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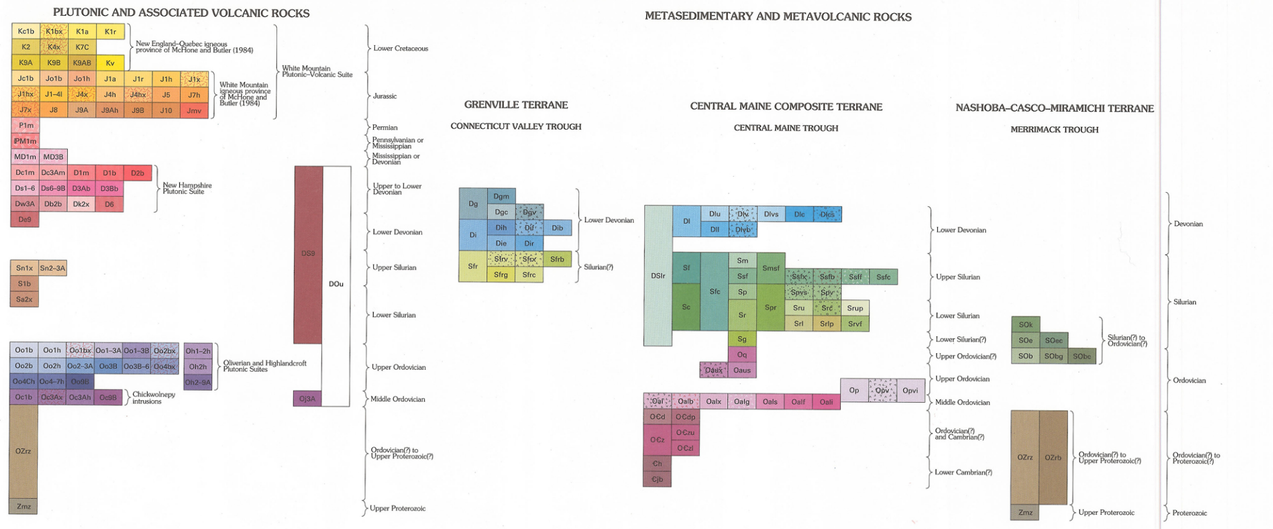
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

PLUTONIC AND ASSOCIATED VOLCANIC ROCKS

[See explanation of map unit symbols in section on "Plutonic Rock Compositions." Note: Because of their relative scarcity and lithologic diversity, volcanic rocks in igneous complexes have not been subdivided on a modified Streckeisen (1973) scheme. The lithologic part of some formal names has been changed in accordance with Streckeisen (1973)]

White Mountain Plutonic-Volcanic Suite (Cretaceous and Jurassic)—Includes Cretaceous alkalic syenite to granitic to gabbroic plutons, minor volcanic rocks, and lamprophyre dikes of the New England-Quebec igneous province of McHone and Butler (1984); also includes Jurassic granite and syenite and less abundant quartz syenite, diorite, gabbro, nepheline syenite, and volcanic rocks of the White Mountain igneous province of McHone and Butler (1984)

- Kc1b — **Mesoperthitic biotite granite (Early Cretaceous)**—Pink Conway-type granite of Kingsley (1931)
- K1bx — **Porphyritic biotite granite**—Pink to gray; hastingsite or riebeckite in some varieties
- K1a — **Rhyolite and fine-grained granite**—Includes some ignimbritic caldera-fill and minor intrusive rocks (part of Ossipee Mountain Complex of Kingsley, 1931); also some aphanitic gray, black, or tan quartz-feldspar porphyry
- K1r — **Medium-grained mesoperthitic granite containing riebeckite and (or) hastingsite**
- K2 — **Biotite-hornblende granodiorite**
- K4x — **Large mesoperthitic phenocrysts in a pink to gray quartz syenite porphyry of "Albany type"**—Alkalic amphibole or fayalite may be present. Part of Ossipee Mountain Complex of Kingsley (1931)
- K7C — **Gray augite-hornblende-biotite monzonite**
- K9A — **Hornblende diorite**—Coarse-grained to porphyritic
- K9B — **Augite-hornblende-biotite gabbro**—Fine- to coarse-grained
- K9AB — **Augite-hornblende diorite and gabbro**—Gray to black, coarse-grained, porphyritic. Found in Mt. Pawtuckaway quadrangle
- Kv — **Basalt**—Black, chiefly massive to porphyritic. Includes minor rhyolitic ignimbrite and andesitic tuff. Part of Ossipee Mountain Complex of Kingsley (1931)
- Jc1b — **Conway Granite (Late? and Middle Jurassic)**—Typically pink, coarse-grained mesoperthitic biotite (amphibole-free) granite; locally fine-grained or porphyritic

Mount Osceola Granite (Middle and Early Jurassic)

- Jo1b — Green biotite mesoperthitic granite
- Jo1h — Granite containing hornblende and, locally, hastingsite, ferrohedenbergite, or fayalite
- J1a — **Fine-grained granite**—Commonly contains alkalic amphibole and mesoperthite
- J1r — **Mesoperthitic granite**—Contains riebeckite and (or) hastingsite
- J1h — **Hastingsite granite**—Leucocratic, pink or light-brown, and mesoperthitic
- J1x — **Porphyritic granite**
- J1hx — **Granite porphyry (Early Jurassic)**—Granite containing phenocrysts of smoky quartz and microperthite; alkalic amphibole, hornblende, and hedenbergite or fayalite may be present. "Mount Lafayette" type granite porphyry of Billings (1955)
- J1–4l — **Leucocratic granite to quartz syenite**
- J4x — **Quartz syenite**—Commonly porphyritic and mesoperthitic; contains biotite and, locally, fayalite, hastingsite, hornblende, or ferrohedenbergite
- J4h — **Hornblende or alkalic amphibole quartz syenite**
- J4hx — **Porphyritic hornblende or alkalic amphibole quartz syenite**
- J5 — **Hornblende-biotite quartz monzodiorite**—Composition ranges from quartz monzonite to diorite
- J7h — **Hornblende (or alkalic amphibole) syenite**
- J7x — **Porphyritic syenite**—Hastingsite or hornblende and (or) hedenbergite are present
- J8 — **Augite monzodiorite**
- J9A — **Diorite**—Contains hornblende, biotite, and hedenbergite
- J9Ah — **Porphyritic hornblende diorite**—Found in northwestern New Hampshire
- J9B — **Gabbro**—Has varying amounts of olivine, augite, and hornblende
- J10 — **Nepheline-sodalite-hastingsite syenite**—Found at Red Hill in Mt. Chocorua quadrangle (see index accompanying "Sources of Map Data")
- Jmv — **Moat Volcanics (Middle Jurassic?)**—Bedded and ignimbritic tuffs, flows, and breccias; also porphyritic rhyolite and minor trachyte

Permian intrusive rocks

- P1m — **Gray biotite granite**—Contains minor muscovite. Found in Milford quadrangle

Pennsylvanian or Mississippian intrusive rocks

- IPM1m — **Two-mica granite of the Sebago batholith and Effingham pluton of eastern New Hampshire**

Mississippian or Devonian intrusive rocks

- MD1m — **Two-mica granite**—Found in northern New Hampshire
- MD3B — **Trondhjemite and abundant pegmatite**—Gray and fine-grained; possibly belonging to the Sebago batholith

New Hampshire Plutonic Suite (Late to Early Devonian)—Includes synkinematic and postkinematic granitoids related to the Acadian orogeny. Ages range from 410 to 365 Ma

- Dc1m — **Concord Granite (Late Devonian)**—Gray two-mica granite, locally grading to tonalite
- Dc3Am — **Two-mica tonalite**—Similar to Concord Granite; found in south-central New Hampshire
- D1m — **Two-mica granite of northern and southeastern New Hampshire**—Similar to Concord Granite
- D1b — **Pink equigranular biotite granite (Late Devonian)**—Found in Woodsville and Whitefield quadrangles and in small intrusive units in northern and southeastern New Hampshire
- D2b — **Porphyritic biotite granodiorite**—Found in Mt. Cube quadrangle
- Ds1–6 — **Spaulding Tonalite (Early Devonian) (Spaulding Quartz Diorite of Fowler-Billings, 1949)**—Weakly foliated to nonfoliated, spotted biotite quartz diorite, tonalite, granodiorite, and granite; garnet and muscovite may or may not be present
- Ds6–9B — **Hypersthene-biotite quartz diorite and hornblende or actinolite diorite or gabbro**—Spatially associated with Spaulding Tonalite plutons
- D3Ab — **Biotite tonalite**—Dark-gray; found in southeastern and western New Hampshire
- D3Bb — **Biotite trondhjemite in Rumney quadrangle**
- Dw3A — **Winnipesaukee Tonalite (Early Devonian) (Winnipesaukee Quartz Diorite of Billings, 1955)**—Gray, massive to foliated tonalite and minor quartz diorite, granodiorite, and granite. Probably coeval with Spaulding Tonalite
- Db2b — **Bethlehem Granodiorite (Early Devonian) (Bethlehem Gneiss of Billings, 1955)**—Gray, strongly foliated biotite-muscovite granodiorite and associated tonalite and granite
- Dk2x — **Kinsman Granodiorite (Early Devonian) (Kinsman Quartz Monzonite of Billings, 1955)**—Foliated granite, granodiorite, tonalite, and minor quartz diorite; large megacrysts of potassium feldspar characteristic; garnet locally abundant
- D6 — **Biotite quartz diorite in northeastern New Hampshire**

Devonian intrusive rocks[1]

- De9 — **Exeter Diorite (Early Devonian)**—Includes associated intrusive rocks of southeastern New Hampshire; pyroxene and pyroxene-hornblende diorite and gabbro, along with minor granodiorite and granite

Devonian(?), Silurian(?), and Ordovician(?) intrusive rocks

- DSØ — **Metamorphosed gabbro, diorite, and intrusive basalt dikes**—Chiefly in northern New Hampshire
- DOu — **Serpentinite and soapstone**—Found in central and western New Hampshire as very small bodies

Silurian intrusive rocks[1]

- Sn1x — **Newburyport Complex (Late Silurian)**—Medium-grained porphyritic granite
- Sn2–3A — **Newburyport Complex (early Late Silurian)**—Gray, medium-grained tonalite and granodiorite
- S1b — **Biotite granite stock and dikes (Late to Early Silurian)**—Northernmost New Hampshire
- Sa2x — **Ayer Granodiorite (Early Silurian)**—Gneissic granite to tonalite, locally coarsely porphyritic and muscovitic, southeastern New Hampshire

Oliverian Plutonic Suite[2] **(Late Ordovician)**—Pink, weakly to moderately foliated, locally porphyritic biotite granitoids found in mantled gneiss domes. Mafic varieties contain hornblende. Variably metamorphosed up to amphibolite facies

- Oo1b — **Biotite granite**—Pink, moderately to weakly foliated
- Oo1h — **Hornblende-biotite granite**
- Oo1bx — **Porphyritic (alkalic feldspar) biotite granite**
- Oo1–3A — **Granite, granodiorite, and tonalite**
- Oo1–3B — **Granite, granodiorite, and trondhjemite**
- Oo2bx — **Porphyritic biotite granodiorite in northern Jefferson dome in Milan quadrangle**
- Oo2b — **Biotite granodiorite**
- Oo2h — **Hornblende granodiorite**
- Oo2–3A — **Granodiorite to tonalite**
- Oo3B — **Trondhjemite**—Contains biotite and hornblende
- Oo3B–6 — **Trondhjemite and quartz diorite in northern Jefferson dome in Gorham quadrangle**
- Oo4qx — **Porphyritic biotite quartz syenite in central Jefferson dome in Mt. Washington quadrangle**
- Oo4Ch — **Hornblende quartz monzonite**
- Oo4–7h — **Hornblende-biotite quartz syenite to syenite**
- Oo9B — **Hornblende gabbro**

Highlandcroft Plutonic Suite[2] **(Late Ordovician)**—Pink to green rocks containing epidote, sericite, and chlorite. Found as stocks metamorphosed to greenschist facies and commonly sheared; coeval with Oliverian Plutonic Suite

- Oh1–2h — **Hornblende granite to granodiorite**—Part of Lost Nation pluton of northwestern New Hampshire
- Oh2h — **Hornblende granodiorite of Highlandcroft pluton**—Contains minor tonalite and diorite
- Oh2–9A — **Tonalite, diorite, granodiorite, and granite**—More mafic rocks have hornblende; part of Lost Nation pluton

Rocks of the Chickwolnepy intrusions in northern New Hampshire (Middle Ordovician)

- Oc1b — **Biotite granite**—Contains minor muscovite. Makes up Cambridge Black pluton
- Oc3Ax — **Porphyritic phase of hornblende-biotite tonalite**
- Oc3Ah — **Hornblende-biotite tonalite**
- Oc9B — **Gabbro and diabase**—Foliated to nonfoliated and coarse- to fine-grained; includes mafic dikes tentatively correlated with Chickwolnepy intrusions

Ordovician intrusive rocks

- O3A — **Tonalite (Middle Ordovician)**—Extended from Joslin Turn, Vermont

Ordovician(?) to Late Proterozoic(?) rocks

- OZrz — **Rye Complex**[3] **(Ordovician? to Late Proterozoic?)**—Migmatite consisting of gray, foliated, sheared or mylonitized two-mica granite and pegmatite, as well as minor hornblende-biotite diorite, intruding metapelites and metavolcanic rocks in southeastern New Hampshire

Late Proterozoic rocks

- Zmz — **Massabesic Gneiss Complex**[4] **(Late Proterozoic)**—Migmatite consisting of pink, foliated biotite granite intruding gneissic and granulose metasedimentary and metavolcanic rocks in southeastern New Hampshire

METASEDIMENTARY AND METAVOLCANIC ROCKS OF THE CONNECTICUT VALLEY TROUGH

- Dg — **Gile Mountain Formation, undivided (Lower Devonian)**—Gray to tan metawacke and schist or phyllite; gradational into the Meetinghouse Slate Member but is much more thickly bedded and less pelitic than the member. Includes minor metavolcanic lentils
- Dgm — Meetinghouse Slate Member—Gray to black phyllite and silty metasandstone turbidite
- Dgc — Interbedded gray slate or phyllite and brown-weathering calcite-ankerite metasiltstone—Contains minor marble and quartzite. Resembles Waits River Formation in Vermont
- Dqv — Mafic metavolcanic member—Possibly equivalent to Putney Volcanics of southeastern Vermont
- Dl — **Ironbound Mountain Formation**[5]**, undivided (Lower Devonian)**—Interbedded gray phyllite, in places containing feldspathic clasts, and feldspathic metasandstone, variably graded
- Dih — Grits at Halls Stream in northern New Hampshire—Thickly bedded feldspathic volcaniclastic grit and interbedded gray slate. Equivalent to Grenier Ponds Member of the Ironbound Mountain Formation in western Maine
- Div — Felsic volcanic member
- Dib — Basaltic to andesitic member
- Die — Euxinic metashale member
- Dir — Metarhyolite and microgranite intrusions
- Sfr — **Frontenac Formation**[6]**, undivided (Silurian?)**—Interbedded thick feldspathic wackes, tan and green slates, and minor calcareous lenses
- Sfrv — Mixed volcanic and sedimentary facies
- Sfrb — Proximal bimodal volcanic facies
- Sfrb — Metabasalt interbeds
- Sfrg — Graded-bedded metagraywacke and subordinate gray phyllite
- Sfrc — Massive tan- or brown-weathering calcite-ankerite-muscovite granofels and interbedded gray metapelite—Probably partly a facies equivalent to the Waits River Formation in Vermont

METASEDIMENTARY AND METAVOLCANIC ROCKS OF THE CENTRAL MAINE TROUGH

[Variably metamorphosed sedimentary and volcanic rocks of greenschist to granulite facies, locally migmatized. Area includes structural belts between the Monroe fault on the west and the Campbell Hill fault on the east; that is, the Bronson Hill anticlinorium, Piermont allochthon, Kearsarge-central Maine synclinorium, central New Hampshire anticlinorium, and Rochester-Lebanon (Maine) antiformal synclinorium]

- Dl — **Littleton Formation, undivided (Lower Devonian; Siegenian)**—Gray metapelite and metawacke and subordinate metavolcanic rocks; generally, but not everywhere, conformable with the underlying Fitch or Madrid Formations. Fossiliferous in western New Hampshire
- Dlu — Upper unnamed member—Light-gray metaturbidite, lithologically identical to, and probably correlative with, the Seboomook Formation of Maine. Coticule layers common
- Dlv — Volcanic lentils—Both mafic and felsic
- Dlvs — Epiclastic metavolcanic sediments
- Dlc — Calc-silicate rock—Possibly equivalent in part to Hildreths Formation of Maine but not restricted to one horizon. Locally fossiliferous, as in Moosilauke quadrangle
- Dlcs — Metaconglomerate and quartzite—Locally fossiliferous in Whitefield quadrangle
- Dll — Lower unnamed member—Thinly or poorly bedded aluminous lower part, somewhat rusty. Rare quartzite lentils. Carrabassett Formation in northwestern Maine is probably correlative
- Dlvs — Metabasaltic greenstone or amphibolite
- DSlr — **Migmatitic rocks (Devonian and Silurian)**—Formations unidentifiable owing to obliteration of original sedimentary or volcanic characteristics by anatexis or by numerous intrusions
- Sf — **Fitch Formation (Upper Silurian; Pridolian and Ludlovian)**—Metamorphosed limestone, calcareous sandstone, siltstone, and dark pelitic schist; lower contact is disconformable on the Clough Quartzite. Fossiliferous
- Sfc — **Fitch and Clough Formations, undivided (Silurian)**
- Sm — **Madrid Formation (Upper Silurian?)**—Massive to weakly foliated, purple biotite-feldspar granofels, layered calc-silicate, and dark pelitic-sulfidic schist containing calc-silicate pods in upper member; an eastern facies equivalent to the upper part of the Fitch Formation. Locally mapped as the Warner Formation of Nielson (1981) in southern New Hampshire
- Smsf — **Madrid and Smalls Falls Formations, undivided (Silurian)**
- Ssf — **Smalls Falls Formation, undivided (Upper to Middle Silurian; Ludlovian and Wenlockian)**—Very rusty weathering, thinly bedded sulfidic-graphitic schist and pyrrhotitic calc-silicate granofels. Eastern facies equivalent to lower part of the Fitch Formation. Locally mapped as Francestown Formation of Nielson (1981) in southern New Hampshire
- Sslv — Mixed metavolcanic rocks and metavolcanic sediments
- Ssfb — Metabasalt member
- Ssfl — Felsic metavolcanic member
- Ssfc — Metaconglomerate member—Found in Errol quadrangle in northern New Hampshire
- Sp — **Perry Mountain Formation, undivided (Middle? to Lower? Silurian)**—Sharply interbedded quartzites, light-gray nongraphitic metapelite, and "fast-graded" metaturbidites. Coticule layers common
- Spvs — Sedimentary and subordinate distal felsic and mafic volcanic facies in Piermont allochthon
- Spv — Volcanic facies in Piermont allochthon
- Spr — **Perry Mountain and Rangeley Formations, undivided (Silurian)**
- Sc — **Clough Quartzite (Lower Silurian; upper Llandoverian)**—Orthoquartzite, quartz metaconglomerate, muscovite schist, and minor polymictic metaconglomerate. Disconformable below the Fitch Formation and unconformable on Ordovician formations. Equivalent, in part, to member C of Rangeley Formation of Maine. Fossiliferous
- Sr — **Rangeley Formation, undivided (Lower Silurian; Llandoverian)**
- Sru — Upper part of Rangeley Formation—Rusty-weathering, pelitic schist, metasandstone, and local coarse-grained metasandstone lentils; calc-silicate pods common; minor coticule. Probably equivalent to member C of Rangeley Formation of Maine
- Src — Member C (uppermost) of the Rangeley Formation in Maine and northeastern and southwestern New Hampshire—Quartz-pebble conglomerate overlain by rusty metapelite and feldspathic quartzite
- Srup — Pink to green calc-silicate and purple biotite granofels—Thinly bedded. Close to transition from lower to upper parts of the Rangeley Formation. Probably equivalent to part of Paxton Formation of Zen and others (1983) in Massachusetts[7]
- Srl — Lower part of Rangeley Formation—Gray, thinly laminated (5-25 mm) metapelite containing local lentils of turbidites and thin quartz conglomerates in western New Hampshire. Sparse calc-silicate pods and coticule. Probably equivalent to member B of Rangeley Formation of Maine
- Srlp — Ribbon-banded calc-silicate of eastern New Hampshire—Probably equivalent to Patch Mountain Member of the Sangerville Formation (Llandoverian and Wenlockian) of central Maine
- Srvf — Felsic metavolcanic rocks—Found in south-central New Hampshire
- Sg — **Greenvale Cove Formation (Lower Silurian?)**—Grayish-violet interlaminated metashale, feldspathic metasandstone, and calc-silicate rock of the Piermont allochthon in western New Hampshire
- Oq — **Quimby Formation (Upper Ordovician?)**—Black graphitic-sulfidic rusty-weathering schist and thickly bedded metagraywacke

Ammonoosuc Volcanics (Upper and Middle Ordovician)

Upper part of Ammonoosuc Volcanics (Upper Ordovician)—Probably equivalent to Partridge Formation in Massachusetts

- Oaus — Bimodal volcanic rocks
- Oaus — Metasedimentary rocks—Contain mafic metavolcanic lenses
- Oal — Metavolcanic and metasedimentary rocks of the lower part of Ammonoosuc Volcanics, undivided (Middle Ordovician)
- Oalb — Metabasalt
- Oalx — Bimodal volcanic rocks—Locally includes unmapped **Oals**
- Oalg — Volcaniclastic metagraywackes
- Oals — Metasedimentary rocks
- Oalf — Felsic metavolcanic rocks
- Oali — White quartz-kyanite rock and silicate iron-formation
- Op — **Partridge Formation, undivided (Upper to Middle Ordovician)**—Black, rusty-weathering sulfidic-graphitic slate or schist and sparse to abundant metagraywacke. Lies stratigraphically between upper and lower parts of the Ammonoosuc Volcanics
- Opv — Interstratified metavolcanic rocks—Chiefly amphibolites, found in southwestern New Hampshire
- Opvi — White quartz-kyanite rock
- OCd — **Dead River Formation, undivided (Lower Ordovician? and Upper Cambrian?)**—Thinly laminated, "pin-striped" gray, green, or tan metapelite and quartzite
- OCdp — Graded-bedded metapelite—Found in Percy quadrangle of northern New Hampshire
- OCz — **Azizcohos Formation, undivided (Lower Ordovician? and Upper Cambrian?)**—Probably a lower pelitic facies of the Dead River Formation (shown in section only)
- OCzu — Upper unnamed member—Gray metapelite containing sparse siltstone laminations and abundant lenses of vein quartz
- OCzl — Lower unnamed member—Rusty, dark metapelite containing thin coticule laminations, feldspathic metatuff, and vein quartz lenses
- Ch — **Hurricane Mountain Formation (Upper Cambrian?)**—Rusty-weathered, dark siliceous scaly slate or schist having flaser structure and polymictic fragments ranging in size from a few millimeters up to (in Maine) several hundred meters. A mélange consisting of metasedimentary, felsic and mafic metavolcanic, and ultramafic rocks
- Cjp — **Jim Pond Formation (Upper Cambrian)**—Pillow metabasalt member. Lenses within the Hurricane Mountain Formation of northern New Hampshire interpreted as tectonic rafts of Jim Pond Formation

METASEDIMENTARY AND METAVOLCANIC ROCKS OF THE MERRIMACK TROUGH

Merrimack Group[8] **(Silurian? to Ordovician?)**—Includes Berwick, Eliot and Kittery Formations. See also footnote 1

- SOk — **Kittery Formation**—Tan, graded-bedded, calcareous metasandstone and purple and green phyllite. Grades into the Eliot Formation but facing direction is uncertain
- SOe — **Eliot Formation**—Gray to green phyllite, calcareous quartzite, quartz-mica schist, and well-bedded calc-silicate
- SOec — Calef Member—Black phyllite at western contact of the Eliot Formation
- SOb — **Berwick Formation**—Purple biotite-quartz-feldspar granofels or schist and interbeds of calc-silicate granofels and minor metapelites. Stratigraphic sequence with respect to Eliot Formation uncertain
- SObg — Gove Member—White muscovite schist. Equivalent to the Gonic Formation of Hussey (1962)
- SObc — Unnamed member—Contains more calc-silicate (15 percent) than does the remainder of the formation (5 percent)
- OZrz — **Rye Complex**[3] **(Ordovician? to Late Proterozoic?)**—Light-colored to gray schists and gneisses, quartzites, and amphibolites. Variably migmatized and mylonitized. Contact with Kittery Formation on west is the Portsmouth fault
- OZrb — Breakfast Hill Granite of Novotny (1964)[9]—Blastomylonitic quartz-feldspar granitic gneiss and pegmatite intruded the Rye Complex and formed a migmatite
- Zmz — **Massabesic Gneiss Complex**[4] **(Late Proterozoic)**—Quartzose-feldspathic gneiss and biotite schists (locally rusty), granofels, and calc-silicate rocks closely intruded by, and grading into, a pink gneissic granite (623 Ma) that produced a migmatite

EXPLANATION OF MAP SYMBOLS

Contact—Dashed where location is inferred (shown in section only); dotted across large lakes

FAULTS

Normal fault—Ticks on downthrown side. Dotted across large lakes. **Abbreviations:** AF, Ammonoosuc; GF, Grantham; NF, Newbury; MBF, Mesozoic border fault; HHG, Hyland Hill graben; MLG Mine Ledge graben; WHG, West Hill graben

High-angle or strike-slip fault—U on upthrown block and D on downthrown block or arrows where relative direction of movement is known. Commonly silicified or expressed as a topographic lineament. Abbreviations: DRF, Dead Water Ridge; DiPF, Diamond Pond; DPF, Deer Pond; TPF, Thrasher Peaks; BLF, Bill Little; NHF, Northey Hill; PPF, Pine Peak; RRF, Roxbury Road; PF, Pinnacle; SF, Spofford; CHF, Campbell Hill; SLF, Silver Lake; FHF, Flint Hill; MHF, Misery Hill

High-angle thrust fault or shear zone—Filled sawteeth on upper plate. Dashed where location is inferred. Characterized by strong ductile fabric. Abbreviations: PTF, Portsmouth; TBF, Tunnel Brook

Low-angle thrust fault or normal slide—Open sawteeth on upper plate. Dashed where location is inferred. Generally folded. Abbreviations: MF, Mahoosuc; PMF, Plumbago Mountain; TF, Thornton; FHF, Foster Hill; MNF, Monroe; CF, Canterbury; CPF, Chesham Pond; BHF, Brennan Hill

Undifferentiated fault—Dashed where location is inferred (shown in section only)

OTHER FEATURES

Premetamorphic breccia—Angular clasts of varying sedimentary protolith scattered through a matrix of sulfidic black phyllite

Dikes

PLUTONIC ROCK COMPOSITIONS

[Modified from Streckeisen (1973) and Osberg and others (1985)]

From left to right, plutonic labels give the age, formation name (if applicable), composition in a modified Streckeisen system (two or more numbers for a compositional range), characteristic mineralogy, and textures or special features. Volcanic rocks (v) are not classified similarly.

Composition

1 Granite (either alkali- or two-feldspar granite)
2 Granodiorite
3A Tonalite
3B Trondhjemite
4 Quartz syenite (4A and 4B)
4C Quartz monzonite
5 Quartz monzodiorite
6 Quartz diorite
7 Syenite (7A and 7B)
7C Monzonite
8 Monzodiorite
9A Diorite
9B Gabbro
10 Foid-bearing syenite
11 Foid-bearing monzodiorite
12 Foid-bearing gabbro-diorite

Other rocks

u Ultramafic rocks

Characteristic mineralogy

b Biotite (may have minor muscovite)
m Muscovite or muscovite and biotite
h Hornblende or hastingsite (plus biotite)
r Riebeckite (plus hastingsite)

Texture or structure

x Porphyritic or megacrystic
z Migmatized
a Aphanitic or fine-grained
l Leucocratic

Examples

Dc1m Devonian Concord two-mica granite
J9B Jurassic gabbro
Dk2x Devonian Kinsman megacrystic granodiorite

FOOTNOTES

[1]The Early Devonian and Late Silurian age assignments for the Exeter and Newburyport plutons of southeastern New Hampshire are based on work by Bothner and others (1993), which supersedes several previously reported isotopic ages.

[2]For age constraints on Oliverian and Highlandcroft Plutonic Suites, please see list of isotopic ages accompanying the "Plutonic Map Showing Isotopic Age and Fossil Control."

[3]The name Rye Formation is here revised as Rye Complex because the unit consists of granite intruding gneissic and granulose metasedimentary and metavolcanic rock. The Breakfast Hill Granite of Novotny (1964), or the granite at Breakfast Hill (Novotny, 1969), has been included in what had been the "upper metavolcanic member" of the Rye Formation of Novotny (1969). Hussey (1980) first recognized that the "metavolcanic member" was composed of strongly deformed granitic intrusions.

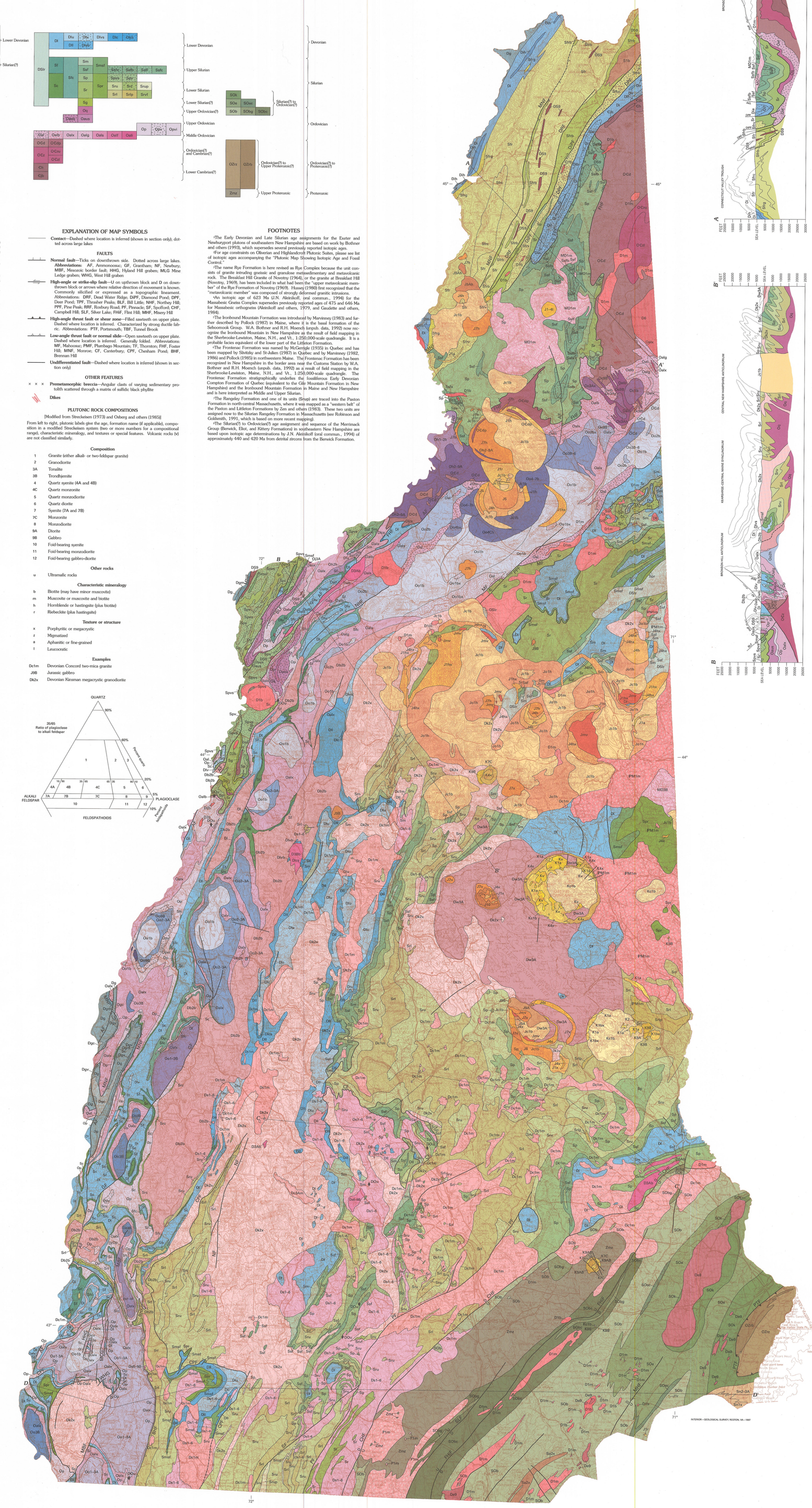
[4]An isotopic age of 623 Ma (J.N. Aleinikoff, oral commun., 1994) for the Massabesic Gneiss Complex supersedes previously reported ages of 475 and 646 Ma for Massabesic orthogneiss (Aleinikoff and others, 1979, and Gaudette and others, 1984).

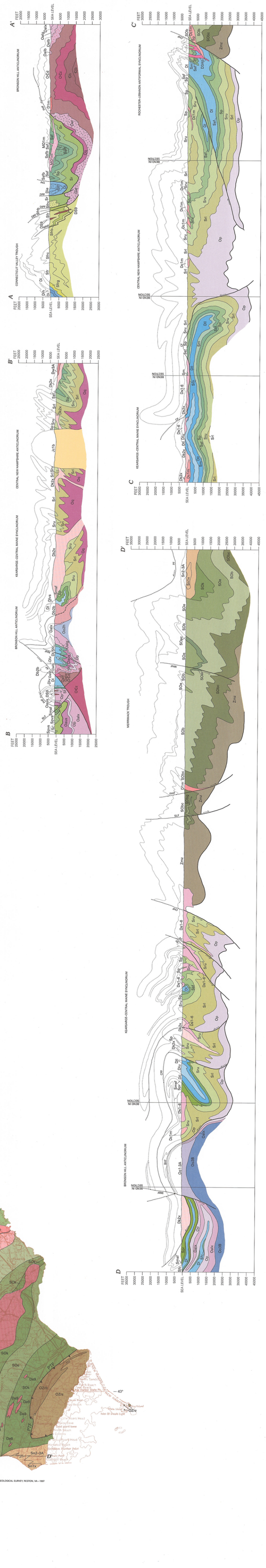
[5]The Ironbound Mountain Formation was introduced by Marvinney (1983) and further described by Pollock (1987) in Maine, where it is the basal formation of the Seboomook Group. W.A. Bothner and R.H. Moench (unpub. data, 1992) now recognize the Ironbound Mountain in New Hampshire as the result of field mapping in the Sherbrooke-Lewiston, Maine, N.H., and Vt., 1:250,000-scale quadrangle. It is a probable facies equivalent of the lower part of the Littleton Formation.

[6]The Frontenac Formation was named by McGerrigle (1935) in Quebec and has been mapped by Slivitzky and St-Julien (1987) in Quebec and by Marvinney (1982, 1986) and Pollock (1985) in northwestern Maine. The Frontenac Formation has been recognized in New Hampshire in the border area near the Customs Station by W.A. Bothner and R.H. Moench (unpub. data, 1992) as a result of field mapping in the Sherbrooke-Lewiston, Maine, N.H., and Vt., 1:250,000-scale quadrangle. The Frontenac Formation stratigraphically underlies the fossiliferous Early Devonian Compton Formation of Quebec (equivalent to the Gile Mountain Formation in New Hampshire) and the Ironbound Mountain Formation in Maine and New Hampshire and is here interpreted as Middle and Upper Silurian.

[7]The Rangeley Formation and one of its units (Srup) are traced into the Paxton Formation in north-central Massachusetts, where it was mapped as a "western belt" of the Paxton and Littleton Formations by Zen and others (1983). These two units are assigned now to the Silurian Rangeley Formation in Massachusetts (see Robinson and Goldsmith, 1991, which is based on more recent mapping).

[8]The Silurian(?) to Ordovician(?) age assignment and sequence of the Merrimack Group (Berwick, Eliot, and Kittery Formations) in southeastern New Hampshire are based upon isotopic age determinations by J.N. Aleinikoff (oral commun., 1994) of approximately 440 and 420 Ma from detrital zircons from the Berwick Formation.





Base from U.S. Geological Survey
Albany, 1956, revised 1974; Boston, 1958, revised 1970; Glens Falls, 1956, revised 1972; Lake Champlain, 1962, revised (United States only) 1972; Lewiston, 1956, revised 1972; Portland, 1956, revised 1972; and Sherbrooke, 1961
Transverse Mercator Projection

SCALE 1:250 000

CONTOUR INTERVALS 50 AND 100 FEET

Geology compiled in 1984-94 from sources shown accompanying the index
Edited by Susan Tufts-Moore and Elizabeth D. Koozmin
Digital cartography by Thomas Falk (Complex Systems Research Center, University of New Hampshire, Durham, N. H.) and D. Paul Mathieux

BEDROCK GEOLOGIC MAP OF NEW HAMPSHIRE

By
John B. Lyons[1], Wallace A. Bothner[2], Robert R. Moench[3], and James B. Thompson, Jr.[4]
1997

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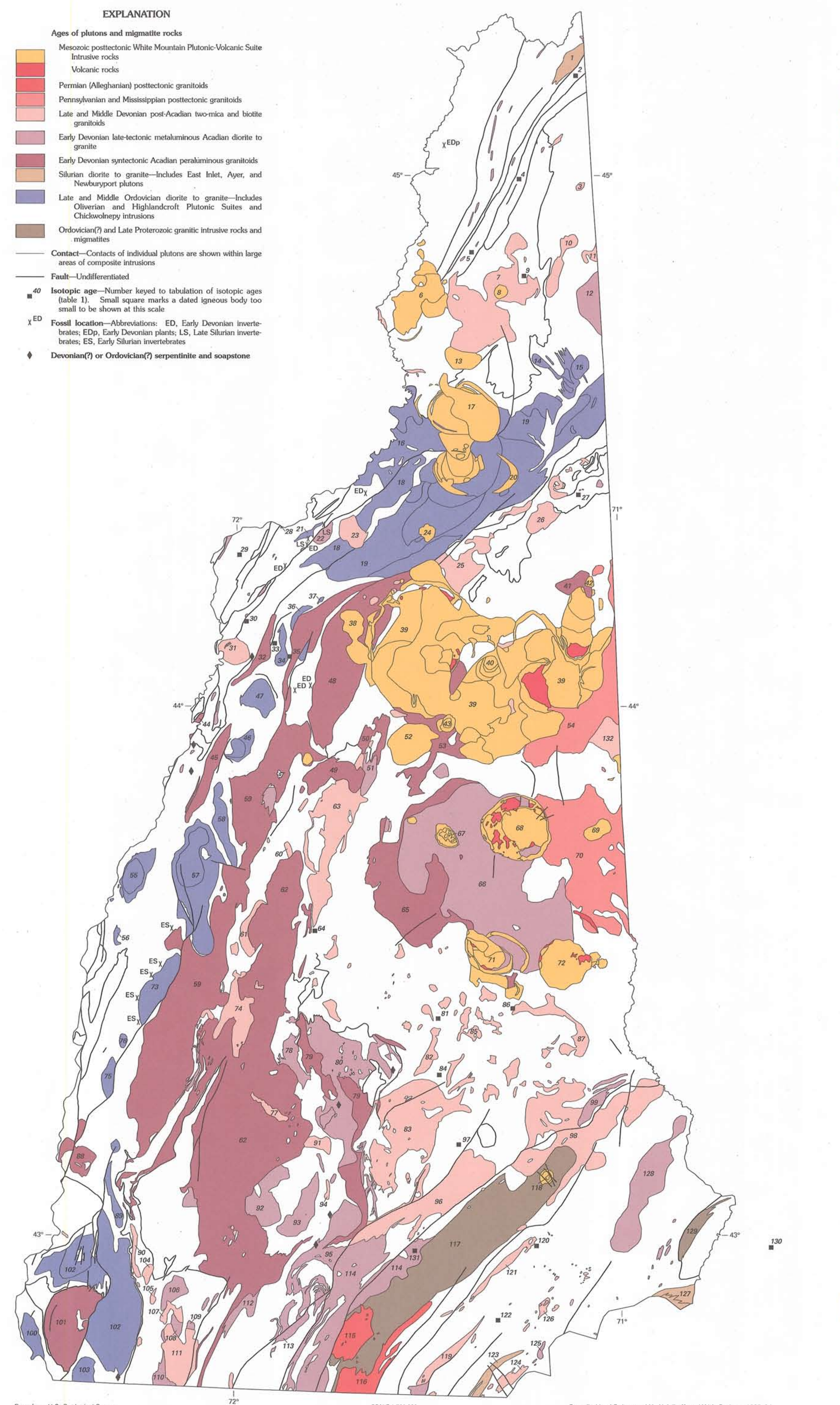
For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225

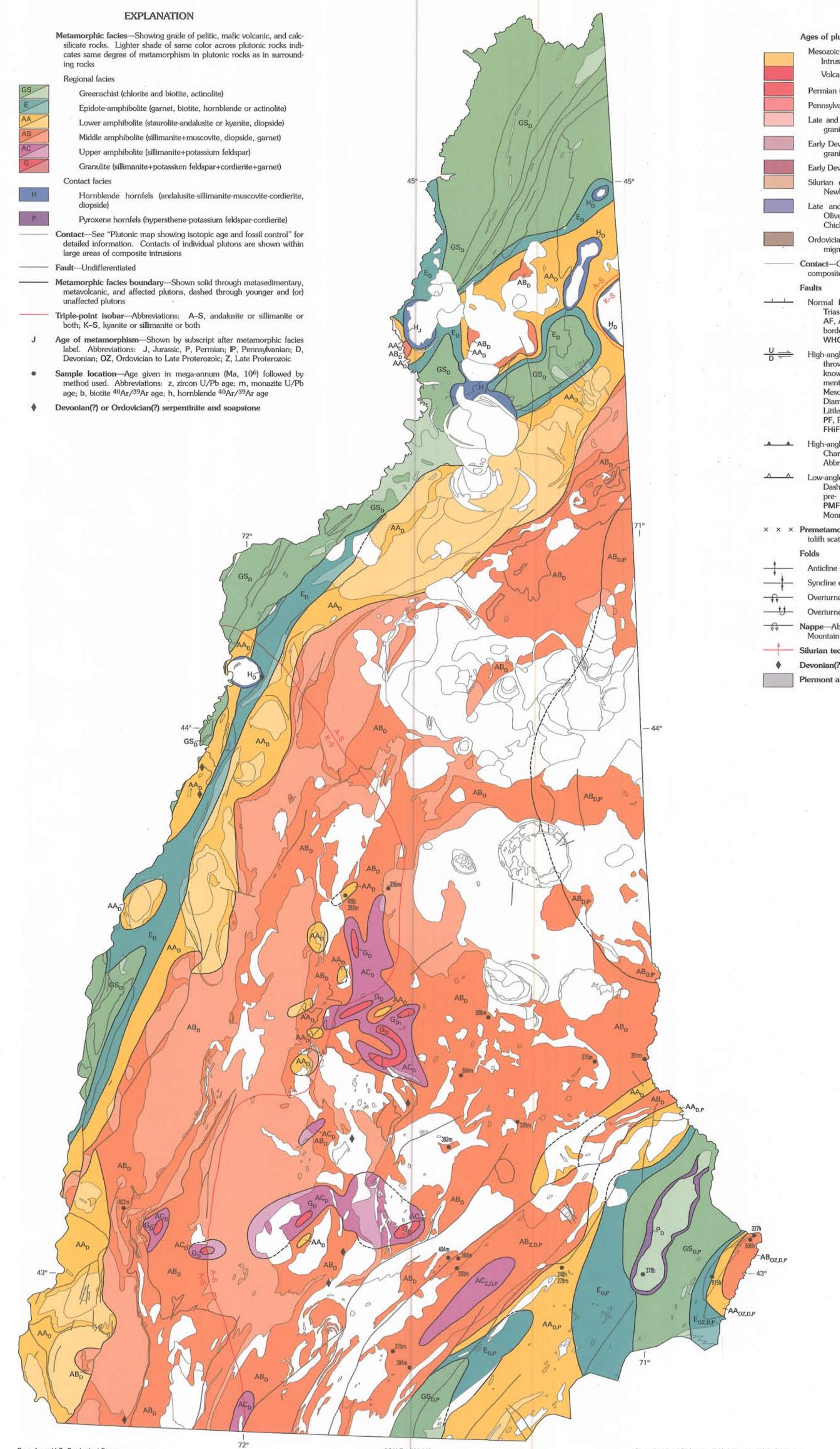


Base from U.S. Geological Survey 1:250,000, 1972
Lambert conformal conic projection based on standard parallels 33° and 45°

SCALE 1:500 000

Compiled by J.B. Lyons, J.N. Aleinikoff, and W.A. Bothner, 1988–94

A, PLUTONIC MAP SHOWING ISOTOPIC AGE AND FOSSIL CONTROL

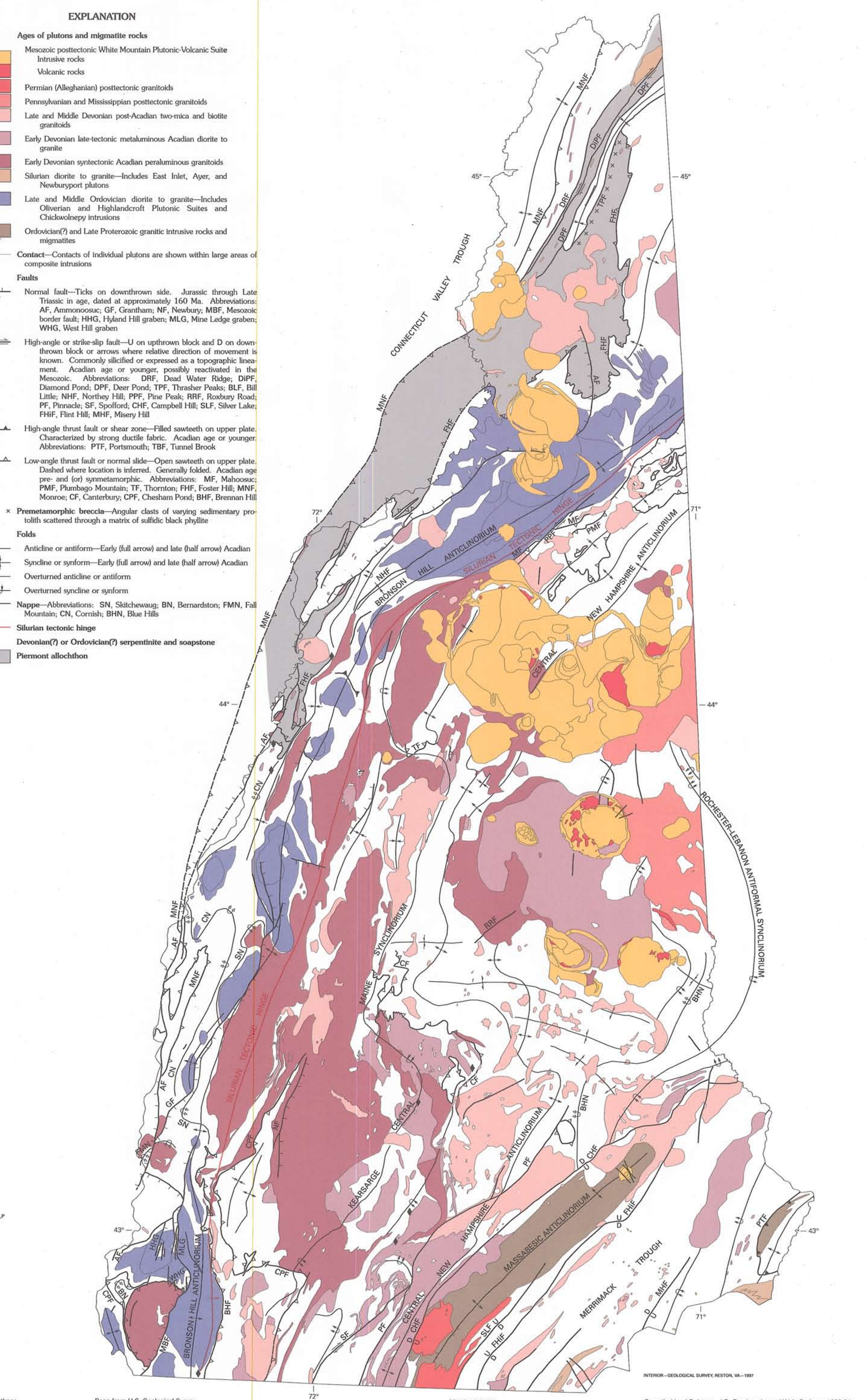


Base from U.S. Geological Survey 1:250,000, 1972
Lambert conformal conic projection based on standard parallels 33° and 45°

SCALE 1:500 000

Compiled by J.B. Lyons, R.H. Moench, W.A. Bothner, C.P. Chamberlain, Douglas Rumble, III, Jo Laird, T.J. Fagan, and J.D. Eusden, Jr., 1988–94

B, METAMORPHIC MAP



INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1997

Base from U.S. Geological Survey 1:250,000, 1972
Lambert conformal conic projection based on standard parallels 33° and 45°

SCALE 1:500 000

Compiled by J.B. Lyons, J.D. Eusden, Jr., and W.A. Bothner, 1988-94

C, GEOLOGIC STRUCTURE MAP

Table 1.—*Isotopic ages: plutons, dikes or sills, and volcanic rocks*

[Numbers are keyed to "Plutonic Map Showing Isotopic Age and Fossil Control." Ages are given in mega-annum (Ma, 10^6). Unless otherwise indicated, uranium-lead (U/Pb) ages are on zircon and are taken as the time of intrusion. U/Pb ages marked below by an asterisk (*) are from a composite discordia of several Oliverian plutons. Monazite U/Pb ages record times at which magmas cooled below approximately 700°C. Rubidium-strontium (Rb/Sr) ages are probable whole-rock emplacement ages, provided magmas initially were homogeneous isotopically. Potassium-argon (K/Ar) and argon-argon (Ar/Ar) ages are on biotite and record times at which magmas cooled below approximately 300°C; for shallowly emplaced plutons, this is slightly less than the age of intrusion]

1. **East Inlet pluton**
   430±4 U/Pb (Lyons and others, 1986; Eisenberg, 1981)
2. **Felsic metatuff of Perry Mountain Formation**
   418±4 U/Pb (Lyons and others, 1983)
3. **Academy pluton**
4. **Felsic metatuff of Frontenac Formation**
   432±10 U/Pb (J.N. Aleinikoff, oral commun., May 3, 1985; Moench and others, 1995)
5. **Felsic dike from possible feeder system for number 2 above**
   418±4 U/Pb (Lyons and others, 1983)
6. **Gore Mountain granitic intrusive rocks of White Mountain Plutonic-Volcanic Suite**
   169±3 K/Ar (Foland and Faul, 1977)
7. **Long Mountain pluton of New Hampshire Plutonic Suite**
   350 (approximate) U/Pb (Harrison and others, 1987)
8. **Owlhead Mountain pluton of White Mountain Plutonic-Volcanic Suite**
9. **Felsic metatuff of the Rangeley Formation (shown on this map as Smalls Falls Formation)**
   432±8 U/Pb (Aleinikoff and Moench, 1987)
10. **Greenough Pond pluton of New Hampshire Plutonic Suite**
11. **Mooselookmeguntic batholith**
    371±6 Rb/Sr (Moench and Zartman, 1976)
12. **Umbagog Granodiorite**
    384±6 U/Pb (Aleinikoff and Moench, 1985)
13. **Percy pluton of White Mountain Plutonic-Volcanic Suite**
    166±4 K/Ar (Foland and Faul, 1977)
14. **Chickwolnepy Complex of Moench and others (1982)**
    467±4 U/Pb (Aleinikoff and Moench, 1992)
15. **Cambridge Black pluton of Chickwolnepy intrusions**
    468±7 U/Pb (J.N. Aleinikoff, oral commun., Feb. 1994)
16. **Lost Nation pluton of Highlandcroft Plutonic Suite**
    439±25 U/Pb (Lyons and others, 1986)
    442±4 U/Pb (J.N. Aleinikoff, oral commun., June 30, 1988)
17. **Pliny Range intrusive rocks of the White Mountain Plutonic-Volcanic Suite**
    182±4 and 189±5 K/Ar (Foland and Faul, 1977)
    183±2 Ar/Ar (Randall and Foland, 1986)
18. **Whitefield Gneiss of Oliverian Plutonic Suite**
    458±8 U/Pb (Zartman and Leo, 1985)
19. **Jefferson dome intrusive rocks of the Oliverian Plutonic Suite**
    441±5 Rb/Sr (Foland and Loiselle, 1981)
    444±8* U/Pb (Zartman and Leo, 1985)
    456±3 U/Pb (Aleinikoff and Moench, 1987)
    454±5 U/Pb (J.N. Aleinikoff, oral commun., Feb. 1994)
20. **Crescent ring dike of the White Mountain Plutonic-Volcanic Suite**
21. **Highlandcroft pluton of the Highlandcroft Plutonic Suite**
    450±5 U/Pb (Lyons and others, 1986)
22. **Remick Tonalite**
23. **Alderbrook pluton**
24. **Cherry Mountain pluton (syenite) of White Mountain Plutonic-Volcanic Suite**
25. **Bretton Woods pluton of New Hampshire Plutonic Suite**
26. **Peabody River pluton of New Hampshire Plutonic Suite**
27. **Shelburne Woods granite dike**
    406(?)±? Rb/Sr (Hayward, 1983)
28. **Joslin Turn pluton (Vt.-N.H.)**
    469±1.5 U/Pb (Aleinikoff and Moench, 1992)
29. **Perry Mountain Formation**
    414±4 U/Pb (tuff bed), 412±2 U/Pb (tuffisite sill), <430 and >410 U/Pb (rhyolite intrusive unit) (J.N. Aleinikoff, oral commun., June 8, 1990)
30. **Ammonoosuc Volcanics, Moosilauke quadrangle, N.H.**
    444±4 U/Pb (J.N. Aleinikoff, oral commun., Oct. 1991)
31. **French Pond Granite**
    365±4 U/Pb (Aleinikoff and Moench, 1987)
32. **Haverhill Granodiorite**
33. **Ammonoosuc Volcanics**
    461±8 U/Pb (J.N. Aleinikoff, oral commun., Feb. 1994)
34. **Moody Ledge Granite of Oliverian Plutonic Suite**
35. **Moody Ledge Granite displaced by Mount Clough pluton**
    435±3 U/Pb (Aleinikoff and Moench, 1987)
    455±? U/Pb (J.N. Aleinikoff, oral commun., June 1994)
36. **Landaff dome intrusive rocks of Oliverian Plutonic Suite**
    444±8* U/Pb (Zartman and Leo, 1985)
    447±4 U/Pb (J.N. Aleinikoff, oral commun., Feb. 1994)
37. **Sugar Hill dome intrusive rocks of Oliverian Plutonic Suite**
    444±8* U/Pb (Zartman and Leo, 1985)
38. **Cannon Mountain pluton of White Mountain Plutonic-Volcanic Suite**
    184±4 K/Ar (Foland and others, 1971)
    194±4 K/Ar (Foland and others, 1977)
39. **White Mountain Plutonic-Volcanic Suite, chiefly Conway Granite, but other lithologies where noted**
    188±5 U/Pb (Tilton and others, 1957)
    177 and 182 Rb/Sr (Tilton and others, 1957)
    180–134 Rb/Sr, biotite (Aldrich and others, 1958)
    173±8 Rb/Sr, biotite (Hurley and others, 1960)
    181±4 K/Ar (Hurley and others, 1960)
    169±3 K/Ar (Foland and others, 1971)
    169±3 and 181±4 K/Ar (Foland and Faul, 1977)
    196, 193, 186, and 175 Rb/Sr, biotite (Eby and Creasy, 1983)
    185 $^{207}Pb/^{206}Pb$ (Eby and Creasy, 1983)
    193±2 Rb/Sr, Carrigain Syenite Porphyry (Eby and others, 1992)
    187±1 Rb/Sr, Mount Osceola Granite (Eby and others, 1992)
    170±3 Rb/Sr, Albany Porphyritic Quartz Syenite (Eby and others, 1992)
    173±2 Rb/Sr, lower part of Moat Volcanics (Eby and others, 1992)
    168±1 Rb/Sr, upper part of Moat Volcanics (Eby and others, 1992)
    201±6 and 193±6 K/Ar, Mount Garfield Porphyritic Quartz Syenite (Eby and others, 1992)
    195±6 K/Ar, Mount Lafayette Granite Porphyry (Eby and others, 1992)
    183±5, 182±4, 180±4, 182±4, 178±4, 171±4, and 155±4 K/Ar (Eby and others, 1992)
    179±5 K/Ar, Albany Porphyritic Quartz Syenite (Eby and others, 1992)
    177±5 K/Ar, riebeckite granite (Eby and others, 1992)
    169±4 and 162±4 K/Ar, trachyte of Moat Volcanics (Eby and others, 1992)
40. **Hart Ledge pluton of White Mountain Plutonic-Volcanic Suite**
    136±6 K/Ar, hornblende (Weston Geophysical Co., *in* Hatch and Moench, 1984)
    168±4 and 163±5 K/Ar, biotite (Eby and others, 1992)
41. **North Baldface pluton of White Mountain Plutonic-Volcanic Suite**
42. **Baldface pluton of White Mountain Plutonic-Volcanic Suite**
    172±4 K/Ar (Foland and Faul, 1977)
43. **Mount Tripyramid intrusive rocks (syenites and some gabbro) of White Mountain Plutonic-Volcanic Suite**
    112±5 K/Ar, hornblende (Weston Geophysical Co., *in* Hatch and Moench, 1984)
44. **Fairlee pluton of New Hampshire Plutonic Suite**
    411±4 U/Pb, zircon and 400±5 U/Pb, monazite (Moench and Aleinikoff, 1987)
45. **Indian Pond pluton of New Hampshire Plutonic Suite**
46. **Baker Pond dome intrusive rocks of Oliverian Plutonic Suite**
47. **Owls Head dome intrusive rocks of Oliverian Plutonic Suite**
    444±8* U/Pb (Zartman and Leo, 1985)
48. **Lincoln pluton of New Hampshire Plutonic Suite**
    <422 and >400 U/Pb, monazite and zircon (J.N. Aleinikoff, oral commun., June 8, 1990)
49. **Rumney pluton of New Hampshire Plutonic Suite**
50. **Thornton pluton of New Hampshire Plutonic Suite**
51. **Campton pluton of New Hampshire Plutonic Suite**
52. **Mad River pluton of White Mountain Plutonic-Volcanic Suite**
    178±5 K/Ar, 158±4 Rb/Sr, biotite (Foland and others, 1971)
53. **Sandwich Mountain pluton of New Hampshire Plutonic Suite**
54. **Sebago batholith**
    325±? Rb/Sr (Hayward and Gaudette, 1984)
    325±3 U/Pb (Aleinikoff and others, 1985)
    298±2 U/Pb (J.N. Aleinikoff, oral commun., Dec. 24, 1992)
55. **Lebanon intrusive rocks of Oliverian Plutonic Suite**
    431±30 Rb/Sr (Naylor, 1969)
56. **Plainfield intrusive rocks of Oliverian Plutonic Suite**
57. **Mascoma Granite of Oliverian Plutonic Suite**
    450±25 U/Pb (Naylor, 1969)
    431±30 Rb/Sr (Naylor, 1969)
58. **Smarts Mountain Granite of Oliverian Plutonic Suite**
59. **Mount Clough pluton of New Hampshire Plutonic Suite**
    410±5 U/Pb (J.N. Aleinikoff, oral commun., Jan. 4, 1989)
60. **Jewell Hill pluton of New Hampshire Plutonic Suite**
61. **Grafton pluton of New Hampshire Plutonic Suite**
62. **Cardigan pluton of New Hampshire Plutonic Suite**
    411±19 Rb/Sr (Lyons and Livingston, 1977)
    413±5 Nd/Sm (Barreiro and Aleinikoff, 1985)
63. **Newfound Lake pluton of New Hampshire Plutonic Suite**
    373 (concordant) U/Pb, monazite (J.N. Aleinikoff, oral commun., Feb. 15, 1984)
64. **Granite pegmatite, Holderness quadrangle**
    393±? U/Pb, monazite (Eusden and Barreiro, 1988)
65. **Meredith Granite of New Hampshire Plutonic Suite**
66. **Winnipesaukee Tonalite of New Hampshire Plutonic Suite**
    392±3 U/Pb (J.N. Aleinikoff, oral commun., Jan. 1995)
67. **Red Hill Syenite of White Mountain Plutonic-Volcanic Suite**
    199±4 K/Ar (Armstrong and Stump, 1971)
    190±4 Rb/Sr, biotite (Foland and Faul, 1977)
    198.5±1.5 K/Ar and 187.3±3 Rb/Sr (Henderson and others, 1989)
68. **Ossipee Mountain Complex of Kingsley (1931)**
    122±2 K/Ar (Foland and Faul, 1977)
69. **Green Mountain pluton of White Mountain Plutonic-Volcanic Suite**
    111±3 K/Ar (Foland and Faul, 1977)
70. **Effingham pluton**
    325±? Rb/Sr (Hayward and Gaudette, 1984)
71. **Belknap intrusive rocks of White Mountain Plutonic-Volcanic Suite**
    159±3 K/Ar (Foland and others, 1971)
    161±5 Rb/Sr and 158±3 K/Ar, biotite (Foland and Faul, 1977)
    169.3±1.7 Rb/Sr (Loiselle and Hart, 1978)
72. **Merrymeeting Lake intrusive rocks of White Mountain Plutonic-Volcanic Suite**
    115±10 Rb/Sr (Foland and others, 1971)
    117±5 K/Ar (Foland and Faul, 1977)
73. **Croydon dome intrusive rocks of Oliverian Plutonic Suite**
74. **Sunapee pluton of New Hampshire Plutonic Suite**
    349±? Rb/Sr (Hayward, 1983)
    366±8 Rb/Sr; recalculation by J.N. Aleinikoff (oral commun., July 20, 1990) of combined Rb/Sr data of Lyons and Livingston (1977) and Hayward (1983)
    364±2 U/Pb (Harrison and others, 1987; J.N. Aleinikoff, oral commun., July 20, 1990)
75. **Unity dome intrusive rocks of Oliverian Plutonic Suite**
76. **Sugar River intrusive rocks of Oliverian Plutonic Suite**
77. **Massasecum pluton of New Hampshire Plutonic Suite**
78. **Kearsarge pluton of New Hampshire Plutonic Suite**
    393±5 Rb/Sr (Lyons and Livingston, 1977)
79. **Weare pluton of New Hampshire Plutonic Suite**
80. **Blackwater pluton of New Hampshire Plutonic Suite**
    398±? U/Pb, monazite (Eusden and Barreiro, 1988)
81. **Granite sill, Gilmanton quadrangle**
    359±? U/Pb, monazite (Eusden and Barreiro, 1988)
82. **Shaker Village pluton of New Hampshire Plutonic Suite**
83. **Concord Granite of New Hampshire Plutonic Suite**
    365±20 U/Pb (J.N. Aleinikoff, oral commun., Mar. 5, 1986)
    375±? U/Pb, monazite from pegmatite in Concord Granite (Eusden and Barreiro, 1988)
84. **Granite sill, Gilmanton quadrangle**
    359±? U/Pb, monazite (Eusden and Barreiro, 1988)
85. **Gilmanton pluton of New Hampshire Plutonic Suite**
86. **Granite sill, Gilmanton quadrangle**
    372±? U/Pb, monazite (Eusden and Barreiro, 1988)
87. **New Durham pluton of New Hampshire Plutonic Suite**
    377±? U/Pb, monazite (Eusden and Barreiro, 1988)
88. **Bellows Falls pluton of New Hampshire Plutonic Suite**
    410–405 U/Pb (T.M. Harrison, quoted by Spear, 1989)
89. **Alstead dome intrusive rocks of Oliverian Plutonic Suite**
90. **Otter Brook pluton of New Hampshire Plutonic Suite**
91. **West Hopkinton pluton of New Hampshire Plutonic Suite**
92. **Antrim pluton of New Hampshire Plutonic Suite**
93. **Deering pluton of New Hampshire Plutonic Suite**
94. **Clinton Grove pluton of New Hampshire Plutonic Suite**
95. **Lyndeborough pluton of New Hampshire Plutonic Suite**
96. **Hooksett pluton of New Hampshire Plutonic Suite**
    402±? Rb/Sr (Hayward, 1983)
    365±20 U/Pb (J.N. Aleinikoff, oral commun., Mar. 5, 1986)
97. **Granite pegmatite, Suncook quadrangle**
    375±? U/Pb, monazite (Eusden and Barreiro, 1988)
98. **Barrington pluton of New Hampshire Plutonic Suite**
    363±? U/Pb, monazite (Eusden and Barreiro, 1988)
99. **Rochester pluton of New Hampshire Plutonic Suite**
100. **Vernon dome intrusive rocks of Oliverian Plutonic Suite**
101. **Ashuelot pluton of New Hampshire Plutonic Suite**
102. **Keene and Surry dome intrusive rocks of Oliverian Plutonic Suite**
     444±8* U/Pb (Zartman and Leo, 1985)
103. **Warwick dome intrusive rocks of Oliverian Plutonic Suite**
     444±8* U/Pb (Zartman and Leo, 1985)
104. **Babbidge Reservoir pluton of New Hampshire Plutonic Suite**
105. **Marlborough pluton of New Hampshire Plutonic Suite**
106. **Spaulding Hill pluton of New Hampshire Plutonic Suite**
107. **Troy Quarry pluton of New Hampshire Plutonic Suite**
108. **Gap Mountain pluton of New Hampshire Plutonic Suite**
109. **Cummings Pond pluton of New Hampshire Plutonic Suite**
110. **Hardwick Tonalite of New Hampshire Plutonic Suite**
111. **Fitzwilliam Granite of New Hampshire Plutonic Suite**
     383±? Rb/Sr (Hayward, 1983, 1987)
112. **Peterborough pluton of New Hampshire Plutonic Suite**
113. **Whitcomb Peak pluton of New Hampshire Plutonic Suite**
114. **Pratt Pond pluton of New Hampshire Plutonic Suite**
     280±6 U/Pb, zircon, 272±2 U/Pb, monazite (J.N. Aleinikoff, oral commun., Dec. 1994)
     365±? U/Pb, zircon, 365±? U/Pb, monazite (J.N. Aleinikoff, oral commun., May 1995)
115. **Granite, Milford quadrangle**
     280±5 U/Pb, monazite, 275±? (approximate) U/Pb, zircon (Aleinikoff and others, 1979)
116. **Hollis pluton**
117. **Massabesic Gneiss Complex**
     620–600 U/Pb, orthogneiss(?) (Besancon and others, 1977)
     646±? U/Pb, paragneiss, 475±? U/Pb, orthogneiss (Aleinikoff and others, 1979)
     641±25 Rb/Sr, paragneiss(?) (Kelly and others, 1980)
     375±? U/Pb, monazite from aplite dike in Campbell Hill fault at western contact of Massabesic Gneiss (Barbara Barreiro, oral commun., 1990)
     384±2 and 275±2 U/Pb, monazite in paragneisses (J.N. Aleinikoff, oral commun., April 1993)
     623±8 U/Pb ion probe, orthogneiss; earlier age of 475 (Aleinikoff and others, 1979) discredited (J.N. Aleinikoff, oral commun., Feb. 1994)
118. **Mount Pawtuckaway intrusive rocks of White Mountain Plutonic-Volcanic Suite**
     122±2 K/Ar (Foland and others, 1971)
     128±2 Rb/Sr, biotite (Eby, 1985)
119. **Hudson pluton of New Hampshire Plutonic Suite**
120. **Onway tholeiite dike**
     177 K/Ar, whole rock (Sundeen and Huff, 1991)
121. **Scobie Pond pluton of New Hampshire Plutonic Suite**
122. **Biotite granite dike**
     381±2 U/Pb (J.B. Lyons, J.N. Aleinikoff, and R.E. Zartman, this map)
123. **Ayer Granodiorite**
     433±5 U/Pb (Zartman and Naylor, 1984)
124. **Chelmsford Granite of New Hampshire Plutonic Suite**
125. **Sweepstakes pluton**
126. **Island Pond pluton**
127. **Newburyport Complex**
     450±15 U/Pb (Zartman and Naylor, 1984)
     418±1 U/Pb (W.A. Bothner and S.A. Bowring, oral commun., Feb. 1994)
128. **Exeter Diorite**
     473±37 Rb/Sr (Gaudette and others, 1984)
     406±1 U/Pb (Bothner and others, 1993; oral commun., Feb. 1994)
129. **Breakfast Hill pluton**
130. **Appledore pluton**
     472±10 Rb/Sr (Henri Gaudette, written commun., 1996)
131. **Quartz syenite dike**
     159 K/Ar (Aleinikoff, 1978)
132. **Dundee Hill pluton**

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SOURCES OF MAP DATA

This map exists largely because of the early efforts of Robert I. Davis and Lincoln R. Page, each of whom was a former state geologist of New Hampshire from 1979 to 1984 and from 1984 to 1986, respectively. The final preparation of the map was made possible by the following contributions, which are given by 15-minute quadrangle, and listed from north to south.

INDIAN STREAM
W.A. Bothner and C.E. Jahrling (unpub. mapping, 1981–83)
Moench and others (1995)

SECOND CONNECTICUT LAKE
Green (1968)
Moench and others (1995)

AVERILL
Chapman (1954)
Myers (1964)
Swift (1966)
W.A. Bothner (unpub. mapping, 1981–84)
Moench and others (1995)

DIXVILLE
Hatch (1963)
Moench and others (1995)

ERROL
Green (1968)
Moench and others (1995)

GUILDHALL
Chapman (1948)
Johansson (1983)
Moench and others (1995)

PERCY
Chapman (1935, 1948)
Moench and others (1995)

MILAN
Milton (1968)
Pyke (1985)
Moench and Pankiwskyj (1988)
Moench and others (1995)

LITTLETON
Billings (1937)
Eric and Dennis (1958)
M.P. Dickenson (unpub. mapping, 1983)
Moench and others (1987)
Moench and others (1995)

WHITEFIELD
R.H. Arndt (unpub. mapping, 1955–59)
Boucot and Arndt (1960)
Hatch and Moench (1984)
R.H. Moench and A.R. Pyke (unpub. mapping, 1985–91)
Moench and others (1995)

MT. WASHINGTON
Billings (1941)
Billings and others (1946)
Czamanske and others (1977)
Hatch and Moench (1984)
Moench and others (1995)

GORHAM
Billings and Fowler-Billings (1975)
Hatch and Moench (1984)
Timothy Allen (unpub. mapping, 1990–91)
Moench and others (1995)

WOODSVILLE
White and Billings (1951)
Hafner-Douglass (1986)
Moench and others (1987)
Moench and others (1995)

MOOSILAUKE
Billings (1935, 1937)
Hatch and Moench (1984)
Moench and others (1987)
Moench and others (1995)

FRANCONIA
Williams and Billings (1938)
Creasy (1974)
Hatch and Moench (1984)
Moench and others (1995)

CRAWFORD NOTCH
Henderson and others (1977)
Hatch and Moench (1984)
Moench and others (1995)

NORTH CONWAY
Billings (1928)
Osberg and others (1978)
Hatch and Moench (1984)
Moench and others (1995)

MT. CUBE
Hadley (1942, 1950)
Rumble (1969)
Moench and others (1987)
R.H. Moench (unpub. mapping, 1988–91)

RUMNEY
Page (1940)
Malinconico (1982)

PLYMOUTH
Moke (1946)
Hatch and Moench (1984)
J.B. Lyons (unpub. mapping, 1988–90)

MT. CHOCORUA
Smith and others (1939)
J.B. Lyons and D.S. Albaugh (unpub. mapping, 1979–80)
Carr (1980)
Hatch and Moench (1984)

OSSIPEE LAKE
Wilson (1969)
J.B. Lyons and D.S. Albaugh (unpub. mapping, 1979–80)
Carr (1980)

HANOVER
Lyons (1955)

MASCOMA
Chapman (1939)
Thompson and others (1968)
Thompson and others (1990)

CARDIGAN
Fowler-Lunn and Kingsley (1937)
Bullen (1977)
J.B. Lyons (unpub. mapping, 1985–89)

HOLDERNESS
Englund (1976)
J.B. Lyons (unpub. mapping, 1981–89)

WINNIPESAUKEE
Quinn (1941)
J.B. Lyons and D.S. Albaugh (unpub. mapping, 1979–80)
Carr (1980)

WOLFEBORO
Quinn (1953)
J.B. Lyons and D.S. Albaugh (unpub. mapping, 1979–80)
Carr (1980)

CLAREMONT
J.B. Thompson, Jr. (unpub. mapping, 1950-1989)
Thompson and others (1968)
Thompson and others (1990)

SUNAPEE
Chapman (1952)
Thompson and others (1968)
Dean (1976)

MT. KEARSARGE
Lyons (1988)
J.B. Lyons (unpub. mapping, 1971–89)

PENACOOK
Lyons (1988)
J.B. Lyons (unpub. mapping, 1975–89)

GILMANTON
Heald (1955)
Eusden (1988a,b)

ALTON
Stewart (1961)
Eusden and others (1987)

BERWICK
Eusden and others (1984)

BELLOWS FALLS
Kruger (1946)
Thompson and others (1968)
Chamberlain (1985)
Thompson and others (1990)

LOVEWELL MOUNTAIN
Heald (1950)
Thompson and others (1968)
Dean (1976)
Chamberlain (1985)
Thompson and others (1990)

HILLSBORO
Nielson (1981)
C.L. Hanson and J.B. Lyons (unpub. mapping, 1985)

CONCORD
Vernon (1971)
Duke (1984)
J.B. Lyons (unpub. mapping, 1986–87)

SUNCOOK
Carnein (1976)
B.K. Pogorzelski (unpub. mapping, 1982)
Eusden and others (1987)

MT. PAWTUCKAWAY
Freedman (1950)
Eusden and others (1987)
Bothner (*in* Lyons and Bothner, 1989)

DOVER
Novotny (1969)
Eusden and others (1987)
Bothner (*in* Lyons and Bothner, 1989)

KEENE
Moore (1949)
Thompson and others (1968)
J.B. Thompson, Jr. (unpub. mapping, 1984–89)
Thompson and others (1990)

MONADNOCK
Fowler-Billings (1949)
Thompson and others (1968)
Thompson (1985)

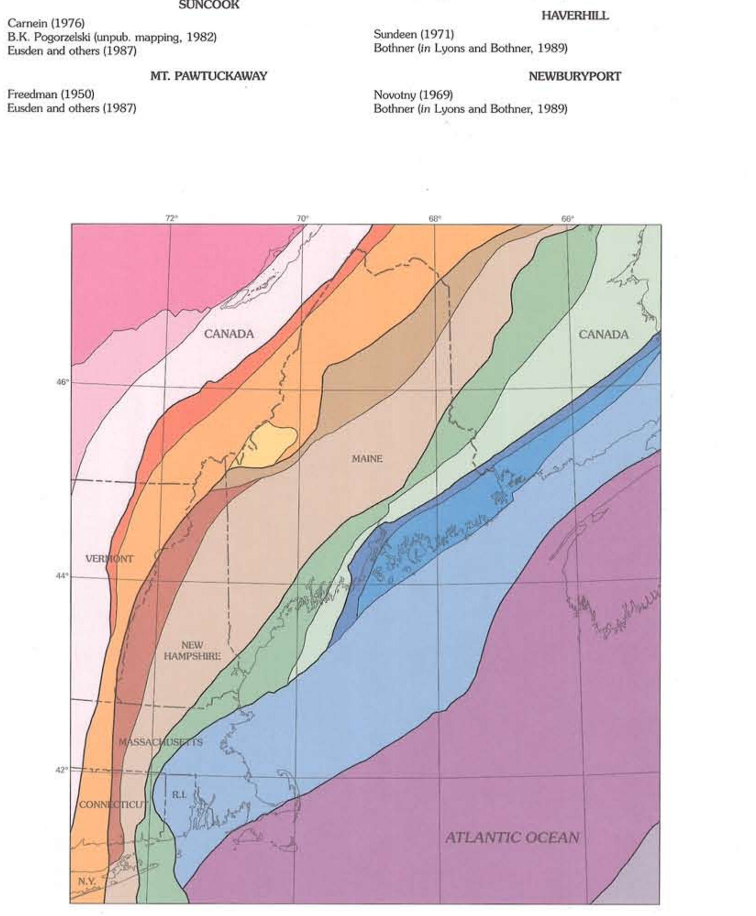
PETERBOROUGH
Greene (1970)
Duke (1984)

MILFORD
Aleinikoff (1978)

MANCHESTER
Sriramadas (1966)
Bothner (*in* Lyons and Bothner, 1989)

HAVERHILL
Sundeen (1971)
Bothner (*in* Lyons and Bothner, 1989)

NEWBURYPORT
Novotny (1969)
Bothner (*in* Lyons and Bothner, 1989)



EXPLANATION

North American craton
- Grenville basement
- Platform sediments
- External and internal nappes

Boundary Mountains composite terrane
- Vermont-Quebec ophiolite and olistostrome belt
- Connecticut Valley trough
- Chain Lakes block

Central Main composite terrane
- Bronson Hill mantled gneiss domes (including Bronson Hill anticlinorium
- Hurricane Mountain ophiolite and olistostrome belt
- Central Maine trough (including Kearsarge-central Maine synclinorium, central New Hampshire anticlinorium, and Rochester-Lebanon (Maine) antiformal synclinorium)

Nashoba-Casco-Miramichi composite terrane
- Merrimack-Orrington belt
- Fredericton trough

Avalon composite terrane
- Saint Croix belt
- Ellsworth belt
- Esmond-Dedham belt

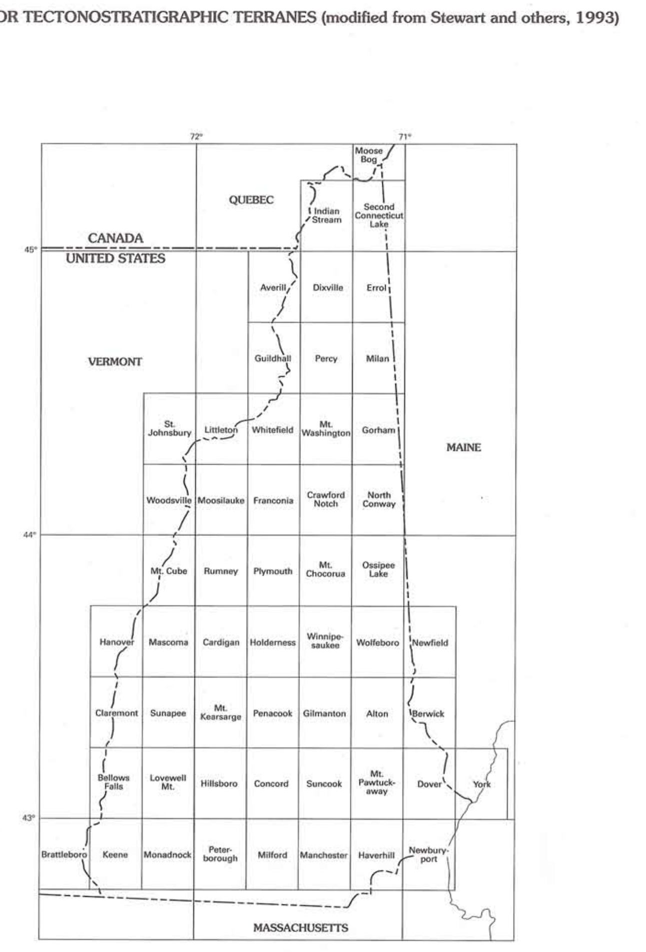
Meguma terrane

Atlantic Ocean crust

Boundary of major tectonostratigraphic terrane

Internal subdivision of major tectonostratigraphic terrane

D, MAJOR TECTONOSTRATIGRAPHIC TERRANES (modified from Stewart and others, 1993)



INDEX TO 15-MINUTE QUADRANGLES

BEDROCK GEOLOGIC MAP OF NEW HAMPSHIRE

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1997

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