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GEOLOGIC MAP OF WESTERN INTERIOR MAINE

By

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature

DESCRIPTION OF MAP UNITS

PLUTONIC ROCKS

Petrographic nomenclature in accord with Streckeisen (1973)

MESOZOIC--Rocks probably related to White Mountain Plutonic-Volcanic Suite of Cretaceous to Triassic age

Mzb Alkali-olivine basalt and associated basaltic breccia in plug at west edge of Old Speck Mountain quadrangle

Mzm Alkali gabbro and syenite at Androscoggin Lake in the Livermore Falls quadrangle

DEVONIAN--Rocks principally of New Hampshire Plutonic Suite of Devonian age, but includes petrologically unrelated varieties. Age relationships not completely known, but felsic rocks typically intrude more mafic varieties

Dghb Biotite- and hornblende-biotite granite and granodiorite--Predominant rock of the Hartland pluton, which grades unsystematically from dark granodiorite to lighter colored quartz monzonite and biotite granite; commonly has phenocrysts of plagioclase near border. Scarce thin dikes of pegmatite and aplite exposed near western margin. Contains accessory garnet and accessory muscovite near margins. Isotopically dated 360±8 m.y. (Dallmeyer and others, 1982; Rb/Sr whole rock)

Dp Pegmatitic granite, pegmatite, and aplite--Largest body shown is subhorizontal sheet that caps Whitecap Mountain, in the Rumford quadrangle. Also forms innumerable small dikes, concordant lenses, and locally extensive subhorizontal discordant sheets that intrude two-mica and older plutonic and metamorphic rocks; rarely more than 15 m thick. Most are mineralogically simple bodies of quartz, albite, microcline, micas, scattered black tourmaline, and sparse pink garnet, but several contain beryl and a few are famous rare-mineral localities, as at Newry Mines and Black Mountain in the Rumford quadrangle (Moench and Hildreth, 1976). Most abundant in sillimanite zone. Associated with most plutons of tonalitic to granitic composition but predominantly is late differentiate of two-mica granite. Forms scarce thin dikes in Bald Mountain pluton and near western margin of Hartland pluton; not reported in Russell Mountain pluton

Dqgt Biotite- and hornblende-biotite quartz diorite to granodiorite and two-mica granite--Foliated rocks of unit Dqg intruded by subequal amounts of unfoliated two-mica granite of unit Dgt

Dgt Two-mica granite--Predominantly pale gray, fine to medium grained, equigranular, massive or weakly foliated; locally contains two-mica granodiorite or muscovite granite, and commonly intruded by pegmatite and aplite. Variably contains accessory garnet, tourmaline, sillimanite, magnetite, zircon, and apatite. Two-mica granite of Mooselookmeguntic batholith isotopically dated 379±6 m.y. (Moench and Zartman, 1976; Rb/Sr whole-rock)

Dgb Biotite granite--Predominant rock of north lobe of the Lexington batholith. Light colored, coarse grained, equigranular;

subporphyritic in northwest part of lobe. Contains accessory magnetite, apatite, zircon, and tourmaline, and secondary muscovite

Dgbp — Porphyritic biotite granite--Exposed in the southern part of the Lexington batholith, the igneous complex at Flagstaff Lake, and at the southwest corner of the Mooselookmeguntic batholith. In Mooselookmeguntic body, it contains 20-40 percent of tabular phenocrysts of microcline about 1.5 to 3 cm long set in a weakly foliated medium-grained, inequigranular, granodioritic matrix; commonly displays primary flow alinement. In Flagstaff body, it contains 5-15 percent of tabular phenocrysts of alkali feldspar about 1.5 to 3 cm long set in a massive medium- to coarse-grained granitic or granodioritc matrix. In Lexington body, the rock is mainly biotite granite porphyry containing upwards of 20 percent of tabular phenocrysts of alkali feldspar that range in length from 2 to 13 cm; matrix is fine to medium grained and tonalitic. Though predominantly granite, the Lexington body grades to quartz syenite and local syenite where the phenocrysts become strongly alined and closely packed

Dtog — Garnetiferous biotite tonalite--Small bodies in northeast corner of Rumford quadrangle; intrude two-mica granodiorite, cut by two-mica granite. Rust spotted gray medium grained and massive, but deformed. Skeletal partial pseudomorphs of almandine garnet comprise about 15 percent of the rock; 2-10 mm across, variably corroded by intergrown biotite, pale-gray chlorite, plagioclase, and quartz, or by chlorite and biotite, rarely with intergrown anthophyllite. Subequigranular matrix contains about 30 percent quartz, 20 percent magnesium-rich biotite, 50 percent normally zoned oligoclase-andesine, and accessory apatite and zircon. The rusty spots are weathered 1 cm nodules of intergrown pyrrhotite and pentlandite

Dgdt — Two-mica granodiorite--Predominant rock of Phillips pluton and small bodies to the west, and in parts of Redington pluton. Similar to two-mica granite (Dgt), but slightly darker gray and contains less microcline relative to plagioclase and somewhat more biotite; locally grades to tonalite, has inclusions of unit Dqg, and is commonly intruded by two-mica granite and pegmatite. Common accessory minerals are magnetite, garnet, apatite, zircon, and tourmaline

Dtp — Porphyritic two-mica granodiorite--Predominant rock of the Redington pluton, but grades to granite. Gray medium grained massive to weakly foliated; contains as much a 20 percent tabular phenocrysts of microcline 1.5-3 cm long, commonly alined subparallel to contacts. Rock grades to unit Dgdt in eastern part of pluton. Common accessory minerals are magnetite, apatite, zircon, and scattered garnet

Dgd — Biotite granodiorite--Predominant rock of the Bald Mountain and Russell Mountain plutons in the Kingsbury quadrangle (Espenshade and Boudette, 1967; Ludman, 1978). In Russel Mountain body, rock is gray, medium to coarse grained, becoming finer grained near borders; contains secondary sericite. Rocks of the Bald Mountain pluton are similar but somewhat more diverse; locally have phenocrysts of plagioclase as long as 4 cm

Dqg Biotite- and hornblende-biotite quartz diorite to granodiorite--Widely exposed in the southern part of the Mooselookmeguntic batholith, northern part of the Sebago batholith (Songo granodiorite of Fisher, 1962; Guidotti, 1965), Rumford pluton, and locally as inclusions in the southern part of the Phillips pluton. Also comprises innumerable irregular dikes and pods of dark fine-grained to dense, commonly metamorphically foliated quartz diorite in the southern part of the Rumford quadrangle and adjacent areas. In Sebago and most of Mooselookmeguntic bodies, rock is medium to dark gray, medium grained, and commonly well foliated subparallel to discordant contacts; variably fine grained in southeastern Mooselookmeguntic body and Rumford pluton. Average composition probably quartz monzodiorite, but ranges from quartz diorite through quartz monzodiorite and tonalite to granodiorite. Magnetite, sphene, allanite, and apatite are conspicuous accessory minerals; pyrite and zircon commonly seen; epidote a common alteration mineral

Dqma Augite-bearing hornblende-biotite quartz diorite and quartz monzodiorite--Predominant rock of the Umbagog pluton (Umbagog Granodiorite of Green, 1964; Guidotti, 1977; Milton, 1961). Previously thought to be Ordovidian(?) in age, on the basis of lead-alpha determinations (Green and Guidotti, 1968), but now known to be Devonian on the basis of isotopic age of about 382 m.y. (J. N. Aleinikoff, oral commun., 1982; lead-uranium zircon). Slightly more mafic than most of unit Dqg, but otherwise similar. Typically dark, massive to moderately foliated, medium-grained and rather variably textured. Contains as much as 10 percent augite, local hypersthene, accessory magnetite, sphene, apatite, and allanite

Dgf Garnet granofels--Exposed in southwest part of igneous complex at Flagstaff Lake. Variably medium to coarse grained and massive; contains 5-60 percent almandine garnet, as much as 50 percent andesine, and smaller amounts of biotite and quartz; commonly contains hypersthene, and amphibole or cordierite (abundant in garnet-poor rocks). Thought to have formed by anatexis and assimilation of Quimby and Greenvale Cove Formations by gabbro (Boudette, 1979; O'Connor, 1981)

Dm Mafic rocks--Two-pyroxene gabbro, augite gabbro, anorthositic gabbro, norite, troctolite, epidiorite, and sparse layers of ultramafic rocks. Pyroxenes (augite and hypersthene) variably recrystallized to complexly intergrown brown hornblende, actinolite, and cummingtonite(?); nowhere preserved south of Rangeley Lake. Mafic rocks of the Plumbago and Sugarloaf plutons, the South Bog dike, and at least the south edge of the igneous complex at Flagstaff Lake show evidence of primary cumulate layering, which is generally not parallel to the margins of the bodies. Other bodies are more homogeneous, though texturally variable from coarse grained to diabasic. Small bodies shown near the Mahoosuc fault in the Old Speck Mountain quadrangle are massive to foliated biotite-bearing hornblende-plagioclase amphibolite, interpreted as metamorphosed gabbro

Dd Dioritic rocks--Diorite, quartz diorite, monzodiorite, and epidiorite exposed in parts of the igneous complex at Flagstaff Lake (Boone, 1973) and associated with granite in small body south of Little Bigelow Mountain. In the Little Bigelow Mountain quadrangle, rock is medium grained, seriate, and weakly porphyritic with sparse phenocrysts of plagioclase; contains about 50 percent plagioclase, 0-20 percent quartz, trace to 15 percent hypersthene, 15-35 percent amphibole, and about 10 percent biotite. In the Kennebago Lake quadrangle, mafic epidiorite (possibly originally gabbro) lies between gabbro and garnet granofels; in the epidiorite, plagioclase is typicallly more sodic and pyroxene more completely recrystallized than in gabbro

Dtr Trondhjemite--Single known small body on Plumbago Mountain fault at southwest corner of Rumford quadrangle. Light gray, fine or medium grained, equigranular; composed of about 25 percent quartz, 60 percent oligoclase, 5-10 percent biotite, minor muscovite, sparse microcline, and accessory zircon, apatite, and magnetite. Conspicuous primary foliation is defined by subparallel biotite and plagioclase

ORDOVICIAN--Includes rocks of the Highlandcroft and Oliverian Plutonic Suites formerly designated Highlandcroft and Oliverian Plutonic Series, which are not distinguished on this map

Og Granite and minor granodiorite--Predominantly granite, but includes rocks of granodioritic composition in the Old Speck Mountain quadrangle. All have a conspicuous metamorphic foliation; metamorphic isograds cross the Adamstown pluton (Adamstown Granite of Guidotti, 1977). Granite of Adamstown pluton and small body to the east is characterized by pink or white deformed megacrysts of microcline 1-2 cm long in a matrix of granulated quartz, feldspar, and phyllosilicates; contains accessory zircon, and sparse accessory molybdenite and scheelite (John N. Aleinikoff, oral commun., 1981). In greenschist facies the granite is composed of quartz, albite, microcline, and ragged muscovite and biotite; in sillimanite zone the plagioclase is oligoclase, and the phyllosilicates are well crystallized muscovite and biotite. Granite and granodiorite in the Old Speck Mountain quadrangle contain biotite and muscovite, probably metamorphic, and accessory zircon, apatite, magnetite, local garnet, and sparse fluorite (Milton, 1961)

STRATIFIED METAMORPHIC ROCKS

As shown by the metamorphic isograds, the northeastern part of the map area is mainly a greenschist facies terrane, and the southwestern part is an amphibolite facies terrane. In the greenschist terrane, individual plutons have well-defined metamorphic aureoles (not shown). Accordingly, original volcanic and sedimentary rocks have been converted variously to slate, phyllite, schist, hornfels, granofels, and migmatitic gneiss. In the staurolite and sillimanite zones, evidence for two and locally three deformations is recognized (Moench and Zartman, 1976). Despite this complex secondary history, only in the areas of migmatitic gneiss is bedding obliterated; in most areas fine details of sedimentary features are preserved and the primary character of the rock is self-evident. Thus, for simplicity and to convey the original stratigraphic character of the rocks, they are described mainly in terms of protolith compositions as metamorphosed shale, sandstone, wacke, conglomerate, and so forth

As shown on the correlation of map units and on the schematic section, the stratified rocks are divided into a thick western succession, and a much thinner and more restricted eastern succession. The boundary trends northeast and is very approximate. The eastern section lies generally southeast of the Piper Pond syncline and Strickland Hill anticline, and beneath the Rumford allochthon southeast of the Phillips Batholith and the Lovejoy Mountain anticline. Rocks of the eastern succession are exposed in windows through the southeastern side of the Rumford allochthon, which itself is composed of rocks of the western succession. The line approximately coincides with a facies transition expressed by changes within the Madrid and Smalls Falls Formations, and by differences between the Perry Mountain and Sangerville Formations, which are interpreted to be approximately coeval

This map presents a simplified stratigraphic nomenclature for the region. Definitions of new stratigraphic names, redefinition of established names, and revision of age assignments are discussed in the outline of stratigraphic nomenclature

Western succession

Ds SEBOOMOOK FORMATION (LOWER DEVONIAN)--Typically composed of metamorphosed cyclically interbedded lead-gray aluminous shale and pale-gray to white-weathering siltstone or sandstone; locally somewhat rusty weathering. In most outcrops each bed of sandstone or siltstone is paired with a shale bed to form a single-graded sedimentation unit; upward gradation is continous from the sharp lower contact of the light-colored sandstone or siltstone, through the dark shale, to the sharp lower contact of the next overlying sandstone bed. Although zones of ungraded sharply interbedded sandstone and shale may be found, the hallmark of the Seboomook is the cyclicity of graded sedimentation units. Sandstones and siltstones may be featureless, except for grading, or delicately cross laminated; locally they are spectacularly convolute laminated and slump deformed. The graded sedimentation units range in thickness from about 2 cm to as much as 1.5 m. The Seboomook is at least 700 m thick in the Little Bigelow Mountain quadrangle; divisible here into a relatively pelitic and thinly bedded lower member and a more arenaceous thicker bedded upper member (not shown). May be more than 2,000 m thick in the Rumford allochthon where the Seboomook is divided into the Day Mountain, Temple Stream, and Mount Blue Members, which in aggregate coarsen upward and southeastward. In the Little Bigelow Mountain quadrangle, the lower contact is interpreted to vary from an angular unconformity to a disconformity against the underlying Hildreths and Carrabassett Formations. Farther south the contact is interpreted to be conformable and varies from sharp to abruptly gradational within a few meters

Dsd Day Mountain Member--Mapped in the southeastern half of the Rumford allochthon. In the western and southwestern parts of its outcrop belt the member is composed of about equal amounts of metamorphosed gray, slightly rusty-weathering shale and quartzose lithic wacke, typically as cyclically repeated graded sedimentation units. In the southeastern part of the belt thick beds of wacke comprise about 80 percent of the member. At least 1,000 m thick

Dsdl Limestone of the Day Mountain Member--Lenses as much as 250 m thick, typically of metamorphosed thinly interbedded arenaceous limestone and calcareous siltstone, and subordinate thin beds and laminations of gray shale; locally contains thickly bedded massive calcareous siltstone and rusty-weathering sulfidic sandstone interbedded with minor shale

Dsdc Conglomerate of Day Mountain Member--Lenses as much as 350 m thick having abundant thick graded beds of granule conglomerate associated with cyclically graded bedded rocks of the member. Coarse sand and granules (maximum diameters about 5 mm) include 60-70 percent quartz, and as much as 35 percent plagioclase, alkali feldspar, and rock fragments; matrix has same composition

Dst Temple Stream Member--About 250 m of sulfidic, rusty-weathering, dark carbonaceous metamorphosed wacke, siltstone, and shale. Granule conglomerate similar to that of unit Dsdc is common near the upper contact; calcareous siltstone or wacke common throughout

Dsm Mount Blue Member--Mapped only in the Dixfield, Phillips, and Kingfield quadrangles, but equivalent to rocks assigned to the Seboomook Formation in the Rumford quadrangle. Approximately 500-750 m of thinly interbedded metamorphosed gray shale and somewhat subordinate paler siltstone or wacke, typically as cyclically repeated graded sedimentation units that range from 2 cm to 5 cm in thickness; thick beds of massive gray shale may be found. Lower part locally rusty weathering

Dl LITTLETON FORMATION (LOWER DEVONIAN)--Mapped in the Bethel and Old Speck Mountain quadrangles and west-adjacent areas; considered broadly equivalent to the Carrabassett Formation, but may include the Hildreths and Seboomook Formations, which have not been identified conclusively in this area. Composed mainly of metamorphosed shale interbedded with minor to abundant siltstone and wacke; widely converted to migmatitic gneiss, but where bedding is preserved it is identical to characteristic features of the Carrabassett Formation

Dh HILDRETHS FORMATION (LOWER DEVONIAN)--Heterogeneously interbedded strongly metamorphosed calcareous quartz-poor lithic wacke, calcareous siltstone and shale, pure white limestone (marble), noncalcareous sulfidic shale, and weakly calcareous wacke, which possibly has a large volcaniclastic component. The wacke forms graded beds as much as 2 m thick; typically, dark, massive, and composed of subequal amounts of oligoclase or andesine and quartz, 10-20 percent biotite, and scattered garnet; pods and lenses of calc-silicate rock common. Member is typically about 100 m thick. Though shown only where positively identified in the migmatitic gneisses of the Rumford quadrangle, it is interpreted here to have been deposited as a continuous sheet. About 300 m thick on the south side of Bigelow Mountain in the Stratton quadrangle; composed here of strikingly banded calc-silicate rock. The lower contact is conformable and gradational within a few meters to thin- or medium-bedded wacke and shale of the Carrabassett Formation

Dhs Sulfidic shale member--Mapped in the upper part of the Hildreths Formation in parts of the Dixfield and Little Bigelow Mountain quadrangles, where locally it is the predominant lithology of the Hildreths. Composed mainly of metamorphosed pyritic or pyrrhotitic, variably graphitic shale thinly interbedded with subordinate wacke

Dsh SEBOOMOOK AND HILDRETHS FORMATIONS--Undivided in areas of migmatitic gneiss in the Rumford quadrangle. Here the Hildreths Formation is preserved only as blocks of banded calc-silicate rock in a matrix of coarsely crystallized, commonly rusty-weathering migmatitic sillimanitic two-mica gneiss. The contact between gneissic Dsh and DScm units can be mapped only approximately ; it is placed where rusty-weathering gneiss with locally abundant blocks of calc-silicate rock changes to nonrusty gray massive gneiss of pelitic composition assigned to the Carrabassett Formation

Dc CARRABASSETT FORMATION (LOWER DEVONIAN)--In the type area in the Little Bigelow Mountain quadrangle, separable into a thinly layered gray shale and white sandstone upper member about 250 m thick and a lower member about 1,100 m thick containing abundant massive gray shale (not distinguished). Upper member is composed of subequal amounts of metamorphosed medium- or pale-gray shale and quartz-rich sandstone or wacke, and sparse lenses of calcareous micaceous quartzite. Bedding is commonly transposed and relict grading may be difficult to find. In the Phillips quadrangle the member is thinner; composed of thinly and sharply interbedded white, massive, poorly graded quartzite or wacke and medium-gray to light-colored muscovite-rich shale. Locally resembles the Perry Mountain Formation, but has lenticular bedding habits and lacks detailed bedding characteristics of the Perry Mountain. The lower member is characterized regionally by thick intervals of massively bedded gray shale; the massive shale passes to cyclically graded siltstone and shale in which bedding may be only barely visible, and to strikingly graded bedded sequences that are more characteristic of the Seboomook Formation. The massive shale locally has scattered pillow-like lenses of white-weathering sandstone as much as 1 cm thick, and layers 2-5 cm thick of rusty-weathering graphitic garnet-rich ironstone, some cupriferous. In the Phillips quadrangle and farther southwest the basal 100 m or so of the Carrabassett contains intervals a few meters thick of calcareous sandstone similar to that of the subjacent Madrid Formation. In the type area the Carrabassett is about 1,350 m thick, but it thins and apparently wedges out northward beneath the Hildreths and Seboomook Formations. The Carrabassett is well represented in the main strike belts to the south, but in extremely variable thicknesses, probably owing to tectonic thinning and thickening. The lower contact of the Carrabassett is conformable and gradational through transition zones a few tens of meters thick to the subjacent calcareous phyllite (unit Scp) or to the Madrid Formation

Dcq Quartzwacke lenses--Thick lenses exposed in the upper part of the Carrabassett in the Little Bigelow Mountain quadrangle. Composed of thickly bedded quartz-rich sandstone and quartzwacke, locally poorly graded to shale; beds locally exhibit channel-filling

Dcs Sulfidic shale member--Layer of sulfide-rich metamorphosed shale mapped in the upper part of the Carrabassett near the northwestern side of the Phillips pluton in the Phillips quadrangle; graphitic and locally contains as much as 30 percent pyrite or pyrrhotite

Scp CALCAREOUS PHYLLITE AND CALC-SILICTAE ROCK (SILURIAN?)--Metamorphosed calcareous shale, siltstone, sandstone, and impure limestone or dolostone exposed in the northern part of the Little Bigelow Mountain quadrangle. As much as 150 m thick; lower contact is interpreted as an angular unconformity

Sm MADRID FORMATION (SILURIAN?)--The type Madrid, at Madrid village in the Phillips quadrangle, is sharply divisible into an upper thickly bedded sandstone member, about 200 m thick, and a lower thinly bedded calcareous member, about 90 m thick. The upper member is composed of metamorphosed thickly bedded pale-gray fine-grained somewhat calcareous feldspathic sandstone, subordinate siltstone, and minor gray shale. The sandstone beds are several centimeters to 2 m thick; pods and lenses of calc-silicate rock interpreted as metamorphosed concretions are common; well cleaned outcrops commonly display medium-scale trough crossbedding, channels, and parallel laminations. Regionally the sandstone is fine grained; largest grain diameters of 1 to 1.5 mm are uncommon and are found only in the coarsest sandstones exposed east of the Phillips quadrangle. Zones as much as 5 m thick of thinly graded bedded pale siltstone and gray shale comprise about 10 percent of the upper member at Madrid. The abundance of shale and siltstone increases southwestward at the expense of sandstone. The lower contact of the member is sharp and conformable. The lower member at Madrid is composed mainly of thinly interbedded arenaceous limestone, calcareous sandstone and siltstone, and minor interlaminated noncalcareous siltstone and shale. These rocks are metamorphosed to strikingly banded calc-silicate rocks and biotite granofels. Parallel lamination and small-scale trough cross lamination are common. Massive coarse-grained sandstone displaying edgewise mud-chip conglomerate forms a bed about 6 m thick a few meters above the lower contact of the lower member. The lower member is well represented southwestward into New Hampshire, but eastward it becomes thinner, less calcareous, and less easily distinguished from the upper member. The total thickness of the type Madrid is nearly 300 m, but regionally the thickness varies greatly. The lower contact is sharp and conformable; although it can be placed within 1 cm at the type locality, rocks similar to those of the lower member of the Madrid Formation are found well within the upper member of the underlying Smalls Falls Formation

DScm CARRABASSETT AND MADRID FORMATIONS--Undivided in areas of migmatitic gneiss in the Rumford and Bryand Pond quadrangles. Characteristically coarsely crystallized, poorly foliated, medium-gray sillimanitic two-mica gneiss, commonly with scattered pods of quartz a few centimeters across and abundant irregular lenses and veinlets of granitic rock. Commonly massive, gray pelitic in composition, and considered to represent the massive shale member of the Carrabassett. Elsewhere contains abundant pods and lenses of granofels and calc-silicate rock (many showing relict bedding truncated at the margins) in a matrix of migmatitic gneiss; considered to be disrupted and mixed rocks of the Carrabassett and Madrid Formations

DSlm LITTLETON AND MADRID FORMATIONS--Undivided in areas of migmatitic gneiss in the Bethel and Old Speck Mountain quadrangles and adjacent areas. Similar to unit DScm, and differentiated from that unit where pelitic rocks are assigned to the Littleton Formation

Ssf SMALLS FALLS FORMATION (SILURIAN, MIDDLE WENLOCK TO LOWER LUDLOW)--Rusty-weathering euxinic deposits separable into three members in the type locality in the Rangely and Phillips quadrangles: an upper calc-silicate member, about 150 m thick, a lower member of interbedded sulfidic shale and quartzite, about 600 m thick, and a thickly bedded grit member found mainly in a small area north of Madrid. The upper calc-silicate member is composed of interlaminated "platy" bedded garnet-rich ironstone and calcareous siltstone in the upper 15 m, underlain by thinly interbedded rusty-weathering sulfidic calcareous quartz-rich sandstone, siltstone, and calcic magnesium-rich shale or shaly dolostone. Most of the member is dark, graphitic, and pyrrhotite-rich, but it contains zones as much as 20 m thick of light-colored nonsulfidic sandstone and siltstone similar to parts of the Madrid Formation. The lower contact of the member is gradational. The lower member is composed principally of cyclically thinly interbedded metamorphosed black graphitic shale and quartz-rich sandstone; it is graphitic and contains 5-10 percent pyrrhotite; scattered meter-thick beds of quartz grit are found in the type locality, and become more abundant and thicker northward. Owing to the abundant pyrrhotite, ferromagnesian silicate minerals tend to be magnesium-rich and iron poor; in the staurolite zone, andalusite is common but staurolite is absent. The thin quartzite beds are graded and cross and convolute laminated. In the grit member, beds of massive quartz-rich, coarse-grained sandstone and quartz granule conglomerate comprise as much as 20 percent of the formation north of Madrid, and are interstratified with typical rocks of the upper and lower members. The grit beds are as much as 3 m thick, typically very massive, but in places display medium-scale trough crossbedding and channels. The Smalls Falls is thickest in the type locality, where it is about 750 m thick. It thins very abruptly northward and is unknown north of the Phillips quadrangle; it apparently thins gradually southeastward. The lower contact is conformable; it varies from knife-sharp to gradational within about 8 m and is marked mainly by downward loss of pyrrhotite and graphite

Sp PERRY MOUNTAIN FORMATION (SILURIAN, WENLOCK?)--Cyclically interbedded metamorphosed quartz-rich sandstone or quartzite and aluminous potassium-rich shale, in subequal amounts; more arenaceous in upper part and in the north, more pelitic in lower part and south. Though locally somewhat rusty weathering, typically the formation is light colored in hues of pale green in the greenschist facies, or light gray at higher grades where it is characteristically strikingly sharply banded white quartzite and coarse muscovite-rich schist. Typically, sandstone beds 2-10 cm thick alternate with shale beds of about the same thickness. The shale, however, is internally laminated with quartzose siltstone; massive shale is absent. The sandstone beds display a wide range of internal sedimentary structures: common cross and convolute lamination in partial to complete Bouma turbidite sequences; many beds are cross laminated throughout, and some are completely massive; most are poorly graded, but their upper contacts against the overlying shale beds are sharp or abruptly graded within a few millimeters. Beds of massive quartzite that range from 10 cm to 3 m in thickness are common near the upper contact, and are particularly abundant north of Madrid. Quartz contents of the sandstones (relative to sodic plagioclase) increase upward through the formation; sandstones having 90-95 percent quartz are found near the upper contact. Some of the sandstones have pods and lenses of coarsely crystallized calc-silicate rock; scarce thin beds of calc-silicate rock are found locally in the formation. The Perry Mountain of the Kennebago allochthon contains a few thin sills or flows of altered latite or quartz latite. The Perry Mountain of the Strickland Hill anticline locally contains granule conglomerate (like that of the Sangerville Formation) with clasts of alkali feldspar and felsite. About 600 m thick in the type locally in the Rangeley quadrangle. Its lower contact with the Rangeley Formation is gradational through a transition zone typically as much as 100 m thick, but only a few meters thick in the Kennebago allochthon

RANGELEY FORMATION (SILURIAN, LLANDOVERY, AND LLANDOVERY?)--A complex package of proximal marine clastic deposits vertically separable into parts C, B, and A on the basis of character of interstratified conglomerates; and horizontally into thin near-shore and shelf facies in the Kennebago Lake quadrangle, and a vastly thicker basin facies in the Rangeley quadrangle. Type locality is 3-6 km southeast of Rangeley village. These relationships are shown on the schematic section. Parts C and B of the Kennebago allochthon are inferred to have accumulated on an erosional surface several kilometers northwest of their present position, and to have slid subsequently along the Kennebago Lake fault into close juxtaposition with the authochthonous strata of the Quimby, Greenvale Cove, and Rangeley Formations exposed immediately south of Kennebago Lake

Sr Undivided--Shown in the Old Speck Mountain and Rumford quadrangles. May locally include Perry Mountain Formation

Src Part C, undivided--Divided regionally into an upper pelitic member with interbedded sandstone, and lower quartz conglomeratic member with interbedded sandstone and shale and local impure limestone. Part C is 250-500 m thick regionally. At the southwest end of the Kennebago allochthon quartz conglomerate of the lower member rests unconformably on polymictic conglomerate of part B (Harwood, 1973). Farther south the lower contact is conformable and is marked by the lowest bed of quartz conglomerate; conglomerates of parts B and A of the Rangeley are polymictic

Srcu Part C, upper member--Thickly to thinly interbedded and interlaminated commonly rusty-weathering gray aluminous shale and white to rusty-weathering sandstone, some coarse grained. Similar to nonconglomeratic zones of part B; sandstones display features of turbidites and fluxoturbidites, but rocks of C shows less evidence of slump deformation and mudflows than those of part B. Sandstones of part C are quartzose, but have lower ratios of quartz to feldspar than those of the Perry Mountain Formation, and higher ratios than those of part B of the Rangeley

Srcl Part C, lower member--Characterized by quartz conglomerate, which in most areas is interstratified with sandstone and shale. Along the northwest side of the Kennebago allochthon the member is composed of pale-gray vitreous-appearing conglomeratic orthoquartzite, in thick lenses interpreted to represent beach or off-shore bar deposits. At the southwest end of the allochthon conglomeratic quartzite unconformably overlaps stratified sandstone and polymictic conglomerate of part B. Immediately south of the allochthon, at fossil localities 1-3, the conglomerate is "pea gravel" that contains a transported shelly fauna; this quartz conglomerte is interbedded with baked gray shale and quartzose sandstone. Here, and at fossil locality 4 within the allochthon, the conglomeratic rocks are overlain by as much as 100 m of impure limestone (which contains the fossils at locality 4), now strikingly banded calc-silicate rock. Fossil-bearing baked limestone described by Pankiwskyj (1959) and Boucot and Heath (1969, p. 46) at Limestone Hill, at the northern border of the Stratton quadrangle, is tentatively assigned to this unit. In the Rangeley quadrangle and from there southwest into New Hampshire, the lower member of C is composed of thickly to thinly interbedded aluminous gray shale, quartzose sandstone, conglomeratic sandstone, and quartz granule to pebble conglomerate. The conglomerate is mainly in the lower parts of thick graded beds. The pebbles and granules may be widely scattered through a matrix of sandstone or closely packed in an impure calcareous matrix, now coarsely crystallized calc-silicate rock; or they are scattered through a matrix of metamorphosed shale. Clasts include gray vein quartz and quartzite; fragments of felsite may be found rarely. Coarse sandstones and conglomerates display common internal massiveness, grading, large load casts, deep channels, irregular rip-up clots of locally derived metamorphosed shale, and parallel lamination; cross and convolute lamination are uncommon. Largest clast sizes range from small cobbles (7 cm) in the north-central part of the Rangeley quadrangle to granules (2-4 mm) near the southern border of the quadrangle; an intermediate facies of small pebble (about 1 cm) and granule conglomerate is represented in the Old Speck Mountain and Gorham quadrangles

Part B--Complexly stratified rusty-weathering gray shale, pale rusty-weathering sandstone (Srb), and quartzose polymictic conglomerate (unit Srbc). Ranges in thickness from about 1,200 m in the Rangeley quadrangle to 300 m or thinner in and near the Kennebago allochthon. Although the lower contact of part B in the allochthon is inferred to be a fault, it was probably an unconformity at the inferred site of deposition to the north. North of the allochthon, near Eustis, shale assigned to part B contains chips of greenish phyllite evidently derived from the subjacent Dead River Formation; here the contact is interpreted to be an unconformity. South of the allochthon the lower contact of part B is conformable and sharp or abruptly gradational

Srb Part B, nonconglomeratic--Gray somewhat graphitic variably rusty-weathering aluminous shale irregularly interbedded with subequal to subordinate amounts of white to pale-orange, commonly rusty-weathering sandstone. The sandstone has somewhat lower ratios of quartz to feldspar (plagioclase) than those of part C. Sandstone beds having a wide range of thickness, commonly 1 cm to 1 m, may be found within a single outcrop; commonly massive and poorly to well graded; may be parallel-laminated, but not commonly cross or convolute laminated; other bedding features include rip-up clots of dark shale, load casts, flute casts, and irregular to planar sandstone dikes

Srbc Part B, conglomeratic--Rocks of unit Srb complexly interstratified with polymictic conglomerate, distributed in two stratigraphic levels along the northwest limb of the Brimstone Mountain anticline in the Rangeley quadrangle. Conglomerates of both levels have clasts of vein quartz and quartzite (stable) and a wide range of sedimentary, volcanic, and plutonic rocks (unstable). Whereas the proportion of stable to unstable clasts is about 10:1 in the upper conglomerate, the proportion is less than 10:1 to about 2:1 in the lower conglomerate. On the northwest limb of the anticline the largest clasts are cobbles about 15 cm across; on the southeast limb the conglomerate is much finer grained and is found only at one locality. Conglomerate commonly occurs in the lower parts of thick-graded beds; or as conglomeratic mud-flow deposits in which the clasts are closely to sparsely scattered through a matrix of dark metamorphosed mudstone; slump folds and intraformational unconformities are associated with the mud-flow deposits, which show much evidence of subaqueous slump mixing. At the southwest end of the Kennebago allochthon conglomerate of part B described by Harwood (1973, p. 37) is exposed in a spectacular lenticular body as much as 300 m thick. It grades upward from massive poorly sorted polymictic boulder conglomerate, having fragments as large as 60 cm across, to irregularly stratified conglomeratic feldspathic quartzite. The boulder conglomerate contains a wide variety of metamorphosed sedimentary, plutonic, and volcanic rocks; the proportion of vein quartz and quartzite increases greatly toward the top of the exposure

Srba Parts B and A, undivided--Shown in Kennebago Lake quadrangle, where composed of metamorphosed shale of part B underalin by polymictic conglomerate of part A

Part A--In the Rangeley quadrangle this unit is about 1,200 m thick; it is composed of downward- and southward-fining polymictic boulder to pebble conglomerate, massively bedded feldspathic sandstone, and rusty-weathering interbedded metamorphosed gray shale and sandstone. In the Kennebago Lake quadrangle and along the line of the Mahoosuc fault in the Old Speck Mountain quadrangle, part B is far thinner but coarsely conglomeratic. In the Rangeley quadrangle the lower contact of part B is conformable; it is sharp or abruptly gradational within a meter or so. At its northernmost exposures in the Kennebago Lake quadrangle the lower contact may be conformable or disconformable, but does not appear to be an erosional surface. Farther north part A, if deposited, probably accumulated on an erosion surface

Srac Part A, polymictic conglomerate--Very thickly bedded boulder to pebble conglomerate and massive feldspathic sandstone and conglomeratic sandstone. About 850 m thick in the type area southeast of Rangeley; here many beds, as much as 10 m thick, display inverse-to-normal grading characterized by upward coarsening from poorly sorted cobble conglomerate at the base to boulder conglomerate about 1 m higher, followed by more gradual upward fining to coarse massive sandstone, which may comprise the upper half of a bed. Massive sandstone in the upper parts of such beds commonly has scattered outsized cobbles and pebbles; faint parallel centimeter-wide laminations are characteristic of the upper parts of the beds. Some beds channel deeply into the underlying strata. Recognized fragments are vein quartz, quartzite, a wide range of other sedimentary types, granitic and dioritic rocks, various felsites, and sparse greenstone; a common plutonic rock is medium-grained tonalite characterized by conspicuous crystals of gray-blue quartz. The proportions of stable clasts (quartz and quartzite) to unstable ones (all others) is 2:1 or smaller. In the type locality boulders are as large as 60 cm; some are slabby and subangular, but most are well rounded; one was found with a predepositional weathering rind. To the south the conglomerate becomes thinner, finer grained, and increasingly restricted to the uppermost stratigraphic level of part A. Conglomerate of A does not extend south of the crestline of the Brimstone Mountain anticline, where part A is almost entirely massive sandstone. To the north in the Kennebago Lake quadrangle the conglomerate also thins greatly, but it locally contains meter-sized boulders; locally imbricated. In the Old Speck Mountain quadrangle the conglomerate forms a narrow belt in an inferred slice along the Mahoosuc fault. Here it contains abundant cobbles of granitic rocks and flattened clasts of other types, all extremely rodded subvertically in the plane of foliation

Sras Part A, feldspathic sandstone--In type locality about 300 m thick and composed of very thickly bedded massive sandstone; contains minor pebble conglomerate near the upper contact and thin partings of gray shale in lower 10 m. Thickens southward at the expense of conglomerate to about 850 m near the nose of the Brimstone Mountain anticline, and tongues farther south to more pelitic facies of unit Sra. Sandstone beds are as much as 10 m thick; very massive; conspicuously graded only near their upper contacts, where they may show faint parallel banding and, locally, exceptionally large convolute structures; crossbedding is uncommon. Quartz content of sandstone is distinctly lower than in the sandstones of parts B and C, but higher than in the volcaniclastic graywackes of the Quimby Formation

Sra Part A, interbedded shale and sandstone--Variably rusty-weathering, irregularly thickly to thinly bedded, gray, somewhat graphitic shale and pale-yellowish, feldspathic sandstone. Proportions of shale to sandstone are subequal, but the unit becomes more pelitic southward and thickens southward at the expense of the sandstone of part A (Sras). Near the southern border of the Rangeley quadrangle this unit is about 900 m thick

Sg GREENVALE COVE FORMATION (SILURIAN?, LOWER LLANDOVERY?)--Thinly interlaminated fine-grained clastic rocks separable into three members at the type locality, 3 km southeast of Rangeley. Upper member composed of about 30 m of interlaminated gray shale and pale sandstone, and scattered lenses of coarse-grained feldspathic sandstone as much as 2 m thick. This member is discontinuous or absent elsewhere. The medial member at the type locality is composed of about 60 m of interlaminated variably calcareous sandstone and siltstone, and minor pale-gray shale. The sandstone laminations are 1 cm thick, or thinner, poorly graded, generally massive, and tend to be slightly lenticular. A few show faint internal cross laminations. This member is well represented elsewhere. In the Upton syncline, south of Umbagog Lake, it is somewhat rusty weathering. The lower member is about 100 m thick at the type locality. It is slightly more pelitic than the upper two, but it is similarly characterized by thinly interlaminated fine-grained clastic deposits. The sandstones of the formation are compositionally transitional between the volcaniclastic graywackes of the Quimby and the somewhat more quartzose sandstones of the Rangeley Formation. The siltstones and shales are very sodic, magnesium rich, and potassium poor; some are phosphatic. Regionally, the Greenvale Cove appears to be rather uniformly about 200 m thick. The lower contact is sharp, conformable, and typically marked by an abrupt downward change to dark graphitic sulfidic rocks of the Quimby Formation

Oq QUIMBY FORMATION (UPPER ORDOVICIAN?)--Undivided. In the type area near Rangeley Lake separable into an upper thinly bedded shale member about 600 m thick, a lower thickly bedded graywacke member about 300 m thick, and a silicic volcanic member that grades laterally to the graywacke member and probably is of about the same thickness. The Quimby is much thinner near the Kennebago allochthon and in the Old Speck Mountain quadrangle. Northwest of Rangeley Lake the lower contact is gradational downward to thinly bedded feldspathic sandstone of unit Os. In the Old Speck Mountain and Milan quadrangles thickly bedded graywacke and associated black schist rests with sharp contact on metamorphosed altered rhyolite of unit Ovx, or on calc-silicate rock of unit Ovc. At one site about 2 km northwest of Upton, volcanic boulder conglomerate at the base of the Quimby rests on calc-silicate rock; the conglomerate has a matrix of pelitic schist and may be a lahar deposit

Oqs Shale member--Mainly rusty-weathering cyclically interbedded metamorphosed gray to black sulfidic shale and subequal to subordinate amounts of quartz-poor volcaniclastic graywacke. Typically, dark shale beds about 1.5 to 5 cm thick alternate with somewhat thinner beds of lighter colored graywacke. The shale has sparse disseminated pyrite or pyrrhotite; it is variably carbonaceous, and is less aluminous and more sodic than most shales of younger formations. The graywacke consistently has less than 50 percent quartz; volcanic and other lithic clasts are seen at low grade, and at high grade plagioclase (oligoclase or andesine) is more abundant than quartz. Graywacke beds are internally massive or parallel laminated, and abruptly graded to dark shale at upper contacts; locally display load casts, flute casts, and planar to slightly sinuous sandstone dikes; cross laminations are uncommon. Scattered thin beds of dense black brittle calc-silicate rock, probably originally calcareous carbonaceous siltstone, are found near the upper contact of the member in the type area. Also in the type area are two extensive layers a few tens of meters thick of thickly bedded poorly sorted polymictic conglomeratic graywacke

Oqg Graywacke member--Mainly thickly bedded coarse-grained graywacke, slate chip graywacke, and polymictic conglomeratic graywacke; interbedded with minor amounts of gray shale. The graywacke consistently has less than 50 percent quartz; at low grade composed of unsorted clasts of sodic plagioclase, volcanic and sedimentary rock fragments, and quartz in a matrix of chlorite, sericite, and sparse calcite. Beds as thick as 1.5 m are common; massive to parallel laminated and graded; cross lamination is uncommon. Where conglomeratic, clasts as large as small cobbles (about 7 cm) are found in the lower parts of thick-graded beds; fragments are felsite, greenstone, quartzite and other sedimentary rocks, and vein quartz

Oqv Silicic volcanic member--Recognized in a small area northwest of Rangeley Lake; originally included in the graywacke member (Moench, 1969). Composed of pale-gray to white flow-banded soda rhyolite, possibly as flows and small domes, interstratified with volcaniclastic graywacke

Ov VOLCANIC ROCKS (MIDDLE ORDOVICIAN)--Undivided; includes volcanic members of Dixville Formation of Harwood (1973), Guidotti (1977), and Green (1964), and Ammonoosuc Volcanics of Milton (1961). Metamorphosed subaqeous mafic and felsic volcanic rocks, reworked volcanics, and associated sedimentary rocks; locally intertongues with black shale of unit Os. Not separated in detail on this map. Thickness extremely variable from about 200 m east of Route 26 in the Old Speck Mountain quadrangle to probably more than 1 km to the west in the Milan quadrangle. West of the map area, the lower contact is sharp and is marked locally by polymictic plutonic-volcanic conglomerate; possibly an unconformity. Within the map area the contact is reported to be gradational (Guidotti, 1977, p. 8; Harwood, 1973, p. 20) and may be conformable

Ovc Calc-silicate layer--Variegated white, pinkish, greenish, locally rusty-weathering calc-silicate rock and impure marble found by Milton (1968) and mapped by Moench below the Quimby Formation south of the Umbagog pluton. Thinly layered; primary features largely masked by coarsely crystallized texture. Recognized minerals at different localities are quartz, calcite, calcic plagioclase, tremolite, diopside, grossular, epidote, idocrase, and wollastonite; minor scheelite found at one locality. The scheelite was discovered by spectrographic analysis, which revealed 0.7 percent tungsten in a grab sample of rusty-weathering calc-silicate rock (James A. Domenico, written commun., 1980). Scheelite was identified only in material that was crushed for analysis, which probably contained one or two crystals; probably is very sparse and far subeconomic in the calc-silicate layer. The layer is no more than about 8 m thick. It lies in sharp contact above metarhyolite, which is weakly to extremely hydrothermally altered and pyritized, and below unaltered metagraywacke, black schist, and local volcanic conglomerate of the Quimby Formation. Tentatively interpreted to be a subaqueous, locally tungsten-bearing hydrothermal spring deposit on the flank of a dying volcano; alternatively, may be a marine shelf deposit that represents westward shoaling of Ordovician sea

Ovx Mixed volcanic rocks--Complexly interlayered metamorphosed felsic and mafic volcanic rocks, reworked volcanics, and black shale. The felsic rocks are light colored and appear to be mainly low-potassium rhyolite or dacite in composition; predominantly tuffaceous; widely altered prior to metamorphism to bleached pyritic quartz-sericite-albite schist, and locally to kyanite-bearing assemblages (Milton, 1961) and quartz-kyanite gneiss. The mafic rocks are basaltic in composition; include tuffs and flows, some pillowed; locally altered and subsequently metamorphosed to assemblages containing hornblende and a calcium-poor amphibole. The mafic volcanics are most abundant in the lower part of the unit. Black shale similar to that of unit Os intertongues with mafic volcanics and is most abundant immediately north of the Mahoosuc fault and northeast of Route 26, in the Old Speck Mountain quadrangle

Ovm Mafic volcanic rocks--Metabasaltic tuffs and flows, shown where other volcanic types are sparse or absent. Metamorphosed to greenstone northwest of Rangeley Lake and to amphibolite in the Old Speck Mountain and Milan quadrangles. At high grade distinctly layered amphibolite is inferred to be metamorphosed basaltic tuff; probable and certain flows are more massive amphibolite, locally pillowed and commonly having relict amygdules

Os BLACK METASHALE (MIDDLE ORDOVICIAN)--Graptolite-bearing black slate and associated feldspathic sandstone exposed northwest of Rangeley Lake previously assigned to the Dixville Formation by Harwood (1973), but unnamed on this map because correlation with the type Dixville of Green (1964) is uncertain. The upper part is composed of thinly interbedded rusty-weathering, sulfidic, feldspathic sandstone and minor dark carbonaceous siltstone and shale. These rocks pass gradationally downward to a thicker lower member of black sulfidic shale interbedded with minor feldspathic sandstone, scattered lenses of basaltic greenstone, and at least one bed of polymictic conglomerate. The conglomerate has clasts of black slate, chert, vein quartz, greenstone, and green phyllite. Unit may be as much as 1,800 m thick (Harwood, 1973), but its lower part intertongues with greenstone of unit Ovm. Where the greenstone is absent, black slate rests on the Albee Formation, but the contact is not exposed and its nature is unknown

Oa ALBEE FORMATION (MIDDLE AND LOWER ORDOVICIAN)--Mainly interbedded metamorphosed shale and quartz-rich sandstone, divisible locally into arenaceous members and more pelitic gray, green, and red members; color variants are preserved only in areas of greenschist facies. Only the gray pelitic upper or Deer Mountain Member (Oad) (Harwood, 1973) is distinguished on this map. The most characteristic rock of the Albee is cyclically interbedded laminated shale and siltstone and sharply defined beds of feldspathic sandstone or quartzite. The arenaceous beds range from a few millimeters to more than a meter in thickness, but most are 2-5 cm thick; most are graded, and many have a characteristic "pinstripe" lamination parallel to bedding and a secondary lamination parallel to cleavage. Although the Albee is reported to contain a few percent of volcanic greenstone or amphibolite, much of this rock occurs as dikes. Although Green (1964) and Harwood (1973) estimate a maximum thickness of about 3,000 m for the Albee, the formation is extremely deformed and is probably far thinner. The lower contact with the Aziscohos Formation is gradational through a transition zone of mixed Albee and noncarbonaceous Aziscohos lithologies as much as 150 m thick (Harwood, 1973, p. 10)

Oad Deer Mountain Member--Gray to greenish-gray thinly laminated metamorphosed shale and siltstone and very minor amounts of feldspathic quartzite; lenses of black pyritic shale occur in the lower part. Unit contains abundant irregular veinlets of quartz. In its type area in the Cupsuptic quadrangle the member is about 760 m thick, but northward it wedges out

AZISCOHOS FORMATION (LOWER ORDOVICIAN)

Ozu Upper member. Composed of gray to greenish-gray thinly laminated metamorphosed shale and siltstone and very minor thin beds of feldspathic quartzite; contains abundant irregular veinlets of quartz. Unit is identical to the noncarbonaceous part of the Deer Mountain Member of the Albee Formation. Harwood (1973) estimates a thickness of about 600 m in the Cupsuptic quadrangle. The lower contact with the carbonaceous lower member is sharp at most localities, but Green (1964, p. 3) suspects that the upper and lower members are facies of one another

Ozl Lower member--Composed of metamorphosed black or dark-gray, thinly laminated, carbonaceous sulfidic shale and minor thin beds of feldspathic quartzite; similar to lenses of black shale in lower part of Deer Mountain Member. Commonly contains thin laminatons and lenses of pink quartz-garnet rock (coticule) as much as 1 cm thick, and everywhere contains irregular thin veinlets of quartz. Amphibolite and greenstone are reported, but may be entirely intrusive. Green (1964) estimates a maximum exposed thickness of 2,000 m in the Errol quadrangle, but the member is strongly deformed, and probably intertongues with the noncarbonaceous upper member. Lower contact not exposed

OꞒd DEAD RIVER FORMATION (LOWER ORDOVICIAN OR UPPER CAMBRIAN?)--Interbedded metamorphosed shale, feldspathic sandstone, and quartzwacke, divisible in the Kennebago Lake quadrangle into a upper arenaceous member and a lower more pelitic member. Similar to and laterally continuous with the Albee Formation of the Cupsuptic quadrangle, but may be coeval with the Aziscohos Formation as well. Probably about 1,200 m thick in the Kennebago Lake quadrangle and 860 m thick in the Little Bigelow Mountain and north-adjacent Pierce Pond quadrangles. Where exposed in the Pierce Pond quadrangle, lower contact is marked by an abrupt downward transition from well-bedded quartzite (showing graded bedding) and shale of the Dead River Formation to poorly bedded sulfidic rocks of the sulfidic metasiltstone unit (OꞒh)

OꞒh SULFIDIC METASILTSTONE (LOWER ORDOVICIAN? OR UPPER CAMBRIAN?)--Dark rusty-weathering sulfidic siltstone exposed near Hurricane Mountain, in the Pierce Pond quadrangle. Characterized by lenticular flaser bedding, and by absence of sections more than a meter thick that display parallel bedding; bedding interpreted to have been disrupted by pervasive penecontemporaneous deformation. The upper part of the unit contains bouldery mudstone with boulders and slabs of orthoquartzite, granite, and amphibolite (Boudette and Boone, 1976, p. 89) and locally many other types. Estimated to range in thickness from about 300 m to not more than 1,500 m. Unit lies probably conformably above volcanics of the Jim Pond Formation (Boudette, 1982), exposed north of the map area

Eastern succession

Dc CARRABASSETT FORMATION (LOWER DEVONIAN)--Includes the Solon Formation of Pankiwskyj and others (1976), which was abandoned by Panakiwskyj (1979) and Ludman (1979) in favor of the Carrabassett Formation. Composed mainly of medium- to dark-gray metamorphosed shale and sparse to abundant light-gray metamorphosed siltstone and sandstone. Similar to the massive metashale lower member of the Carrabassett at the type locality in the Little Bigelow Mountain quadrangle. Probably more than 1 km thick, but upper contact is not exposed. Lower contact is gradational through a transition zone about 100 m thick

Sme MADRID FORMATION, EASTERN FACIES (SILURIAN?)--Includes Fall Brook Formation of Pankiwskyj and others (1976). Similar to the upper member of the type Madrid, but is generally less calcareous and locally contains coarser-grained detritus; the eastern facies also is much thicker but lacks the thinly bedded calcareous lower member. The uppermost 70-100 m is a transition zone to dark-gray massive shale of the Carrabassett Formation; this zone is composed of thinly interbedded feldspathic wacke and greenish-gray shale. The wacke beds are poorly sorted and display grading, partial Bouma sequences, sole markings, and small channels. The medial and thickest part of the facies is composed of thickly to thinly interbedded feldspathic sandstone or wacke and greatly subordinate gray shale; bedding styles are distributed into packets 10 m or so thick of interlaminated or thinly interbedded sandstone and siltstone that alternate with thick zones characterized by massive, locally crossbedded sandstone in beds as much as 2 m thick. The beds either grade at the top to gray shale, or they are ungraded and directly overlain by more sandstone. The thinly bedded packets are characterized by internal parallel and cross lamination and grading. The lower 250 m of the eastern facies contains abundant thick beds of massive coarse-grained sandstone commonly having scattered clasts as large as 2 mm of quartz, feldspar, feldspathic igneous rocks, and quartzite. The eastern facies is estimated to be as much as 1,000 m thick, or about three times the thickness of the type Madrid at Madrid. The lower contact is sharply gradational and commonly may be placed within several centimeters

Ssfe SMALLS FALLS FORMATION, EASTERN FACIES (SILURIAN, MIDDLE WENLOCK TO EARLY LUDLOW)--Includes Parkman Hill Formation of Pankiwskyj and others (1976). Similar to the lower member of the type Smalls Falls, but is not as pervasively graphitic and rusty weathering. The calcareous upper member of the type Smalls Falls is rarely seen; it is well developed only near the eastern margin of the Kingsbury quadrangle. Most of the eastern facies is composed of subequal amounts of rusty-weathering sulfidic graphitic shale and quartz-rich sandstone; zones of laminated siltstone and thickly bedded granule conglomerate are common. Most rocks contain several percent of sulfide minerals, mainly pyrite in areas of low-grade metamorphism and pyrrhotite at high grade. Beds of sandstone are variably thick to thin; the thicker beds are massive and poorly graded, but the thinner beds are graded. Clasts in the granule conglomerates include quartz (greatly predominant), plagioclase, alkali feldspar, and sparse felsite. The eastern facies is not more than 300 m thick in the eastern part of the map area; it is absent in the Farmington quadrangle, where the eastern facies of the Madrid Formation rests directly on the Anasagunticook Member of the Sangerville Formation. The lower contact of the eastern facies is conformable and sharp or abruptly gradational. At many localities the eastern facies of the Smalls Falls is directly underlain by rocks of the Sangerville that closely resemble the Perry Mountain Formation

SANGERVILLE FORMATION (SILURIAN, UPPER LLANDOVERY TO LOWER LUDLOW)--Complexly interstratified clastic and carbonate rocks divided into members, facies, and lenses. Probably at least 2,000 m thick, but the lower contact is not exposed in the map area

Ss Principal facies--Predominantly weakly calcareous lithic wacke irregularly interstratified with greatly subordinate massive gray shale or interlaminated shale and siltstone. Cyclically bedded rocks identical to the Perry Mountain Formation are commonly found in contact with the overlying Smalls Falls

Formation. The wacke beds of the facies average about 25 cm in thickness, but range from a few centimeters to at least 5 m in thickness; they are poorly sorted and have a wide range of clasts, best seen in granule conglomerate of units Sscu and Sscl. The beds are graded and crossbedded; locally display small channels, sole markings, flame structure, convolute bedding, slump folds, sedimentary breccia, and calcareous lenses and pods. Thick beds of coarse-grained wacke are most abundant near the mapped conglomeratic lenses, northeast of the Farmington quadrangle

Sscu — Upper conglomerate lenses--Mainly thickly bedded wacke and other rocks of the principal facies, but containing polymictic granule to small pebble conglomerate, found in the lower portions of thick-graded wacke beds. Clasts as large as 2.5 cm have been found in the Kingsbury quadrangle, but most commonly they are 2-4 mm granules. The clasts include quartz, plagioclase, alkali feldspar, possibly detrital muscovite, and many kinds of rock fragments, including: slate, phyllite, and schist derived from a previously metamorphosed source area; plutonic granite and granodiorite and hypabyssal intrusives; and distinctive fine-grained volcanics ranging from metarhyolite to metabasalt, but most having the approximate composition of rhyodacite

Ssll — Lower limestone lenses--Similar to the Patch Mountain Member

Sscl — Lower conglomeratic lenses--Similar to the upper conglomeratic lenses

Ssa — Anasagunticook Member--A fine-grained facies of the Sangerville Formation; divided locally into upper and lower parts by a thin medial unit of metamorphosed limestone. The member is characterized by thick sequences composed entirely of interlaminated siltstone and shale, but it contains thinly bedded, cross- and convolute-laminated lithic wacke comparable to that of the principal facies. The wacke alternates with generally more abundant interlaminated siltstone and shale. In sedimentary styles the member closely resembles the more pelitic parts of the Perry Mountain Formation, but in composition most of the wackes and siltstones are much less quartzose than those of the Perry Mountain and probably have a large original lithic or volcaniclastic component. The maximum thickness is about 1,000 m

Ssab — Upper part of Anasagunticook Member--Differentiated solely on the basis of position above unit Ssal

Ssal — Limestone of Anasagunticook Member--Lithologically similar to the Patch Mountain Member

Ssaa — Lower part of Anasagunticook Member--Differentiated solely on the basis of position below unit Ssaa

Ssp — Patch Mountain Member--Thinly interbedded and interlaminated gray micritic limestone, arenaceous limestone, limy sandstone, siltstone, and shale, and minor less calcareous rocks. At metamorphic grades above the greenschist facies the details of primary features are obliterated and the unit is a distinctive coarsely crystallized "ribbon" calc-silicate rock. Guidotti (1965) estimates a minimum thickness of about 600 m for the Patch Mountain Formation (changed to member rank of the

Sangerville by Pankiwskyj, 1979) in the type area in the Bryant Pond quadrangle. To the northeast the member is thick and continuous, but it is interpreted to wedge out abruptly northwestward, normal to the regional strike

OUTLINE OF STRATIGRAPHIC NOMENCLATURE

This map presents a simplified stratigraphic nomenclature for Lower and Middle Paleozoic rocks in central and western Maine that supersedes nomenclature published previously by some of the contributors, and by other geologists who have worked in the region. A summary of these changes and their justifications is necessary.

Albee Formation (Oa), Aziscohos Formation (Ozl,Ozu), and Dead River Formations (O€d): These formations are closely interrelated with one another and represent a single but lithically variable unfossiliferous package of Lower Paleozoic pelitic and arenaceous flyschoid marine deposits. On this map the names Albee Formation and Aziscohos Formation are used in New Hampshire, and in Maine east to Longitude 70°45′ at the east side of the Cupsuptic quadrangle. Farther east, rocks of the assemblage are assigned to the Dead River Formation of Boone (1973) and this name is adopted herein.

Usage of the names Albee Formation and Aziscohos Formation conforms to that of Green (1964, 1968), Green and Guidotti (1968), and Harwood (1973). Harwood assigned an Early Ordovician age to the Aziscohos, on the basis of long distance correlations and because it lies below the Albee Formation. He assigned an Early and Middle Ordovician age to the Albee, because it underlies graptolite-bearing Middle Ordovician black slate. Although the Aziscohos lies generally below the Albee and is distinctly more peletic than most of the Albee, the sedimentary styles of the two formations are very similar. As noted by Harwood (1973, p. 10) and Green (1964), the Aziscohos can be considered as a facies of the Albee. This package of formations has long been considered to represent the oldest rock assemblage in New Hampshire and westernmost Maine (Billings, 1956; Green and Guidotti, 1968; Harwood, 1973), but it is now known to be underlain by an older assemblage that includes unit O€h and ophiolite (Boudette and Boone, 1976; Boudette, 1982).

Boone (1973) named the Dead River Formation for well-bedded pre-Silurian rocks exposed in the northern part of the Little Bigelow Mountain quadrangle and in the north- and northeast-adjacent Pierce Pond and The Forks quadrangles. He has provided a thorough description. Because no single set of outcrops adequately represents the formation, Boone (1973) did not name a specific type locality. The name is taken from the Dead River, which flows north from Flagstaff Lake into the Pierce Pond quadrangle, thence east to its confluence with the Kennebec River at The Forks, in The Forks quadrangle. A type area is here designated to include exposures along the Dead River at Long Falls (below the dam at the outlet of Flagstaff Lake), on Blanchard Mountain in the Little Bigelow Mountain quadrangle, and on Basin Mountain in the Pierce Pond quadrangle. As described by Boone (1973, p. 13), the exposures on Basin Mountain and at Long Falls represent a total minimum thickness of 860 m for the Dead River Formation in the type area and vicinity. In that area the Dead River Formation is unconformably overlain by unnamed calcareous phyllite of Silurian(?) or possibly Devonian age, and is conformably underlain by unnamed sulfidic metasiltstone of Early Ordovician(?) or Late Cambrian(?) age.

Boone (1973) assigned an unrestricted Ordovician(?) or Cambrian(?) age to the Dead River Formation. The Dead River Formation is now known to be no younger than Early Ordovician (Arenig) (Boone and others, 1981). It is laterally continuous with part of the Albee Formation, of Middle and Early Ordovician age, and it is conformably underlain by an older succession that includes probable Upper Cambrian and Precambrian rocks (Boudette, 1982; Boudette and Boone, 1976; Eisenberg, 1981). Because the Dead River Formation may also be Cambrian in part, an Early Ordovician or Late Cambrian(?) age is adopted on this map.

Middle Ordovician black slate (Os) and volcanic rocks (Ov): Rocks of this assemblage lie above the Albee Formation, of Early to Middle Ordovician age, and below the Quimby Formation, of Late Ordovician(?) age. A Middle Ordovician age can be assigned with confidence to the whole assemblage, on the basis of graptolites found by Harwood (Harwood and Berry, 1967) at locality 5. Harwood (1973) assigned the graptolite-bearing black slate and associated greenstone of the Cupsuptic quadrangle to the Dixville Formation of Green (1964, 1968). Previously, Milton (1961, 1968) assigned the more strongly metamorphosed volcanic rocks and rusty-weathering graphitic shale and graywacke of the Old Speck Mountain and Milan quadrangles to the Ammonoosuc Volcanics and the Partridge Formation. Although all of these correlations may be at least partly correct, details of stratigraphic relationships, correlations, and nomenclature for the whole assemblage in northern New Hampshire and western Maine are under review. For this reason, rocks of this assemblage are left unnamed on this map.

Quimby Formation (Oq): Usage of this name conforms to the original definition of Moench (1969). Since the original definition was written, however, felsic volcanic rocks (soda rhyolite) were found to be more abundant than recognized originally in the lower graywacke member of the Quimby. On this map a silicic volcanic member is separated in the vicinity of Quimby Pond and Ephraim Ridge northwest of Rangeley Lake.

Greenvale Cove Formation (Sg): Moench (1969) originally assigned a Late Ordovician(?) age to this formation, mainly because the abrupt coarsening that occurs at the contact with the overlying Rangeley Formation provided the most convenient place for the Ordovician-Silurian boundary, in the absence of fossils. On this map the Greenvale Cove Formation is reassigned to the Silurian(?) (early Llandovery?), on the basis of lithic and sequential similarity to the fossiliferous Aroostook River Formation, of early Llandovery age (Roy and Mencher, 1976), which is exposed in extreme northeastern Maine. The Aroostook River Formation, composed of thinly interlayered dark-gray to greenish-gray calcareous slate and fine-grained calcareous graywacke and siltstone, strongly resembles the Greenvale Cove Formation. Moreover, the Aroostook River Formation, like the Greenvale Cove Formation, is conformably overlain by much more coarsely clastic Rangeley-like rocks of the Frenchville Formation, of late Llandovery to Ludlow age (Roy and Mencher, 1976). Farther south in northeastern Maine, a similar well-dated (Caradoc to Llandovery) succession is represented by the calcareous ("ribbon rock") Carys Mills Formation, which is conformably succeeded by more coarsely clastic rocks of the Smyrna Mills Formation (Llandovery to Ludlow). The Smyrna Mills, composed of interbedded slate, quartzite, and quartzwacke, is not unlike the distal facies of the Rangeley Formation. The conformable contact between the Carys Mills and the Smyrna Mills is closely dated by graptolites of earliest middle Llandovery age (Pavlides, 1972). On the assumption that the Greenvale Cove-Rangeley contact represents approximately the same boundary as the contacts between the Aroostook River and Frenchville Formations and between the Carys Mills and Smyrna Mills Formations, a tentative Silurian? (early Llandovery?) age seems appropriate for the Greenvale Cove Formation, and is assigned on this map.

Rangeley Formation (Sr): The Rangeley Formation was adopted (revised from Smith, 1923) by Osberg and others (1968, p. 251) for exposures of conglomeratic, arenaceous, and pelitic rocks at Cascade Stream southeast of Rangeley, in the Rangeley quadrangle. These authors assigned a Silurian(?) age to the Rangeley. Harwood (1973) assigned an unqueried Silurian age to the Rangeley in the Cupsuptic quadrangle, on the basis of fossils that occur in rocks that he (1973) and Moench and Boudette (1970) assigned to the Rangeley in the Cupsuptic and Kennebago Lake quadrangles. The fossils, identified by A. J. Boucot, are late Llandovery C_4-C_5 in age. They occur in quartz conglomerate exposed immediately south of Kennebago Lake (localities 1-3), outside the Kennebago allochthon. At locality 4 a less restricted fauna (C_3-C_5) occurs within the allochthon in laminated metalimestone that rests on quartz conglomerate. The fossil-bearing rocks comprise parts of the lower member of part C of the Rangeley Formation. Although the type locality of the Rangeley Formation is in a different strike belt of unfossiliferous rocks some 15 km south of the dated rocks, the sequences and lithologies are closely comparable (Moench and Boudette, 1970). As shown on the map, quartz conglomerates of part C are restricted to a thin but regionally extensive unit in the Kennebago Lake, Rangeley, Oquossoc, and Old Speck Mountain quadrangles. In the Kennebago Lake quadrangle they represent shoreline and shelf facies, but farther south they represent a marine basin facies; here they have characteristics of rapidly deposited turbidites, fluxoturbidites, and grain flow deposits. The lower member of part C of the Rangeley thus appears to represent a brief time when quartz-rich gravel was spread over a wide area. Accordingly the C_4-C_5 age of the rocks at localities 1-4 probably applies regionally to the quartz conglomerates of part C. Most of the more pelitic upper member of part C must also be late Llandovery, although the uppermost beds (in the transition zone to the Perry Mountain Formation) could be earliest Wenlock in age. On the other hand, parts B and A--by far the greatest thickness of the Rangeley Formation in the type locality--must be older than C_4-C_5. If the underlying Greenvale Cove Formaton is in fact early Llandovery in age, as proposed, parts B and A of the Rangeley must be middle to late Llandovery in age. The Rangeley Formation as a whole is thus considered to be mainly Llandovery in age, with a possible range from early or early-middle Llandovery to earliest Wenlock.

Perry Mountain Formation (Sp): The Perry Mountain Formation is unfossiliferous and was originally assigned a Silurian(?) age by Osberg and others (1968, p. 251). However, because it lies above the Rangeley Formation (mainly Llandovery) and below the Smalls Falls Formation (middle Wenlock to early Ludlow), the Perry Mountain Formation must also be Silurian in age. The Perry Mountain is lithologically identical to some rock assemblages that occur in the fossiliferous Sangerville Formation, particularly in the uppermost part of the Sangerville, which has a probable maximum range in age of late Llandovery to early Ludlow, but is mainly Wenlock in age. Accordingly, a Wenlock(?) age is assigned to the Perry Mountain Formation on this map.

Sangerville Formation (Ss): Pankiwskyj and others (1976, p. 274) named the Sangerville Formation for exposures of pelitic, arenaceous, and calcareous deposits along Maine State Highway 23 between North Dexter and Sangerville, in the Guilford quadrangle, which is the type area. They estimated a late Llandovery through early Ludlow age for the Sangerville of the type locality, where it lies directly below the eastern facies of the Madrid Formation, and a late Llandovery through middle Wenlock age to the west, where the Sangerville is overlain by the eastern facies of the Smalls Falls Formation. A maximum range of late Llandovery to early Ludlow for the full thickness of the Sangerville Formation is assigned on this map.

The Anasagunticook Member of Pankiwskyj (1979) was previously named as a formation by Pankiwskyj and others (1976, p. 274) for well-bedded metasandstone and thinly laminated metasiltstone and metashale exposed along the east shore and adjacent hills of Anasagunticook Lake, in the northeastern part of the Buckfield quadrangle. The Anasagunticook is distinctly finer grained than the type Sangerville, but it contains sparse to abundant coarsely arenaceous deposits identical to those of the Sangerville Formation, and the two units complexly intertongue with one another. Accordingly, the Anasagunticook is appropriately interpreted as a fine-grained facies, or member, of the Sangerville Formation (Pankiwskyj, 1979) and this usage is adopted on this map. The member is about 1,000 m thick, and it is locally divided into upper and lower pelitic-arenaceous parts by as much as 100 m of thinly bedded metalimestone, calcareous metasiltstone, metashale, and polymictic granule conglomerate, also included in the member. Coarsely arenaceous rocks are rather sparse in the Anasagunticook Member. The Anasagunticook lies conformably and gradationally above the calcareous Patch Mountain Member, and is most widely exposed in the southwestern part of the strike belt of the Sangerville Formation. In the Farmington and Dixfield quadrangles the Anasagunticook Member is conformably overlain by the eastern facies of the Madrid Formation; the Smalls Falls Formation is absent in this area.

The Patch Mountain Member of Pankiwskyj (1979) was defined as a formation by Guidotti (1965, p. 12) for excellent exposures of interbedded calc-silicate rock and purplish-gray quartz-feldspar-biotite schist on the eastern slope of Patch Mountain, in the Bryant Pond quadrangle. Pankiwskyj (1979) changed the Patch Mountain to member status of the Sangerville Formation because it lies entirely within the Sangerville, and this usage is adopted on this map. Guidotti (1965) estimates a minimum thickness of about 650 m for the Patch Mountain. The type Patch Mountain of the Bryant Pond quadrangle is exposed in the core of a broad northwest-trending antiform and cannot be mapped directly into the extensive northeast-trending belts of calcareous rocks that are parallel to the southeast side of this map. These belts of calcareous rocks are correlated with one another and with the type Patch Mountain on the basis of lithologic and sequential similarity and structural reconstructions. To the northwest across strike, the Patch Mountain wedges out within the main body of the Sangerville Formation. Contacts with the underlying and overlying noncalcareous rocks of the Sangerville Formation are typically gradational.

The Sangerville Formation of this map includes the Moody Brook Formation (pelitic schist), the Berry Ledge Formation (layered calc-silicate rock similar to the Patch Mountain Member, but much thinner), and the Noyes Mountain Formation (pelitic schist and biotitic quartzite), all of Guidotti (1965) and Warner and Pankiwskyj (1965). It also includes the Turner Formation of Warner and Pankiwskyj (1965). These names were applied to sillimanite-zone metamorphic units during the early stages of mapping in western Maine; all are abandoned herein because the respective rock units are now recognized to be parts of a single major sedimentary package defined as the Sangerville Formation.

<u>Smalls Falls (Ssf, Ssfe) and Madrid (Sm, Sme) Formations</u>: Osberg and others (1968) named the Smalls Falls Formation for exposures of metamorphosed black sulfidic shale and quartzite at Smalls Falls, in the Rangeley quadrangle; and they named the overlying Madrid Formation for exposures of thinly bedded calcareous metasandstone, metashale, and calc-silicate rock succeeded by thickly bedded metasandstone at Madrid village, in the Phillips quadrangle. In the absence of fossils they assigned a Silurian(?) age to both

formations, on the basis of their stratigraphic position below pelitic rocks that they tentatively correlated with the Seboomook Formation, of Early Devonian age. Subsequently this pair of formations was mapped southwestward into New Hampshire and northeastward to the northeast corner of the area of this map.

Meanwhile, a lithologically and sequentially similar pair of formations--the Parkman Hill and Fall Brook Formations of Pankiwskyj and others (1976)--was mapped farther southeast, where they comprise parts of a fossil-bearing succession. The Parkman Hill Formation was named by Pankiwskyj and others (1976, p. 274) for dark sulfidic arenaceous and pelitic rocks on the south and southeast slopes of Parkman Hill, in the northeast part of the Anson quadrangle. On the basis of graptolites found at eight localities, the Parkman Hill was dated as middle Wenlock to early Ludlow; graptolites from one of the localities (locality 8, on the map) yielded a restricted early Ludlow age. The overlying Fall Brook Formation was named by the same authors (p. 275) for exposures of metasandstone and minor metashale along Fall Brook in the village of Solon, in the northern part of the Anson quadrangle. This formation is barren of fossils. Pankiwskyj and others (1976) assigned a Late Silurian to Early Devonian(?) age to the Fall Brook, on the basis of its position conformably below pelitic rocks believed to be of Early Devonian(?) age, and above dated Silurian rocks.

In the Kingfield and Anson quadrangles, Pankiwskyj (1979) assigned well-bedded nonrusty pelitic and arenaceous rocks in the axial zone of the Strickland Hill anticline to the Perry Mountain Formation, and he assigned sulfidic rocks exposed on the limbs of the anticline to the Smalls Falls Formation. These formations are flanked on the southeast by thickly bedded somewhat calcareous arenaceous rocks that Pankiwskyj assigned to the Fall Brook Formation, and on the northwest (across the Black Hill Pond fault) by rather similar rocks that he assigned to the Madrid Formation. Pankiwskyj correlated the Madrid and Fall Brook, but he retained the two names in order to emphasize differences between them.

In order to simplify nomenclature and to emphasize stratigraphic continuity, on this map the name Fall Brook Formation is abandoned in favor of the Madrid Formation, in accord with the rule of priority. To account for real differences, rocks of the former Fall Brook Formation are called the eastern facies of the Madrid Formation on this map. The same nomenclature is applied on this map to the sequentially and lithologically similar rocks exposed along the troughline of the Currier Hill syncline, some 20 km southeast of the strike belt of the former type Fall Brook. Although Pankiwskyj and others (1976) assigned these same rocks of the Currier Hill syncline to the Vassalboro Formation, the strike belt of the type Vassalboro is another 20 km father southeast, and the stratigraphy of that area is currently under review by Osberg (1981). Ludman (1977) correlated the rocks of the syncline with the Fall Brook, and not the Vassalboro, and on this map they are assigned to the eastern facies of the Madrid Formation.

In the absence of fossils, Osberg and others (1968) assigned a Silurian(?) age to the Madrid Formation and Pankiwskyj and others (1976, p. 275) assigned a Late Silurian (post-early Ludlow) to Early Devonian(?) age to the Fall Brook Formation. At least the calcareous thinly bedded lower member of the type Madrid is almost certainly approximately equivalent to the fossiliferous Silurian Fitch Formation, which lies below dark graded-bedded pelitic rocks of the Lower Devonian Littleton Formation. On this map the Littleton is correlated mainly with the Carrabassett Formation. The type Fitch near Littleton, New Hampshire, is now known to be latest Silurian

(Pridoli) in age (Harris and others, in press), and this age may apply approximately to the lower member of the Madrid as well. A Silurian(?) age is retained for the Madrid, however, to allow for the possibility of slight time transgression, and for the possibility that the thickly bedded sandstone upper member of the Madrid is earliest Devonian.

Pankiwskyj (1979) correlated the Parkman Hill Formation of the Kingfield and Anson quadrangles with the Smalls Falls Formation, on the basis of close lithic and sequential similarity. On this map the Parkman Hill Formation is abandoned in favor of the Smalls Falls Formation. In order to emphasize differences--the general lack of the upper calcareous member of the type Smalls Falls and the less pervasively sulfidic character of the Parkman Hill--the former Parkman Hill Formation is called the eastern facies of the Smalls Falls Formation on this map. Pankiwskyj and others (1976, p. 275) assigned an age of middle Wenlock to early Ludlow to the Parkman Hill Formation, and this age is accordingly transferred to the Smalls Falls Formation on this map.

<u>Carrabassett (Dc) and Hildreths (Dh) Formations</u>: Boone (1973) named the Carrabassett Formation for a predominantly pelitic assemblage of rocks in the Little Bigelow Mountain quadrangle that lies above the Madrid Formation and below the Seboomook Formation. The type area is the valley of the Carrabassett River in the southwestern part of the quadrangle. The name is adopted on this map, but with the revisions described in a later paragraph. The Carrabassett of the eastern succession in the Kingsbury, Bingham, and Anson quadrangles includes the Solon Formation of Pankiwskyj and others (1976), who named the Solon for gray massively bedded to well-bedded gray metashale exposed in the Solon Township, in the northern part of the Anson quadrangle. Subsequently, Newell (1978) demonstrated that the solon is equivalent to the Carrabassett. Accordingly, Pankiwskyj (1979) and Ludman (1979) reassigned the type Solon and that of the Kingsbury quadrangle to the Carrabassett Formation. The name Solon is thus abandoned herein in favor of the Carrabassett.

Boone mapped and described three regionally extensive members in the Carrabassett: a color-variegated upper member about 120 m thick, and composed of calc-silicate rocks and sulfidic schist; a medial member of thinly layered schist about 250 m thick, and composed of interbedded impure quartzite and pelitic two-mica schist; and a lower member of massive metapelite about 1,070 m thick, composed largely of gray massively bedded metashale and only minor metagraywacke. He also mapped thick lenses of impure quartzite at various stratigraphic levels in the formation. According to Boone (1973), the lower contact of the formation varies from an unconformity to a disconformity in the northern and central part of the quadrangle, and probably to a conformity farther south.

Osberg and others, (1968, p. 250) named the Hildreths Formation for an extensive unit, 60-240 m thick, of thinly layered variegated calc-silicate rock, biotite granofels, sulfidic schist, and local marble that lies conformably between far thicker sequences of interbedded pelitic and arenaceous rocks. The type locality is on Maine Route 156, 1 km east of Hildreths Mill in the Dixfield quadrangle, an area mapped in detail by Pankiwskyj (1964). Although Osberg and others (1968) were unable to define the exact stratigraphic relations of the sequence that contains the Hildreths Formation, subsequent mapping in the Phillips, Rumford, and Dixfield quadrangles and adjacent areas has shown (1) that the Hildreths is regionally extensive; (2) that it lies conformably above a thick unit composed mainly of gray massive metapelite, which in turn lies conformably above the Madrid Formation; and (3) that it lies conformably below a thick unit composed mainly of cyclically interbedded metapelite and metasandstone. It became clear that this succession is lithically and sequentially nearly identical to that of the Carrabassett and Seboomook Formations of Boone (1973); and particularly, that the Hildreths Formation of Osberg and others (1968) is equivalent to the calcareous upper member of the Carrabassett Formation of Boone (1973).

The name Carrabassett Formation is adopted on this map, with the following modifications of Boone's (1973) definition. The calcareous upper member of the Carrabassett Formation of Boone (1973) is assigned to the Hildreths Formation. As now redefined, the Carrabassett Formation is divisible into two regionally extensive members: a rather thin upper member of thinly interbedded metashale and metasandstone, and a far thicker lower member containing abundant gray massive metashale and subordinate to greatly subordinate metasandstone. The type locality of the Carrabassett Formation of Boone (1973) requires little redefinition, except to exclude the localities he cites (Boone, 1973, p. 35) for his former upper member.

Boone (1973, p. 38) assigned an Early Devonian(?) age to the Carrabassett Formation on the grounds that it lies above the Silurian(?) Madrid Formation and below well-bedded pelitic and arenaceous rocks that he correlated with the Seboomook Formation, of Early Devonian age. An unqueried Early Devonian age is adopted on this map for the Hildreths and Carrabassett Formations on the following grounds. On the basis of recent unpublished mapping by N. L. Hatch, Jr., R. H. Moench, and J. B. Lyons and his students in New Hampshire it now appears that at least the lower member the Madrid Formation can be correlated with the fossiliferous Fitch Formation of Late Silurian age, and that the Carrabassett can be correlated with the fossiliferous Littleton Formation of Early Devonian age. Both the Madrid and Fitch are calcareous units that lie directly below distinctive dark, graded-bedded pelitic rocks and subordinate arenaceous rocks assigned to the Littleton Formation in New Hampshire and the Carrabassett in Maine. New fossil data of Harris and others (in press) have shown that the Fitch is Pridoli in age, which suggests that the overlying beds of the Littleton Formation can be no older than Early Devonian. The type Fitch is very calcareous and is comparable to the calcareous lower member of the type Madrid; but the Fitch lacks the thickly bedded sandstone upper member of the type Madrid, at least part of which could be earliest Devonian in age. On this map the pelitic rocks that lie above the Madrid Formation near the New Hampshire border are assigned to the Littleton Formation. Most of these rocks are clearly equivalent to the Carrabassett Formation, but Maine nomenclature is not used in this area because the Hildreths and Seboomook Formations have not been recognized, though they may be present, southwest of the Rumford quadrangle.

In the absence of direct fossil data, it can be inferred that the Hildreths and Carrabassett Formation are predominantly and perhaps entirely Helderberg in age. These formations lie below the Seboomook Formation, which in the type section (Boucot, 1961, p. 169) in northern Maine is mainly Oriskany and, perhaps, in part late Helderberg in age. The lower contact of the Seboomook in the type section is a disconformity (Boucot and Heath, 1969), which can be inferred to represent an hiatus that was accompanied farther south by deposition of the Hildreths and Carrabassatt Formations, in earlier Devonian (Helderberg) time.

Seboomook Formation (Ds): Usage of this name conforms to that of Boone (1973) and Boucot and Heath (1969). In the eastern part of the Rumford allochthon the Seboomook has been divided into three extensive units previously informally called (descending order) the Staples Pond, Temple

Stream, and Saddleback Mountain Formations (Warner and Pankiwskyj, 1965). These units were named as formations when regional correlations were very uncertain. All three can now be correlated confidently with the Seboomook Formation of northern Maine, which has priority. Accordingly, Pankiwskyj (1979) changed the Staples Pond, Temple Stream, and Saddleback Mountain to member rank. He retained the Temple Stream as a formal member name, but he abandoned the names Staples Pond and Saddleback Mountain because the type localities were not the most appropriate available for each unit. Pankiwskyj (1979) abandoned the name Staples Pond in favor of Day Mountain Member, and he abandoned the name Saddleback Mountain in favor of the Mount Blue Member. Pankiwskyj's (1979) member nomenclature of the Seboomook Formation of the Rumford allochthon is adopted herein.

The Day Mountain Member of the Seboomook Formation is named for cyclically graded-bedded gray metashale, and paler gray metasiltstone and metagraywacke exposed on Day Mountain at the southeast corner of the Phillips quadrangle, which is the type locality (Pankiwskyj, 1979, p. 34-39). The member also contains lenses of granule metaconglomerate and metalimestone. The member is at least 1,000 m thick, but its upper contact is not exposed. The lower contact is gradational and the member also intertongues with the underlying Temple Stream Member.

The Temple Stream Member is named for exposures of rusty-weathering sulfidic dark-gray pelitic and arenaceous rocks and minor granule metaconglomerate exposed along Temple Stream, in the northeastern corner of the Dixfield quadrangle (Pankiwskyj, 1979, p. 31-34). The type locality is between elevations 730 and 790 feet along the stream. The member is 200-300 m thick. The lower contact is gradational.

The Mount Blue Member is named for exposures of cyclically bedded gray metashale and paler gray metasiltstone on Mount Blue, in the northern part of the Dixfield quadrangle (Pankiwskyj, 1979, p. 29-31). The type locality is at the summit of this mountain. The member is lithically similar to most of the Day Mountain Member, but is somewhat more pelitic, tends to be rustier weathering, and lacks the lenses of calcareous and conglomeratic rocks that can be mapped in the Day Mountain Member. The Mount Blue Member is 500-750 m thick in the Kingfield quadrangle. Its contact with the underlying Hildreths Formation is conformable but rather sharp.

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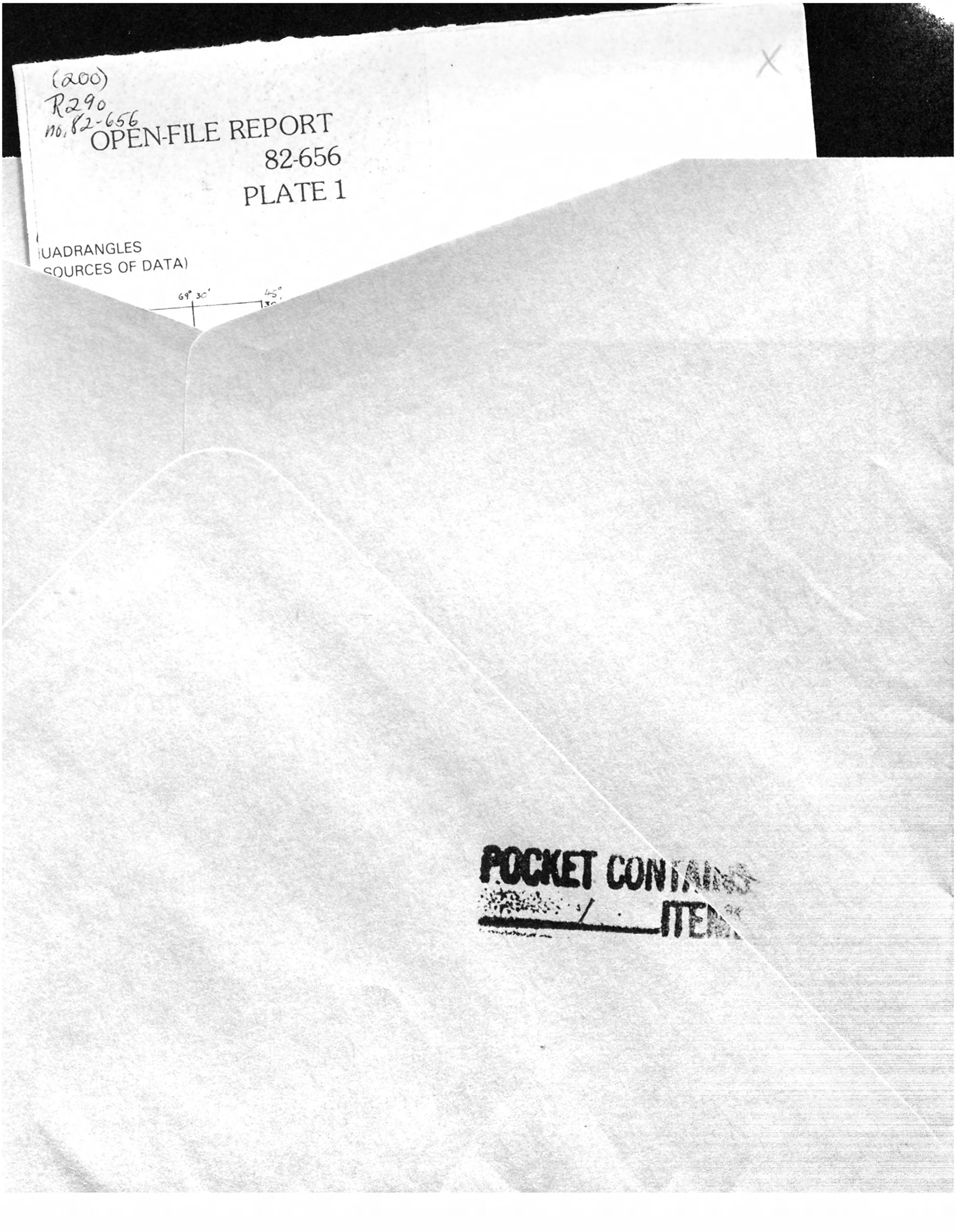
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