpi)

Ocbe

Beldens Member—Light-gray to creamy-white-weathering fine-grained limestone, orangey-buff-weathering dolostone, and reddish-streaked (hematite) calcite marble

Ocbu

Burchards Member—Light-bluish-gray mottled dolomitic limestone

Ocw

Weybridge Member—Light-gray to cream-colored fine-grained calcite marble, and thin dolomitic layers, locally crossbedded; may occur as lenses at several positions within the Beldens Member

Ob

Bascom Formation (Middle and Lower Ordovician)—Interbedded orangey-tan- to buff-weathering dolostone and bluish-gray to gray mottled dolomitic limestone or calcite marble and calcareous sandstone. In southern Vermont east of the Taconic Range, rocks mapped as Bascom Formation may include unmapped members of the Chipman Formation

Ocu

Cutting Dolostone (Lower Ordovician)—Gray, thinly bedded dolomitic sandstone, grading upward into dolomitic limestone or mottled dolomitic marble. In southern Vermont east of the Taconic Range, unit is not recognized and may appear as sandy zones within rocks mapped as the Shelburne Marble

Os

Shelburne Marble (Lower Ordovician)—Predominantly light-gray- to white- and bluish-gray-streaked calcite marble and massive white- and green-streaked calcite marble. Locally contains intermediate dolostone and gray limestone beds

€sp
€spl

Clarendon Springs Formation (Upper Cambrian)—Steel-gray-weathering, light-gray, massive calcitic dolostone grading upward into darker, more fissile calcitic dolostone containing white quartz knots near top; unit locally brecciated. Locally contains light-bluish-gray to whitish-gray calcite marble (€spl) within dolostone and beneath the calcitic marbles of the overlying Shelburne Marble

€d

Danby Formation (Upper Cambrian)—Thin, light-gray beds of vitreous quartzite and crossbedded sandy dolostone. Unit discontinuous in southern Vermont

€w

Winooski Dolostone (Middle Cambrian)—Well-bedded dolostone weathering beige, cream, and buff, with green, red, or gray phyllite, siliceous partings, and thin beds of blue-quartz-pebble conglomerate and quartzite

€m

Monkton Quartzite (Middle Cambrian)—Reddish-brown, pebbly, thin- to thick-bedded sandstone, orangey-gray- and buff-weathering well-bedded dolostone, and reddish-brown-weathering dolomitic quartzite. Unit discontinuous in southern Vermont

€du

Dunham Dolostone (Lower Cambrian)—Buff- and pink-mottled and massive, or light-gray, pinkish-gray-weathering, and massive to poorly bedded dolostone. Contains distinctive small pebbles and grains of well-rounded quartz; minor beds of dolostone-breccia and conglomerate occur near Rutland

€cb
€c
€ca

Cheshire Quartzite (Lower Cambrian)—Light-gray- to tannish-gray-weathering, massive to poorly bedded vitreous quartzite, containing layers of dark-gray biotite-muscovite-quartz phyllite near top (€cb); locally contains a mappable brown-weathering, gray to brown argillaceous quartzite member (€ca)

Dalton Formation (Lower Cambrian and Neoproterozoic)
(unit interfingers to the north with rocks of the Tyson Formation and to the east with rocks of the Hoosac Formation)

€Zd

Dalton Formation, undivided—Heterogeneous unit consisting of rusty- to tan-weathering flaggy feldspathic quartzite, tan-weathering quartz phyllite, and feldspathic quartzite

€Zdq

Quartzite member—Tan to whitish-gray vitreous quartzite and minor blue-quartz-pebble quartzite

€Zdb

Dark phyllite member—Dark-gray to gray, rusty-weathering, well-laminated tourmaline-biotite-muscovite-quartz phyllite containing thin beds of laminated quartzite. Resembles dark phyllite of the Moosalamoo Formation (€Zmp), with which it is in part correlative

€Zdfq

Feldspathic quartzite member—Light-tan to gray-weathering, massive to thin-bedded, flaggy, tourmaline-muscovite-feldspar quartzite and interbedded phyllitic quartzite

€Zds

Lustrous quartz schist member—Dark-gray to silvery-gray, tourmaline-muscovite-biotite-quartz schist and feldspathic schist and quartzite. Occurs on eastern flank of the southern Green Mountain massif; similar in appearance to €Zhs of the Hoosac Formation exposed to the east

€Zdph

Phyllite member—Rusty-tan to gray, thinly layered phyllite, tourmaline-biotite-muscovite-quartz phyllite, and quartzite mapped along western flank of the Green Mountain massif in the South Wallingford area

€Zdm

Dolostone member—Buff, sandy, massive dolostone as lens in €Zdph

€Zdc

Conglomerate member—Commonly tan- to yellowish-tan-weathering, coarse- to fine-grained quartz-pebble to -cobble, quartz conglomerate and schistose quartz conglomerate. Locally dark-gray biotite-muscovite-blue-quartz-pebble wacke to conglomerate. Occurs at or near base of unit

Lower Cambrian and Neoproterozoic cover rocks of the Lincoln Mountain massif and northwestern flank of the Green Mountain massif

Moosalamoo Formation (Lower Cambrian and Neoproterozoic)

€Zmf

Feldspathic quartzite and granofels member—Gray to dark-gray, biotite-albite-quartz granofels and flaser-bedded tan to gray feldspathic quartzite; the latter resembles similar rocks of the Dalton Formation (€Zdfq), whereas the former resembles albitic rocks of the Hoosac Formation (€Zhab)

€Zmq

Quartzite member—Light-tan to gray, vitreous and non-vitreous quartzite and feldspathic quartzite and quartz conglomerate

€Zmp

Gray phyllite and metawacke member—Dark-gray, sooty-weathering, splintery sulfidic to non-sulfidic quartz phyllite and pebbly and gritty biotite metawacke

€Zmmt

Magnetite metasiltstone member—Grayish-brown- to pale-green-weathering, well-laminated, magnetite-studded chloritic metasiltstone; near base contains magnetite-cemented quartz-pebble conglomerate and bedded magnetite quartzite. Directly overlies dolostones of the Forestdale Formation

Forestdale Formation (Lower Cambrian and Neoproterozoic)

€Zfd
€Zfco

Dolostone member—Upper part of €Zfd consists of orangey-tan- to brown-weathering quartz-pebble dolostone and dolomitic crossbedded feldspathic metasandstone; lower part of €Zfd largely cream- to beige-weathering massive dolostone; €Zfco is boulder and cobble dolostone conglomerate

€Zfq

Quartzite member—Grayish-tan to light-gray vitreous quartzite and white feldspathic gritty quartzite

€Zfb

Phyllite and dolostone breccia member—Dark-gray to sooty-black carbonaceous phyllite, interbedded dolostone boulder conglomerate to breccia, and blue- and gray-mottled sulfidic dolostone

Pinnacle Formation (Cambrian and Neoproterozoic)

€Zpu

Pinnacle Formation, undivided—Gray, foliated muscovite-chlorite-biotite-feldspar-quartz schist, phyllite, and metagraywacke. Quartz is commonly blue, and local thin conglomeratic horizons are present. Feldspathic biotite phyllitic metawacke is interlayered with lenses of quartz, feldspar, and gneiss-pebble to -cobble conglomerate (€Zpc)

€Zpc

Light-gray phyllitic conglomerate member—Feldspathic biotite phyllitic metawacke interlayered with lenses of quartz, feldspar, and gneiss-pebble to -cobble conglomerate

€Zpw
€Zpwd

Metawacke member—Gray- to light-brownish-gray-weathering, massive to bedded muscovite-biotite-chlorite metawacke, conglomerate, and blue-quartz pebbly phyllite, wacke and feldspathic quartzite; heterogeneous unit consists of coarse- to medium-grained clastic wacke, beige-weathering dolostone, and quartz-rich dolostone (€Zpwd)

€Zps

Metawacke and phyllite member—Light-gray, medium-grained, massive quartz-sericite-chlorite-albite metawacke, gray to grayish-green magnetite-chlorite-muscovite-quartz schist, and phyllite or pebbly phyllite, locally rich in magnetite

€Zpq

Quartzite and quartz-pebble conglomerate member—Light-gray quartz-feldspar conglomerate and quartzite

€Zpcg

Cobble and boulder conglomerate member—Poorly sorted, matrix-supported quartz- and gneiss-cobble to boulder conglomerate, locally containing quartzite boulders as large as 3 m in diameter, in a matrix of gray-weathering magnetite-calcite-chlorite-muscovite-biotite-feldspar schist

€Zpv

Metabasalt and volcaniclastic rocks, undifferentiated—Largely carbonate-epidote-albite-chlorite (±actinolite) greenstones

€Zpva

Amphibolitic greenstone member— Calcite-biotite-sphene-albite-actinolite-epidote-chlorite greenstone with dark-green porphyroblasts of actinolitic hornblende

€Zpvc

Calcareous greenstone member—Rusty-weathering and pitted, dark-green greenstone with laminae and splotches of calcareous material; locally interbedded with calcareous metagraywacke

€Zpvf

Feldspathic greenstone member—Olive-drab-weathering, dark-green, fine-grained greenstone with remnant plagioclase feldspar phenocrysts up to 1.5 cm in diameter

€Zth

Tibbit Hill Formation (Cambrian and Neoproterozoic)—Largely metabasalt and minor metasedimentary rocks consisting of massive, fine-grained, dark-green metabasalt flows, pillow basalt, vesicular basalt composed of albite, epidote, chlorite (±actinolite); and interbedded phyllitic grits, feldspathic quartzite, chloritic metawacke, and basaltic tuffaceous metasedimentary rocks, all similar to rocks of the Pinnacle Formation. Volcanics are alkalic to transitional metabasalts

Cambrian to Middle Ordovician rocks of the St. Albans area

Oml

Morses Line Slate (Ordovician)—Medium-gray to black calcareous slate

Ohg

Highgate Formation (Lower Ordovician)—Banded limestone and calcareous slate with local lenses of conglomerate composed of limestone, sandstone, and dolostone clasts in a sandy limestone matrix

O€g

Gorge Formation (Lower Ordovician and Cambrian)—Dolomite, and dolomite breccia composed of angular clasts of dolostone, sandstone, and chert in a buff to gray quartzose dolostone

O€sw

Sweetsburg Formation (Lower Ordovician and Cambrian?)—Black to gray, graphitic, quartzose phyllite and schist, with tan-weathering layers and pods of gray dolostone and black quartzite

O€sk

Skeels Corners Slate (Lower Ordovician and Cambrian)—Laminated black slate with thin orange dolostone beds; includes massive dolostones mapped as Saxe Brook Formation by others in the Highgate area

O€skl

Limestone matrix conglomerate member—Limestone and sandstone clasts in a limestone matrix, interbedded with sandstone

O€sks

Sandy matrix conglomerate member—Limestone and sandstone clasts in a quartz sand matrix

€p

Parker Slate (Cambrian)—Black arenaceous slate with dolomite horizons; interbedded dolostone and sandstone breccia in a dolostone matrix; and massive dolostone with thin sandstone beds

€pdo

Dolostone member—Massive beds of white to buff dolostone

€pq

Sandstone member—Thin- to thick-bedded calcareous coarse-grained sandstone

€psh

Conglomerate member—Conglomerate with dolostone and sandstone clasts in a shaly matrix

€psc

Calcareous sandy conglomerate member—Conglomerate with dolostone and sandstone clasts in a calcareous sandy matrix

€ps

Sandy dolostone member—Sandy dolostone containing limestone clasts, interfingered with sandy dolostone containing dolostone clasts

€pc

Dark conglomerate member—Conglomerate consisting of round clasts of orange dolostone in a black arenaceous matrix

Ordovician, Cambrian, and Neoproterozoic cover rocks north of the Lincoln Mountain massif

West Bridgewater Formation (Middle Ordovician)

Owb

Black to dark-gray, sulfidic to nonsulfidic, carbonaceous, fine-grained, well-foliated biotite-muscovite-quartz phyllite; contains pods and thin beds of medium-dark-gray and gray-and-white-mottled dolostone, thin beds of ankeritic quartzite, and, in upper part, rhythmically layered gray quartzite, limestone breccia and laminated silicic phyllite. Dolostone contains Middle Ordovician conodonts (Ibexian to mid-Whiterockian at West Bridgewater and Whiterockian at Buels Gore and West Bolton (Ratcliffe and others, 1999; Thompson and others, 2002)

Owbg

Dark-gray and green phyllite member—Interbedded dark-gray and grayish-green chlorite-muscovite-quartz-knotted albitic phyllite, containing pods of bluish-gray dolostone. (Correlation with West Bridgewater Formation uncertain.) Mapped only in the area west of Granville

----------unconformity----------

€Zfp

Fairfield Pond Formation (Cambrian and Neoproterozoic)—Light-gray to light-green, quartz-sericite-chlorite (±magnetite±biotite) phyllite and foliated quartzite

€Zwb

White Brook Formation (Cambrian and Neoproterozoic)—Buff to cream-colored massive dolomite and dolomitic sandstone, containing prominent zone of massive and specular hematite near top at Sheldon

€Zun
€Zunw
€Zungs

Underhill Formation (Cambrian and Neoproterozoic)—Silvery-green quartz-muscovite-chlorite schist and phyllite, commonly with albite and magnetite; locally contains dolomite. Local lenses of white to pale-gray quartzite, quartz-albite granofels, quartz-granule chlorite (±biotite) metawacke (€Zunw), and garnet schist (€Zungs)

€Zung

Greenstone and amphibolite member—Thinly bedded carbonate-albite-epidote greenstone and massive magnetite-albite-amphibole-biotite-epidote amphibolite; light- to dark-green, fine- to medium-grained epidote-chlorite albite-amphibole schist; dark-green, coarse-grained, weakly foliated epidote-biotite-albite-amphibole amphibolite

€Zunql

Quartz-laminated schist member—Light-gray to tan and rusty-weathering, fine-grained, well-foliated mylonitic albite-chlorite-muscovite-quartz (±dolomite)-laminated schist

Hazens Notch Formation (Cambrian and Neoproterozoic)

€Zhn

Hazens Notch Formation, undivided—Schist, gneiss, and quartzite; dark-rusty-brown graphitic biotite-muscovite-chlorite-quartz (±garnet) schist and gneiss; black albite porphyroblasts, large euhedral pyrite, and beds of dark-gray foliated quartzite are common. Unit includes rusty-weathering schist without graphite and rocks identical to Fayston Formation

€Zhng

Greenstone and amphibolite member—Dark-green, pitted-weathering, foliated mafic schist to massive greenstone containing varying amounts of chlorite, albite, carbonate, epidote, amphibole, and sphene; and amphibolite containing varying amounts of hornblende, actinolite, albite, chlorite, epidote, biotite, magnetite, and sphene

€Zhnn

Schist member—Rusty-weathering, non-graphitic, sulfidic chlorite-muscovite-quartz schist

Fayston Formation (Lower Cambrian and Neoproterozoic)

€Zf

Albite schist member—Silvery-green to grayish-green, medium-grained albite-chlorite-muscovite-quartz (±garnet±magnetite) schist with white albite porphyroblasts; resembles albitic schists of the Tyson Formation (€Ztab) and green albitic granofels of the Hoosac Formation (€Zhgab). Locally contains unmapped light-gray, thin quartzites; salt-and-pepper-colored, medium- to coarse-grained pyrite-magnetite-biotite-albite-quartz schist and gneiss; and silvery-dark-gray to rusty-weathering, medium-grained chlorite-tourmaline-albite-muscovite-quartz schist. The Fayston south of Mount Abraham is intercalated with rocks of the Tyson Formation and with the schists of the Pinney Hollow Formation

€Zfa

Greenstone member—Dark-green, pitted-weathering, foliated carbonate-albite-chlorite (±magnetite±epidote) greenstone or amphibolite

€Zfw

Foliated metawacke member—Salt-and-pepper-colored, medium- to coarse-grained quartz-albite-biotite gneiss

BEDROCK GEOLOGIC MAP OF VERMONT

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Cartography by Linda M. Masonic[1]
2011

€Zfc

Carbonaceous albite schist member—Gray to medium-dark-gray, rusty-weathering, carbonaceous albite-chlorite-quartz-muscovite schist, containing porphyroblasts of black albite. Unit resembles gray albitic granofels and schist of the Hoosac Formation (€Zhab)

€Zfqz

Quartzite member—White quartzite and tan to light-gray, medium-grained muscovite quartzite locally rich in magnetite. Resembles quartzite of the Tyson Formation (€Ztq)

€Zfs

Schist member—Silvery-green to rusty-tan, fine-grained chlorite-quartz-sericite (±garnet±chloritoid±allanite) schist and phyllite. Resembles green phyllites of the Pinney Hollow Formation (€Zph) and Mount Abraham Formation (€Za) and chloritic phyllite (€Ztg) of the Tyson Formation

Pinney Hollow Formation (Cambrian and Neoproterozoic)

€Zph
€Zphc

Phyllite member—Light-greenish-gray to lustrous pale-green chlorite-muscovite-quartz (±chloritoid±garnet±magnetite) phyllite. Chloritoid-rich rocks (€Zphc) appear gritty owing to distributed porphyroblasts of chloritoid. Unit is locally albitic and contains minor beds of quartzite

€Zphq

Feldspathic quartz schist member—Light-gray to grayish-green, laminated, gritty feldspathic chlorite-muscovite-plagioclase-quartz schist

€Zphw

Metawacke member—Silvery-gray, "pinstriped," coarse- to medium-grained, blue-quartz-pebble chlorite-biotite-plagioclase-quartz metawacke; locally conglomeratic and rich in epidote

€Zphb

Black phyllite member—Dark-gray to black, sulfidic biotite-plagioclase-quartz schist, commonly interbedded with or adjacent to amphibolite and greenstone member (€Zpha); locally is a silvery-gray sulfidic biotite phyllite

€Zpha

Amphibolite and greenstone member—Dark-green to black plagioclase-biotite-hornblende (±quartz) amphibolite, epidote amphibolite, and ankeritic-chlorite-magnetite-plagioclase (albite) greenstone. Shows all gradations from massive but well-foliated metabasalt to well-bedded basaltic volcaniclastic rock and volcanic metawacke

€Zphf

Metafelsite member—White to pale-green, laminated to massive epidote-calcite-muscovite-quartz-albite metarhyolitic gneiss or schist; is a volcanic or volcaniclastic rock. U-Pb zircon age of 571±5 Ma, no. 21 (Walsh and Aleinikoff, 1999). Contains purplish-gray feldspathic quartzite

€Zmt
€Zmtg

Monastery Formation (Cambrian and Neoproterozoic)—Heterogeneous unit consisting of coarse-grained, gray- to rusty-brown-weathering garnet-biotite-muscovite-quartz schist, beds of gritty feldspathic quartzite (€Zmtg), gray albitic biotite-quartz granofels, well-bedded light-gray to steel-gray biotite, minor epidote-magnetite-actinolite-chlorite feldspathic wacke, and, near base, grayish-green laminated chlorite-muscovite-albite granofels and phyllite. Unit mapped in Hancock and Ripton in part as lateral equivalent of the Tyson Formation to the south and the Underhill Formation to the north

Eastern flank of the Green Mountain massif and eastern domes

Plymouth Formation (Cambrian)

€pd

Dolostone member—Light-gray- to beige-weathering massive dolostone and bluish-gray-weathering mottled dolostone breccia and conglomerate, passing upward into more thinly bedded bluish-gray and buff dolostone breccia; dark-gray phyllitic dolostone and limestone in upper part. Correlative in part with boulder and conglomerate beds of the Dunham Dolostone near Rutland and with similar beds in the upper part of the Forestdale Formation

€pfq

Feldspathic quartzite member—Thinly laminated but massive-appearing, gray- and brownish-gray- to tan-weathering flaggy biotite-muscovite feldspathic quartzite and phyllitic quartzite. Resembles feldspathic quartzite of the Dalton Formation (€Zdfq) and similar quartzite of the Moosalamoo Formation (€Zmf) above the Forestdale Formation

Tyson Formation (Lower Cambrian and Neoproterozoic)
(shown on the eastern and western flanks of the Green Mountain massif)

€Zt

Tyson Formation, undivided—Phyllite and metawacke. Shown east of Rutland

€Ztab

Albitic magnetite granofels member—Gray and greenish-gray, magnetite-chlorite-(biotite)-muscovite-albite-quartz granofels and schist. Similar to gray or green albitic granofels of the Hoosac Formation (€Zhab and €Zhgab)

€Ztg

Chlorite-muscovite phyllite and schist member—Pale-greenish-gray to yellowish-greenish-gray, chlorite-muscovite-quartz phyllite and schist; locally contains beds of pebbly metawacke and magnetite phyllite. Similar to but finer grained than the metawacke and phyllite member of the Pinnacle Formation (€Zps)

€Ztrg

Quartz phyllite member—Rusty-weathering, gray to grayish-green, chlorite-muscovite-quartz phyllite and minor beds of pebbly-quartz metawacke

€Ztgr

Quartz-pebble phyllite and wacke member—Gray to grayish-green, biotite-chlorite-quartz-pebble phyllite; albitic metawacke is similar to metawacke member of the Pinnacle Formation but more thinly bedded and contains less metawacke. Albitic biotite-(chlorite)-quartz granofels and wacke locally present

€Ztq

Quartzite member—Gray to very light gray, vitreous and nonvitreous, massive to thin-bedded quartzite, magnetite and biotite quartzite, and feldspathic quartzite, locally interbedded with dolostone. Similar to quartzite in the Forestdale Formation (€Zfq)

€Ztd

Dolostone member—Largely massive, gray-, beige-, and pinkish-gray-weathering dolostone, beds of pebbly quartz dolostone, and pink- to orange-tan-weathering dolostone as lenses in phyllite. Contains beds of bluish-gray and whitish-gray vitreous quartzite. Similar to dolostone of the Forestdale Formation (€Zfd)

€Ztbs

Albite schist member—Dark-gray to black, locally carbonaceous, rusty-brown-weathering biotite-rich quartz schist and dark biotite-albite schist

€Ztc

Conglomerate member—Massive to well-bedded chlorite-biotite (±albite)-quartz-pebble, -cobble, and -boulder conglomerate, feldspathic conglomeratic metawacke, and locally a dolomite-cemented feldspathic quartz-pebble conglomerate. Occurs at base and in lower part of the Tyson Formation

Hoosac Formation (Lower Cambrian and Neoproterozoic)

€Zh

Hoosac Formation, undivided—Heterogeneous unit consisting mainly of dark-gray to medium-light-gray-weathering, white-plagioclase-studded schist, gray slabby quartz-rich muscovite (±garnet) schist, and layers of dark-gray biotitic quartzite and metawacke

€Zhcgt

Garnet schist member—Lustrous, green, ilmenite-chlorite-chloritoid-garnet-muscovite-quartz (±paragonite) schist; resembles Pinney Hollow Formation but lacks amphibolite. Aluminous schists at Devils Den and aluminous rocks of the Cavendish Formation may be correlative

€Zhbs

Biotite phyllite member—Coal-black, lustrous, rusty- to non-rusty-weathering, biotite-muscovite-plagioclase-quartz schist and phyllite, containing lenses of white laminated quartzite as beds and discoidal boudins

€Zhtm

Turkey Mountain Metabasalt Member—Dark-green to black, hornblende-plagioclase (±garnet±epidote) amphibolite and grayish-green epidote-plagioclase ankeritic greenstone; grades into epidote-quartz-plagioclase volcaniclastic wacke. Occurs as lenses at multiple stratigraphic levels. Lower layers are transitional and alkalic metabasalts; higher units are typical midocean ridge basalt (MORB)-type metabasalts

€Zhd

Dolomite marble member—Light-gray-, cream- or pinkish-gray-weathering, medium- to fine-grained phlogopite-quartz-dolomite marble. Occurs as thin beds in gray albitic granofels member (€Zhab); locally contains beds of vitreous to bluish-gray laminated quartzite

€Zhrab

Albite schist and granofels member—Rusty-weathering, medium- to dark-gray, black albite-biotite-quartz schist and granofels, marked by large spangles of muscovite and weathered-out pits of dolomite or ankerite

€Zhq

Quartzite member—Light-gray-, yellowish-gray- to dark-dull-gray-weathering, biotite or muscovite quartzite, feldspathic quartzite, and pebbly muscovitic quartzite, commonly occuring as basal member or as layers in schist member (€Zhs)

€Zhs

Schist member—Lustrous, dark-gray to silvery-gray tourmaline-muscovite-biotite-quartz schist and steel-gray muscovitic quartzite

€Zhgt

Garnet biotite schist member—Medium-dark-gray to lustrous silvery-gray garnet-biotite-muscovite-plagioclase-quartz schist and feldspathic garnet schist; associated with €Zhs member which it laterally replaces

€Zhgab

Chlorite albite schist and granofels member—Pale-green to light-greenish-gray, chlorite-magnetite-white-albite-spotted-quartz granofels and schist

€Zhab

Albite-quartz granofels member—Light-gray- to whitish-gray-weathering, massive to thickly bedded medium-grained biotite-white albite-quartz granofels; locally is a medium-gray, finer grained, more biotite-rich albitic quartz schist of gneissic aspect

€Zhabc

Albite granofels and gneiss-boulder conglomerate member—Light-gray, massive, coarse-grained biotite-white albite-quartz granofels like €Zhab but containing boulders of pegmatite and of granitic gneiss, and disarticulated beds of albitic granofels as pseudoconglomerate

€Zhc

Conglomerate and quartzite member—Light-grayish-tan-weathering, biotite-muscovite-quartz conglomerate and pebbly muscovite quartzite, and dark-medium-gray blue-quartz biotite quartzite and schist

----------unconformity----------

Neoproterozoic and Mesoproterozoic rocks of the Green Mountain and Lincoln Mountain massifs and eastern domes

**Cardinal Brook Intrusive Suite (Neoproterozoic)
(965±4 Ma to 945±7 Ma)**

Zd

Mafic dikes—Medium- to coarse-grained, foliated, actinolite-chlorite-calcite-epidote retrograded metadiabasic dikes; commonly have relict diabasic texture

$Y^{3C}cbs$
$Y^{3C}cbsa$

Stamford Granite—Light-gray to medium-gray, very coarse grained biotite-plagioclase-microcline rapakivi granite; contains large megacrysts of microcline perthite having rims of plagioclase that contain inclusions of biotite and garnet. Unit includes lesser irregular dikes and segregations of hornblende-biotite ferrodiorite and ferromonzonite. A fine-grained facies consisting of white-weathering, muscovite-biotite-microcline-plagioclase aplitic granite ($Y^{3C}cbsa$) locally forms a border facies or thin internal dikes. U-Pb zircon upper-intercept age of 962±1 Ma, no. 20 (revised from Karabinos and Aleinikoff, 1990)

$Y^{3C}cbsr$
$Y^{3C}bsa$

Somerset Reservoir Granite—Light-pinkish-gray-weathering, biotite-microcline-perthite or porphyritic rapakivi granite and pegmatitic granite; where deformed is a mylonitic augen gneiss. White to pinkish-gray, medium-grained plagioclase-microcline-perthite aplitic to pegmatitic granite ($Y^{3C}bsa$) forms dikes in country rocks and irregular border facies. U-Pb zircon upper-intercept age of 965±4 Ma, no. 19 (Karabinos and Aleinikoff, 1990)

$Y^{3C}cbhr$

Harriman Reservoir Granite—Light-gray to pinkish-gray, biotite-plagioclase-microcline megacrystic granite and augen gneiss; rapakivi texture locally preserved. Unit occurs in the Rayponda and Sadawga domes

$Y^{3C}cbbh$

Bull Hill Gneiss of Richardson (1931)—Light-pinkish-gray to gray, very coarse grained to medium-grained and mylonitic biotite-plagioclase-quartz-microcline augen gneiss; locally has large ovoidal relict microcline with rapakivi rims and intrusive breccia containing xenoliths of gneissic units of the Mount Holly Complex. Restricted to the Chester and Athens domes, occurring in the core as well as in fault slivers along the eastern and western margins, and tectonically intercalated with rocks of the Mount Holly Complex and the Hoosac Formation. U-Pb zircon upper-intercept ages of 945±7 Ma, no. 17, and 955±5 Ma, no. 18 (Karabinos and Aleinikoff, 1990)

Mount Holly Complex intrusive rocks (Mesoproterozoic)

$Y^{3C}p$

Pegmatite (Mesoproterozoic)—Light-gray to pinkish-gray, biotite-muscovite (±garnet±tourmaline±magnetite) granite pegmatite as crosscutting pods and larger bodies. Albitic garnet-muscovite pegmatite common in metapelitic rocks of the Mount Holly Complex, and especially prominent in the northern and east-central parts of the Green Mountain massif. Assignment of individual pegmatites to Y^{3C} is highly interpretive based on crosscutting of gneissosity and weakly deformed character

$Y^{3B}p$
$Y^{3B}g$

Albitic biotite granite and pegmatite at Baker Brook (Mesoproterozoic)—Pinkish-gray garnet-biotite-albite pegmatite and granitic augen gneiss, distinguished by abundant rose-colored zircon; U-Pb zircon SHRIMP age of 1,037±6 Ma, no. 16 (Aleinikoff and others, 2011). Undated light-gray biotite granite gneiss ($Y^{3B}g$) containing abundant rose-colored zircon also is confined to the Pine Hill slice

$Y^{3A}fg$

Granulose albitic gneiss (Mesoproterozoic?)—Massive to poorly layered, highly lineated, light-tannish-gray to grayish-green, medium-grained, granulose, epidote-magnetite-biotite (chlorite)-muscovite-albite-quartz gneiss, veined with magnetite; spots of ankerite and clots of chlorite after original amphibole, pyroxene, or garnet are common. Highly altered rock is perhaps metasomatic and related to 1,170- to 1,120-Ma period of granitic intrusions. Unit shows all gradations from pinkish-gray biotite-quartz-plagioclase gneiss having centimeter-thick veins of garnet-bearing albitic micropegmatite, to nonlayered albitic granulose white gneiss. Occurs in central Green Mountain massif from Plymouth to Shrewsbury, on Robinson Hill, and along the eastern margin of the Green Mountain massif east of Rutland

**Chittenden Intrusive Suite (Late Mesoproterozoic)
(1,149±8 Ma to 1,119±3 Ma)**

$Y^{3A}gb$

Hornblende gabbro-diorite (Mesoproterozoic)—Biotite-hornblende (±pyroxene) gabbro and diorite at Robinson Hill in Shrewsbury; exhibits fine-grained chill contact that crosscuts paragneiss units. Unit also in Lincoln Mountain massif and at Brandon Gap; similar rock mapped in the Adirondacks

$Y^{3A}ma$
$Y^{3A}g$
$Y^{3A}pg$

Microcline-augen granite and monzogranite gneiss—Gray to whitish-gray, coarse-grained biotite-microcline megacrystic granite and monzogranitic gneiss; passes locally into more equigranular granitic gneiss ($Y^{3A}g$) and locally into extensive areas of biotite pegmatoid granitic gneiss ($Y^{3A}pg$), locally muscovite-bearing. Enclaves of metasedimentary units in these granites and associated gneisses are locally albitized and enriched in magnetite; enclaves of highly aluminous altered rocks now contain restites of chloritoid and abundant sericite. U-Pb zircon ages of 1,119±3.3 Ma (no. 15) and 1,121±1.4 Ma (no. 14) determined on samples near Sherburne Center and on Telegraph Hill east of Chittenden Reservoir by Karabinos and Aleinikoff (1990)

$Y^{3A}mb$
$Y^{3A}ma$

Microcline-magnetite augen gneiss at Brandon Gap—Pinkish-gray to medium-dark-gray, biotite-magnetite-microcline-plagioclase augen gneiss. U-Pb zircon SHRIMP age of 1,149±8 Ma, no. 13 (Aleinikoff and others, 2011). Unit is associated with minor exposures of metadiorite to tonalitic gneisses; crosscuts a gneissosity in country rocks and may extend northward along eastern limb of Lincoln Mountain massif as unit $Y^{3A}ma$

$Y^{3A}gg$

Granitic gneiss of Chittenden Intrusive Suite (?)—Light-gray, coarse-grained, biotite-microcline megacrystic to even-grained granite gneiss closely associated with 1,149- to 1,120-Ma augen gneisses, in the northern part of the Green Mountain massif. Not distinguishable with certainty from older granitoids of the Stratton Mountain Intrusive Suite of the central and southern Green Mountains

$Y^{3A}la$

Microcline augen gneiss of Lincoln Mountain massif—Light- to medium-gray, medium-grained, biotite-quartz-plagioclase-microcline gneiss; contains microcline augen as much as 4 cm in length

**Stratton Mountain Intrusive Suite (Middle Mesoproterozoic)
(1,244±8 Ma to 1,221±4 Ma)**

Y^2gg

Biotite-granitic gneiss—A heterogeneous unit consisting of granitic and granodioritic and aplite biotitic microcline-rich gneisses, highly gneissic and locally migmatitic, occurring in the southern part of the Green Mountain massif. U-Pb zircon TIMS age of 1,221±4 Ma, no. 12 (Ratcliffe and others, 1991; Aleinikoff and others, 2011) obtained from Londonderry. Unit intrudes rocks of South Londonderry Igneous Suite

Y^2ap

Aplitic gneiss—Light-gray to white, fine-grained aplitic granite gneiss as border of Y^2gg or as thin dikes or sills in paragneiss units

Y^2ch

College Hill Granite Gneiss—Light-gray to medium-dark-gray, porphyritic biotite-microcline-perthite granodioritic gneiss and pegmatite. Strongly deformed, lineated, and saturated with less deformed later pegmatite; grades outward into a migmatitic border exhibiting decreasing concentration of microcline megacrysts. Forms a single large intrusive mass on College Hill in Jamaica and west of Stratton Mountain; truncates structure in older gneisses. U-Pb zircon TIMS age of 1,244±8 Ma, no. 11 (Ratcliffe and others, 1991; Aleinikoff and others, 2011)

Y^2lg

Granitic gneiss of Lincoln Mountain massif (Middle Mesoproterozoic)—Heterogeneous unit consisting of medium-grained biotite-microcline-plagioclase gneiss and pinkish-gray, medium- to coarse-grained microcline-perthite granitic gneiss. Interpreted as intrusive granitic rock older than Y^3 rocks of Chittenden Intrusive Suite

Migmatitic and mylonitic rocks of uncertain origin

Y^2mig

Migmatitic gneiss (Middle Mesoproterozoic)—Light-gray and pinkish-gray to yellowish-gray, massive, medium-grained plagioclase granitic gneiss, and migmatite-veined biotite-plagioclase gneiss. Occurs prominently in Jamaica, in Andover in the Chester dome, and in Weston where it appears to form an integral part of $Y^{1,2}bg$, but also locally appears to be intrusive. A mixed rock of uncertain origin. U-Pb zircon SHRIMP age of 1,326±4 Ma, no. 8 (Aleinikoff and others, 2011), suggests affinity with metamorphic and igneous events associated with the Middle Mesoproterozoic Ludlow Mountain and Proctor Hill granodiorite gneisses of the South Londonderry Igneous Suite. Age of migmatization is younger than 1,326 Ma

Y^2myu

Mylonitic gneiss (age uncertain)—Highly schistose, biotite-muscovite (±chlorite) feldspathic mylonite and mylonitic gneiss mapped near Brandon Gap; in the Pine Hill slice near South Wallingford is mapped as Yur

**South Londonderry Igneous Suite (Middle and Early Mesoproterozoic)
(1,393±9 Ma to 1,309±6 Ma)**

Y^2lgg

Ludlow Mountain granodiorite gneiss (Middle Mesoproterozoic)—Light-gray, medium- to fine-grained garnet-biotite-microcline-perthite granodiorite, magnetite-studded white aplite, and kyanite-tourmaline pegmatite. Contains 0.5-cm clots of muscovite possibly after beryl. Intrudes quartzite, lustrous schists (Y^1rs), and calc-silicate rocks on Ludlow Mountain. U-Pb zircon SHRIMP age of 1,309±6 Ma, no. 9 (Aleinikoff and others, 2011)

Y^2lga

Ludlow Mountain aplitic gneiss (Middle Mesoproterozoic)—Light-gray to white, very fine grained microcline-plagioclase-quartz (±magnetite) aplitic gneiss; contains sparing amounts of biotite, and secondary muscovite. Unit interpreted to be border facies of Y^2lgg. Y^2ap is similar aplitic gneiss, but is not in contact with either Y^2lgg or Y^2phg. Exposed on Ludlow Mountain

Y^2phg
Y^2pha

Proctor Hill granodiorite gneiss (Middle Mesoproterozoic)—Gray to pinkish-gray, gneissoid magnetite-biotite-microcline-perthite granodiorite, and locally microcline megacrystic gneissic granite, well-foliated and highly variable in composition, having aplitic and hornblende-rich reaction zones (Y^2pha) where in contact with calc-silicate rocks. Crosscuts all paragneiss units; is a thoroughly gneissic rock. Correlated with the Ludlow Mountain granodiorite gneiss

Y^2cp

Cole Pond tonalite gneiss (Middle Mesoproterozoic)—Gray to medium-dark-gray, biotite-rich metatonalite gneiss, having irregular screens, and xenoliths of more mafic hornblende-biotite tonalite or diorite gneiss. U-Pb zircon SHRIMP age of 1,321±9 Ma, no. 7 (Ratcliffe and others, 1991; Aleinikoff and others, 2011)

Y^2bv

Bondville metadacite and trondhjemite gneiss (Middle Mesoproterozoic)—Light-gray to whitish-gray, fine-grained biotite trondhjemitic gneiss, locally containing abundant magnetite. U-Pb zircon SHRIMP age of 1,342 Ma, no. 6B (Ratcliffe and others, 1991; Aleinikoff and others, 2011)

Y^1rta
Y^1rt

Rawsonville trondhjemite gneiss (Early Mesoproterozoic)—Chalky-white to light-gray-weathering, medium- to coarse-grained biotite metatrondhjemite and aplite (Y^1rta). Dated sample with U-Pb zircon SHRIMP age of 1,367±16 Ma, no. 3 (Ratcliffe and others, 1991; Aleinikoff and others, 2011) from crest of Bromley Mountain; U-Pb zircon age of 1,348±3 Ma, no. 6 (Ratcliffe and others, 1991)

Y^1tg

Tonalite gneiss (Early Mesoproterozoic)—Medium-gray- to light-gray-weathering, biotite (±hornblende) tonalite gneiss exposed on Torment Hill in Weston; probably correlative with the Baileys Mills tonalitic gneiss or the Felchville trondhjemite facies (Y^1fg) of the Chester dome, but undated

Y^1dg

Hornblende diorite gneiss (Early Mesoproterozoic)—Coarse-grained hornblende-plagioclase (±quartz) dioritic gneiss and gabbroic gneiss mapped in the Londonderry area, where it is interpreted as metagabbro and has a U-Pb zircon SHRIMP age of 1,393±9 Ma, no. 1 (Aleinikoff and others, 2011)

Y^1bm

Baileys Mills tonalitic gneiss (Early Mesoproterozoic)—Light-gray to whitish-gray-weathering, medium-grained biotite-quartz-plagioclase gneiss flecked with coarse biotite. Contains numerous lenses of fine-grained amphibolite similar to amphibolites associated with calc-silicate rocks of the type Mount Holly Complex in Mount Holly, rather than coarser grained dioritic gneiss associated with the Cole Pond and Rawsonville gneisses. U-Pb zircon SHRIMP age of 1,383±13 Ma, no. 2 (Ratcliffe and others, 1991; Aleinikoff and others, 2011)

Y^1bmp

Plagioclase-phenocrystic tonalite gneiss—Coarse-grained facies of the Baileys Mills tonalitic gneiss exposed on the northeast flank of the Chester dome

Felchville Gneiss (Early Mesoproterozoic)

Y^1fga

Felchville aplitic facies—Light-gray to whitish-gray, fine-grained, magnetite trondhjemitic gneiss and aplitic trondhjemite, intricately intrusive into layered paragneisses of the Chester dome; contains xenoliths of more mafic gneiss. U-Pb zircon SHRIMP age of 1,372±11 Ma, no. 4 (Aleinikoff and others, 2011). Similar fine-grained magnetite aplitic gneisses exposed in the Green Mountain massif are associated with tonalitic gneisses on Torment Hill, Weston

Y^1fg

Felchville trondhjemite facies—Light-gray to whitish-gray-weathering, magnetite-biotite-microcline-quartz-plagioclase metatrondhjemite to granodioritic gneiss; intrudes paragneiss units of the Chester dome. U-Pb zircon SHRIMP age of 1,370±11 Ma, no. 5 (Aleinikoff and others, 2011)

Mount Holly Complex paragneiss (Middle to Early Mesoproterozoic)
(includes possible felsic metavolcanic rocks and volcaniclastic rocks; relative age uncertain; abundant interfingering of units and stratigraphic duplication likely)

Problematic rocks at Devils Den in Weston and Danby areas (Mesoproterozoic?)—Near Devils Den and Moses Pond includes albitic biotite-muscovite schist, chloritoid-chlorite-muscovite (±garnet) schist, dolomite marble and minor quartzite which resemble rocks of the Tyson Formation, and retrograde varieties of the paragneisses of the Mount Holly Complex. Because these rocks are structurally compatible with Grenvillian or older folds in the Mount Holly Complex and are transitional into rocks of the Mount Holly Complex, a Mesoproterozoic age is favored. Nevertheless the resemblance to rocks of the Tyson Formation is striking

$Y^?cms$

Muscovite-chlorite-garnet schist—Light-silvery-green to grayish-green, lustrous muscovite-chlorite-quartz (±garnet±chloritoid±ilmenite) schist and biotite-albite-muscovite-quartz schist. Unit is highly variable both in texture and in composition (from ultrafine-grained phyllonitic schist to medium-grained muscovite-garnet schist). Albitic varieties tend to contain more biotite and less muscovite. Rock is highly retrograded and contains abundant chlorite derived from the breakdown of garnet that contained large anhedral quartz and grains of coarse muscovite and biotite. Robust grains of rutile are abundant. Chloritoid commonly occurs in the fine-grained sericitic matrix but locally is found within large subhedral garnets. The contact with adjacent $Y^?mfs$ is gradational and determined by a higher abundance of biotite (commonly chloritized) and albite in $Y^?mfs$ near $Y^?cms$. The contact with Y^2rs of the Mount Holly Complex is gradational

$Y^?mfs$

Biotite-muscovite-plagioclase-quartz schist—A highly heterogeneous unit, distinguished from $Y^?cms$ by its generally rusty-weathering, nonlustrous appearance and by the abundance of large albite crystals, conspicuous large plates of muscovite and biotite, and abundant clinozoisite. Locally contains fresh garnet as inclusions in albite, or abundant totally retrograded chlorite-sericite clots after original highly poikiloblastic garnet. Near the contacts with Y^1fga, abundant sills of granitic gneiss, plagioclase-tourmaline veins and highly albitic, very coarse grained schist occur. Unit is interbedded near its base with either garnet-muscovite-quartz-plagioclase quartzite (Y^2q) or a fine-grained, black hornblende-garnet amphibolite (Y^2a) or calc-silicate rock (Y^2cs), all of the Mount Holly Complex and containing pegmatite ($Y^{3C}p$)

$Y^?dm$

Dolomite marble—Beige to pinkish-gray-weathering, pyrite-bearing, medium- and fine-grained phlogopite-chlorite-dolomite marble exposed in cliffs east of the road at Devils Den. Grades into chlorite-biotite (±actinolite)-carbonate schist at structural base and has sharp contact with structurally overlying quartzite ($Y^?q$)

$Y^?q$

Quartzite—Light-gray to pinkish-gray, magnetite-muscovite-plagioclase quartzite at Devils Den. Grades into structurally overlying biotite-muscovite feldspathic schist and garnet-bearing feldspathic gneiss that contains pegmatite

Cavendish Formation (Early Mesoproterozoic)

The term "Cavendish Formation" is restricted to two belts of rocks within the Chester dome; the larger belt occurs at Cavendish and on Hawks Mountain, and a less extensive belt, containing similar rocks, occurs near Star Hill. An Early Mesoproterozoic age is here favored for the Cavendish Formation on the basis of (1) the presence of deformed pegmatite ($Y^{3C}p$) and areas of Felchville Gneiss (Y^1fg and Y^1fga) within the Cavendish and (2) the marked resemblance of members of the Cavendish to aluminous and feldspathic schists, calc-silicate rocks, and quartzites within the Mount Holly Complex. Similarities to rocks of the Hoosac Formation are also striking and cannot be altogether dismissed; however, the Hoosac Formation lacks pegmatite and contains distinctive and well-bedded albitic granofels, mafic volcanics, and coarse pebble-to-cobble conglomerate, all absent from the Cavendish. Zircons from a quartzite lens in dolomite marble at locality 4 have Pb-Pb ages between 1,290 and 934 Ma and suggest some of the marble of the Cavendish may be younger than the Felchville Gneiss (Karabinos and others, 1999). Retrograded muscovite-rich, chlorite-spotted, chloritoid-bearing quartz phyllites and garnet granofels and other rocks of the Wilcox Formation (Y^2wxs) closely resemble those of the Cavendish Formation, as do chloritic-muscovitic retrograded Y^2rs members of the Mount Holly Complex in the Green Mountain massif. Dolomite marble, talc-tremolite rock, diopside quartzite, calc-silicate gneiss, and lustrous chlorite-spotted, chlorite-muscovite-rich retrograded garnet gneiss and schist in the Mount Holly Complex contain abundant pegmatite ($Y^{3C}p$) on Blue Ridge Mountain in Chittenden and are identical but lower-grade correlatives of the Cavendish Formation. The coarse garnet-staurolite- and kyanite-bearing Gassetts Schist Member is interpreted to be an Acadian remetamorphosed product of the retrograde aluminous rocks now seen throughout the Mount Holly Complex of the Green Mountain massif and in the Pine Hill area

Y^1cg

Gassetts Schist Member—Lustrous, yellowish-grayish-green, ilmenite-staurolite (±kyanite)-garnet (large)-plagioclase-biotite-muscovite-quartz schist and warty-textured, dark-gray, biotite-rich garnet (large)-plagioclase-quartz schist. Passes locally into greenish, chlorite-spotted, magnetite-garnet (small)-plagioclase granofels in which large chlorite clots appear to replace earlier large garnet crystals. Unit closely resembles retrograded chlorite-spotted, biotite-garnet-plagioclase-quartz granofels and garnet-quartz-feldspar schist or gneiss of the Wilcox Formation of the Mount Holly Complex (Y^2wsx)

Y^1cfs

Feldspathic schist and granofels member—Light-gray to medium-dark-gray, rusty-weathering, white-plagioclase-spotted biotite-quartz-plagioclase granofels, massive grayish-green chlorite-spotted, magnetite-studded, biotite-plagioclase-quartz granofels and gneiss, and porphyroclastic plagioclase-augen-biotite mylonite gneiss. Unit less well-bedded than granofels of the Hoosac Formation and lacks amphibolites common in the Hoosac flanking the Chester and Athens domes

$Y^{1?}cm$
Y^1cs

Marble and calc-silicate member—Highly variable unit. Includes white, coarse-grained calcite marble; beige to gray, medium- to coarse-grained phlogopite-tremolite-dolomite-quartz-(±talc) marble; greenish actinolite-dolomite-calcite marble; phlogopite-diopside-scapolite-calcite-dolomite marble; coarse-grained dark-green diopside (±hornblende±zoisite)-calc-silicate rocks; white talc-tremolite (±dolomite)-calc-silicate schist; and minor quartzite, diopside quartzite, and schistose bluish-gray marble. Contains pods, stringers, and larger masses of granite pegmatite and interlayered aplitic gneiss. Marble and calc-silicate rocks are identical to units (Y^2cs) within the biotite-quartz-plagioclase paragneiss member ($Y^{1,2}bg$) of the Mount Holly Complex of the Green Mountain massif and eastern domes

Altered rocks adjacent to the Chittenden Intrusive Suite

$Y^{3A}bga$

Albite-magnetite-studded gneiss (Late Mesoproterozoic)—Gray or greenish-gray, albite- and magnetite-studded granulose biotite-quartz-plagioclase gneiss, containing chloritized biotite and garnet. Occurs as altered varieties of $Y^{1,2}bg$ near 1,150-Ma intrusive augen gneisses of the Chittenden Intrusive Suite ($Y^{3A}ma$); in the Lincoln Mountain massif a dark-gray biotite-microcline-chlorite-spotted gneiss contains magnetite grains as much as 1 cm in diameter

Aluminous schists and gneisses of the Washington Gneiss and Wilcox Formation and related rocks

Yur

Retrograde gneiss (Mesoproterozoic)—Mylonitic chlorite-biotite-microcline-quartz gneiss, occurring as a sliver in the Shelburne Marble, South Wallingford

Y^2wg

Washington Gneiss (Middle Mesoproterozoic)—Dark-rusty-grayish-brown-weathering, graphitic garnet-plagioclase-biotite-quartz (±sillimanite) schist; rusty-weathering blue-quartz-ribbed quartz schist; and garnet quartzite and rusty-weathering layers of sulfidic calc-silicate rock. Exposed in southernmost part of Green Mountain massif. Distinctive quartz ribbing decreases northward where more aluminous, less quartzofeldspathic rocks are mapped as Y^2rs

Y^2rs
Y^2bgt

Quartz schist and gneiss (Middle Mesoproterozoic)—Dark-tan- to rusty-tan-weathering, garnet-muscovite-biotite-quartz-plagioclase gneiss and rusty schist, locally containing abundant chloritized garnet; lustrous yellowish-grayish-green phyllonitic retrograde varieties contain chloritoid-chlorite and relict garnet (red dot overprint). Unit locally includes steel-gray-weathering, garnet (small)-quartz-biotite gneiss and quartzite (Y^2bgt)

Y^2rss

Carbonaceous sulfidic schist (Middle Mesoproterozoic)—Dark-gray, rusty-weathering carbonaceous to graphitic schist associated with quartzite and calc-silicate rock near Killington

Y^2wxs

Wilcox Formation (Middle Mesoproterozoic)—Lustrous to rusty-weathering biotite-muscovite (±chloritoid) schist and retrograde coarse-garnet schist; probably is the retrograde equivalent of charnockitic garnet-rich feldspathic quartz gneisses of the eastern Adirondacks. Locally contains mappable quartzite, garnet quartzite, calc-silicate gneiss, and marbles, mapped separately

Y^2wxq

Quartzite member—Tan, yellowish-gray-weathering garnet-muscovite quartzite and feldspathic retrograde-garnet quartz gneiss

Y^2wxg

Garnetiferous quartzite and quartz schist member—Lustrous muscovite-chlorite-chloritoid or muscovite-chlorite-biotite-clinozoisite retrograde schistose quartzite and large-garnet schist. Resembles a retrograde variety of the Hague Gneiss (of Alling, 1918) (Y^2hgn) near Whitehall, N.Y.

Y^2wxcs

Calc-silicate gneiss and marble member—Dark-green, massive, diopside-hornblende rock, lenses of bluish-gray to gray, medium- to coarse-grained calcite marble and calcite-diopside marble and dolomitic talc-phlogopite-tremolite schist

Y^2wxd

Dolomite marble member—Beige-weathering to whitish-gray, fine-grained dolomite marble

Y^2lq

Okemo Quartzite (Middle Mesoproterozoic)—Light-tan to whitish-gray, massive vitreous quartzite in beds several meters thick, interlayered with rusty-grayish-brown garnet-muscovitic quartzite and aluminous sericite-muscovite-tourmaline retrograde phyllite. Occurs as a thick unit on Ludlow Mountain, in Okemo State Forest. U-Pb ages of detrital zircons range from 1,359±32 Ma to 1,261±62 Ma, no. 10 (Aleinikoff and others, 2011), and suggest derivation from trondhjemitic gneiss of the South Londonderry Igneous Suite

Y^2q
Y^1q

Quartzite, undifferentiated (Middle to Early Mesoproterozoic)—Tan to rusty-brown or gray, thinly layered garnet-biotite quartzite and schistose quartzite associated with aluminous schists and calc-silicate rocks or interbedded within biotite-quartz-plagioclase paragneiss. Unit probably occurs at various stratigraphic levels; may be Early Mesoproterozoic in part (Y^1q)

Y^2dm

Dolomite marble (Middle Mesoproterozoic)—Light-gray to yellowish-gray, coarse-grained dolomite-phlogopite-scapolite marble; pyritiferous varieties weather salmon pink to beige. Unit occurs on West Mountain in Chittenden, in Sherburne Center, Weston, and in the Pine Hill slice; is commonly associated with tremolite-talc marble and tremolite-talc schist

Y^2m

Calcite marble (Middle Mesoproterozoic)—Light-bluish-gray and white, coarse- and medium-grained calcite-diopside marble and calcite-diopside-talc marble in beds or pods less than 5 m thick, interbedded with or passing laterally into other calc-silicate rock

Y^2cs

Calc-silicate rock (Middle Mesoproterozoic)—Heterogeneous unit consists of dark-green hornblende-diopside rock or pale-green diopside rock; hornblende-calcite-diopside knotted rock; and rusty-weathering, beige scapolite-quartz-plagioclase gneiss, tremolite-phlogopite schist, and diopside quartzite

Y^2a
Y^1a

Amphibolite (Middle Mesoproterozoic)—Dark-grayish-green, fine-grained quartz-hornblende-plagioclase amphibolite, locally garnetiferous, and medium-grained hornblende-plagioclase amphibolite. Occurs with belts of calc-silicate rocks and as lenses within biotite-quartz-plagioclase paragneiss. Unit probably includes both meta-igneous and metasedimentary rocks intercalated throughout the Early and Middle Mesoproterozoic-age rocks of the Mount Holly Complex

Y^2hg

Hornblende-plagioclase gneiss (Middle Mesoproterozoic)—Medium- to coarse-grained hornblende dioritic-appearing gneiss

Y^2rgt

Garnet-biotite gneiss (Middle Mesoproterozoic)—Dark-gray- to rusty-grayish-brown-weathering, sulfidic muscovite-biotite-magnetite gneiss or schist marked by abundant small garnets, biotite, and fine laminae of quartz and plagioclase. Contains thin belts of amphibolite and calc-silicate gneiss

$Y^{1,2}bg$

Biotite-quartz-plagioclase gneiss (Middle and Early Mesoproterozoic)—A widespread, heterogeneous unit of well-layered, predominantly biotite-quartz-plagioclase gneisses containing variable amounts of magnetite, hornblende, and garnet, and little potash feldspar. Plagioclase-rich layers contain epidote-crowded plagioclase and isolated igneous quartz grains and probably are metadacitic volcanics and volcaniclastic rocks. Unit varies from very dark gray biotitic gneiss to light-gray more plagioclase- and quartz-rich gneiss, contains quartz-rich layers, minor amphibolites, rusty-weathering garnetiferous quartzites, and calc-silicates and marbles which locally are mappable. Association suggests an accumulation of volcaniclastic and clastic sediments. Areas of $Y^{1,2}bg$ associated with 1,400- to 1,350-Ma intrusive rocks range down into the Early Mesoproterozoic, whereas the upper parts may be Middle Mesoproterozoic. Rocks mapped as $Y^{1,2}bg$ may not all be correlative

$Y^{1,2}be$

Biotite-epidote-quartz gneiss and epidotic quartzite (Middle and Early Mesoproterozoic)—Light-pale-yellowish-green to gray quartzite gneiss containing abundant epidote and locally magnetite, and frosted round grains of quartz associated with diopside-bearing quartzite

Y^1rs

Quartz schist (Early Mesoproterozoic)—Rusty-weathering sulfidic schist and minor amphibolite older than part of the South Londonderry Igneous Suite

THE TACONIC ALLOCHTHON

Five structural slices of the Taconic allochthon in Vermont (Zen, 1961, 1972; Potter, 1972) contain rocks ranging in age from Neoproterozoic to Ordovician. The lowermost slices, the Sunset Lake, Giddings Brook, and North Petersburg slices, contain the complete stratigraphic range whereas the higher and more easterly Bird Mountain and Dorset Mountain slices are inferred to contain largely Cambrian and Neoproterozoic rocks and to exhibit different facies from those of the lower slices. The structural boundaries among the slices are commonly late post-emplacement imbricate thrust faults, thus complicating both the inferred stacking sequence and the identification of primary emplacement relations. For example, the boundary and distinction between the Bird Mountain and Giddings Brook slices is particularly uncertain and is not shown on this map; there may be no distinction. Although the structural stacking sequence and boundaries are indefinite, the names are useful for describing geographic areas and stratigraphic distinctions and are retained here for descriptive purposes (see Zen, 1961, 1964, 1967).

Ofh

Forbes Hill conglomerate and breccia in the Ira and Hortonville Formations (Upper Ordovician)—Black slate containing angular to irregular chips of greenish-gray to yellowish-gray slate, quartz wacke, and limestone; interpreted by Zen (1961) as sedimentary wildflysch

Obvb

Vesicular basalt breccia at East Hoosick (Upper Ordovician)—In the Walloomsac Formation; perhaps intrusive

Oww

Whipstock Breccia in the Walloomsac Formation (Upper Ordovician)—Largely a tectonic breccia formed in situ; contains abundant pseudo-pebbles

Wildflysch-like conglomerates within the Hortonville, Ira, and Walloomsac Formations occur as local areas of black slate rich in inclusions of quartzite, greenish-gray slate, wacke, and punky-weathering bluish-gray limestone, interpreted as sedimentary breccias, deposited in front of the advancing Taconic allochthon (Upper Ordovician) (Zen, 1961; Potter, 1972; Fisher, 1985). Exposed near the western and northern margin of the allochthon and in the Bennington area at the type Whipstock. Here and at many localities the Forbes Hill and Whipstock breccias are tectonic breccias formed in situ by disruption of thin to thick beds, laminae, and carbonate-quartz-sulfide veins rather than clastic sedimentary rocks. The cleavage and related folding commonly is a late strain-slip cleavage characterized by a strong down-plunge lineation parallel to reclined hingelines of minor folds of foliation and compositional layering. Units are retained although interpretation as sedimentary wildflysch deposits is in part questionable