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**GEOLOGIC MAP AND CROSS SECTIONS  
of the  
KINGSBURY 15' QUADRANGLE,  
MAINE**

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by

ALLAN LUDMAN

Dept. of Earth and Environmental Sciences  
Queens College, City Univ. of N. Y.  
Flushing, New York

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BEDROCK GEOLOGY  
OF THE KINGSBURY QUADRANGLE,  
CENTRAL MAINE

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Allan Ludman  
Department of Earth and Environmental Sciences  
Queens College  
Flushing, New York

INTRODUCTION

The Kingsbury 15' Quadrangle is located in central Maine a few miles southeast of the axial zone of the Merrimack Synclinorium, in the heart of what Rodger (1970) termed the Central Maine Slate Belt. It is the site of major regional topographic, stratigraphic, structural, and metamorphic transitions, and is thus important in understanding the tectonic evolution of the Northern Appalachians in Maine. The change from the gently rolling hills of the adjacent Skowhegan quadrangle to the more rugged and higher topography in the Kingsbury Quadrangle marks the boundary between the Central Uplands and Moosehead Plateau (Toppan, 1935), and reflects the transition from slightly metamorphosed Silurian rocks of the south to moderately metamorphosed, dominantly Devonian rocks to the north.

Previous mapping within the quadrangle was limited to brief reconnaissance traverses in the southwestern part by Pankiwskyj (personal communication) and in the northern part by Espenshade and Boudette (1967). The adjacent Greenville (Espenshade and Boudette, 1964, 1967), Anson (Pankiwskyj, in press), Bingham (Newell, 1978), and Skowhegan (Ludman, 1977) quadrangles have been mapped in detail, and the Guilford quadrangle in detailed reconnaissance (Griffin, 1973; Ludman and Griffin, 1974). Pankiwskyj and others (1976), Ludman (1976), and Ludman and Griffin (1974) have described the regional tectonic and stratigraphic setting of the Kingsbury quadrangle.

## STRATIGRAPHY

The Kingsbury quadrangle is underlain by a thick sequence of variably metamorphosed turbiditic sedimentary rocks which range in age from Late Llandovery (Early Silurian) through Early Devonian (?), and form the southeast flank and axial region of the Merrimack Synclinorium. Although all of the stratified rocks have been multiply deformed and subjected to regional and contact metamorphism, recrystallization is for the most part slight and preservation of primary sedimentary features permits reconstruction of the original stratigraphic relationships shown in Figure 1. Several graptolite localities were discovered during mapping (see Map; Appendix I). In some instances these yielded age-diagnostic fauna provide firm ages for the lowermost two formations of the five mapped in the quadrangle.

Distinction between units of formation rank is not always straight-forward, particularly in the lower part of the section where the units are lithologically heterogeneous and contain similar rock types. For small isolated exposures, distinction between formations may prove impossible.

The names used below for the stratigraphic units reflect the advances in understanding of Maine geology in the past 10 years. Moench (1971) established a stratigraphic section in western Maine, while Pankiwskyj and others (1976) proposed one in central Maine that included rocks of the Kingsbury quadrangle. Recent work by Newell (1978) has demonstrated the equivalence of several units of the two regions. Wherever appropriate, the nomenclature of Moench (1971) is applied to the rocks of the Kingsbury quadrangle in recognition of its priority, but the names by which the rocks were described earlier (Pankiwskyj and others, 1976; Ludman, 1977) are included for clarity.

The stratified rocks of the Kingsbury quadrangle provide what appears to be a continuous depositional record of post-Taconic through pre-Acadian events. Silurian rocks (Sangerville and Smalls Falls Formations) are characterized by rapid vertical and lateral changes. They consist for the most part of metagraywacke and metapelite, and occupy the southeastern part of the quadrangle. Relatively homogeneous rocks of Late Silurian (?) and/or Devonian (?) age (Madrid Formation) are dominantly metasandstones; they are overlain by dominantly pelitic Devonian (?) units (Carrabassett and Seboomook formations) and underlie the bulk of the quadrangle.

### Silurian Rocks

#### Sangerville Formation

The Sangerville Formation (Ludman and Griffin, 1974; Pankiowskyj and others, 1976) underlies the southeastern part of the Kingsbury quadrangle and has been traced along strike for several tens of kilometers to both northeast and southwest (see Pankiowskyj and others, 1976). The formation is highly heterogeneous and is subdivided into four lithologic members characterized by turbiditic bedding features. Of these members, one comprises most of the formation; the others occur at several horizons within the formation and represent repetition of specific sedimentologic/tectonic conditions in the depositional basin and its margins.

Metagraywacke and metapelite member(Ss): Most of the Sangerville Formation consists of variably bedded metagraywacke and metapelite. Exposures on hilltops east and west of Buzzell Brook, west of King Hill, and in fields south of Trout Pond illustrate the variety of bedding style, thickness, and lithologic proportions characteristic of this member. Light buff-weathering, locally calcareous gray metagraywacke

and dark gray-black non-calcareous slate typically occur in well graded sets 4 cm to over 1.5 m thick. The abundant gradations of grain size and color within a bedding unit provide useful facing indicators throughout this member. Within a single exposure, bed thickness may span the entire range cited above, but in some exposures are of relatively uniform thickness. Metagraywacke to metapelite proportions in the graded beds range from 10:1 to 1:3, with metagrawacke dominating the thicker bedded varieties. Some horizons do not exhibit graded bedding and consist of homogeneous metagraywacke. In the Skowhegan quadrangle to the south, horizons of uniform dark gray-black slate devoid of metagraywacke are also mapped (Ludman, 1977).

Several primary bedding features are preserved in addition to the graded bedding. Convolute and cross-laminations and climbing ripple exposed north of Wellington, just north of the road to Taylor Cemetery. Scour-and-fill features, flame structures, small-scale soft sediment slump folds, and sedimentary breccias are also present, particularly in the thicker bedded graded units. Ellipsoidal calcareous pods abundant in the upper part of the formation in the Skowhegan quadrangle (Ludman, 1977) have not been observed in the equivalent position in the Kingsbury quadrangle.

The metagraywacke is characteristically poorly sorted, with clasts ranging from fine silt to coarse sand. Most of the larger clasts have been flattened and are aligned parallel to the dominant cleavage. Monomineralic clasts and polymineralic and polycrystalline lithic fragments range in abundance from specimen to specimen and are set in a variety of matrix types: argillaceous (muscovite + chlorite ± biotite), calcareous, fine grained detrital particles, or some combination of these. Some large deformed and ragged muscovite flakes appear to have

been detrital.

Metagraywacke and metapelite in chlorite-grade exposures commonly contain a ferroan carbonate phase, as along Route 154 south of Wellington. Ankerite, siderite, and some composite grains of both minerals have been identified within the area. Alteration of ferroan carbonates to limonite and hematite produces a distinctive light red-brown weathering rind which in some samples penetrates to depths greater than 3 cm. This rind is absent in rocks metamorphosed to biotite grade because of the breakdown of ferroan carbonates at the biotite isograd (Ludman, 1975).

Polymictic granule metaconglomerate members (Ssc; Sscu): Granule metaconglomerate with clasts ranging from 2.0 mm to 2.5 cm in diameter forms continuous bands at two levels within the Sangerville Formation, and also occurs as isolated lenses which interfinger with the finer grained metagraywackes. The metaconglomerate occurs either as well graded bedding units that display the nearly complete Bouma sequences of turbidity current deposits, or as massive homogeneous beds over 1 m thick. Exposures southeast of Hutchins Corner in the south-central part of the quadrangle, and east-southeast of Huff Corner illustrate the variety of bedding styles of these members.

The metaconglomerates are far less argillaceous and calcareous than the metagraywackes, and contain a fine-grained detrital matrix (quartz, plagioclase) with little muscovite, chlorite, or biotite. A wide variety of monomineralic clasts and lithic fragments has been identified in the metaconglomerates, including: quartz, plagioclase, muscovite, microcline, chert, muscovite schist, graphitic schist, felsic and mafic volcanic rocks, hypabyssal plutonic rocks with myrmekitic textures. Slate chip intraclasts ripped up from underlying beds are abundant in the well graded varieties. In the Kingsbury quadrangle, all the conglomerates are decidedly polymictic, but in

some exposures in the Skowhegan quadrangle, a single clast type predominates (Ludman, 1977). Most clasts have been tectonically elongated and many show the effects of pressure solution.

All of these types of clasts have also been identified in the metagraywacke and metapelite member, but the lithic fragment to monomineralic clast ratio is much higher in the metaconglomerate. The metaconglomerate is typically clast supported while the metagraywacke is typically matrix supported. There is little discernible difference between the upper and lower metaconglomerate members. Position within the formation is based on the position relative to the major ribbon limestone member.

Ribbon metalimestone members (Ss1; Ss11): Thinly and rhythmically interbedded dark gray argillaceous micritic metalimestone and non-calcareous slate, phyllite, and metagraywacke form distinctive members at two levels in the Sangerville Formation in the Skowhegan quadrangle (Ludman, 1977) and also occur as isolated lenses. In the Kingsbury quadrangle, only a small lens of the lower metalimestone crops out, occurring in a fault-bounded sliver in Higgins Brook in the southeast part of the quadrangle.

In most exposures, 1 mm to 10 cm thick micritic metalimestone and non-calcareous lithologies are interbedded in varying proportions. The upper member (not exposed in the Kingsbury quadrangle) is typified by a higher proportion of micrite and thinner, more regular bedding than the lower. Preferential solution of the micrite layers results in the distinctive ribbed weathering appearance that has given this rock type the name "ribbon rock" in central and eastern Maine. Non-calcareous lithologies associated with the micrite are typical Sangerville slates and metagraywackes, but are not as well graded as most. Some of the metasandstones show excellent cross-laminations.

The ribbon metalimestone in the Kingsbury quadrangle is exposed only in the chlorite metamorphic zone. It consists of very fine grained, only slightly recrystallized gray calcite muds with up to 35% chlorite, muscovite, and fine grained quartz, plagioclase, and pyrite.

Crinoid columnal segments have been identified in the Skowhegan quadrangle on strike with the Kingsbury exposures, and similar fossils have been found to the northeast in the Dover-Foxcroft quadrangle by Giffin (1973), but no fossils have been found in the Kingsbury exposures. An attempt to find microfossils in ribbon metalimestones from the Kingsbury and Skowhegan quadrangles was unsuccessful.

Carbonaceous metapelite member (Ssr): Small isolated lenses of carbonaceous metapelite (slate, phyllite) with associated sulfidic and non-sulfidic metagraywacke and metamudstone occur at several horizons within the Sangerville Formation, commonly associated with ribbon metalimestone and granule metaconglomerate. Some lenses consist entirely of pyritiferous, highly carbonaceous, soft sooty metapelite; others contain nearly equal amounts of pyritiferous and non-pyritiferous metagraywacke and metamudstone interbedded with the metapelite on a scale of 2-8 cm. In many exposures, 1-5 mm laminae of non-sulfidic white weathering metasiltstone are intercalated with the carbonaceous rocks. Volumetrically this member is the least significant part of the Sangerville Formation. Its importance is the fact that it contains 12 of the 13 graptolite localities discovered in the formation (Pankiwskyj and others, 1976).

Lateral variations: In addition to the local interfingering of the minor members of the Sangerville Formation along strike, systematic regional cross-strike changes have been observed (Ludman and Griffin, 1974; Pankiwskyj and others, 1976). In the Kingsbury and Anson (Pankiwskyj, in press) quadrangles, the Sangerville is thicker bedded,

coarser grained, and has a greater volume of metaconglomerate and lower volume of metapelite than in exposures to the southeast in the Skowhegan and Pittsfield quadrangles. In the Pittsfield quadrangle, the Sangerville interfingers with the thin-bedded, fine grained eastern facies of the Waterville Formation of Osberg (1968).

Age and correlation: In the Kingsbury quadrangle, graptolites collected from three localities yield an age of Late Llandovery through Middle Wenlock for the Sangerville Formation (Appendix I). Similar ages have been obtained from graptolites in the Anson and Skowhegan quadrangles where the Sangerville Formation is overlain by the Smalls Falls Formation (Pankiwskyj and others, 1976). In the type area of the Sangerville Formation, in the eastern part of the Guilford quadrangle, the Smalls Falls Formation is absent and the Sangerville passes directly upward into the Vassalboro Formation (a Madrid correlative). In the type area, graptolites indicate that the formation is of Late Llandovery through Early Ludlow age (Pankiwskyj and others, 1976, Appendix II). Although the upper contact of the Sangerville Formation with the Smalls Falls and Vassalboro Formations is well documented, the lower contact has not been recognized and it is possible that the formation is in part as old as Upper Ordovician.

On the basis of faunal evidence and lithologic similarity, the Sangerville Formation is equated with the eastern and western facies of the Waterville Formation and the Mayflower Hill Formation in the Waterville and Pittsfield quadrangles to the south. It is also correlated with the Rangeley and Perry Mountain Formations in western Maine (Moench, 1971) by lithologic similarity and similarity of stratigraphic sequences. The ribbon metalimestone members have been traced to the southwest into the Patch Mountain and Berry Ledge Formations (Pankiwskyj and others, 1976), and thus provide firm correlation with

the highly metamorphosed terrain of western Maine.

To the east and east-northeast, Griffin (1973) has traced the Sangerville to the Penobscot River. There are many similarities in lithology, bedding style, and stratigraphic sequence between the Sangerville and the Digdeguash Formation of eastern Maine and southwestern New Brunswick (Ruitenberg and Ludman, 1978) and the two may be correlative albeit on opposite sides of the axis of the original depositional trough (see below). The "ribbon rock" of the Carys Mills Formation of the Meduxnekeag Group in the Arcostook-Metapedia region (Pavlidis, 1968) is similar to the Sangerville metalimestones and is known to range from Ordovician through Early Silurian. It and the Smyrna Mills Formation of northeastern Maine are probably also correlatives of the Sangerville.

SMALLS FALLS FORMATION (Parkman Hill Formation of Pankiwskyj and others, 1976):

The Smalls Falls Formation consists of rusty weathering sulfidic metasandstones, metasiltsstones, and granule metaconglomerates interbedded with highly carbonaceous sulfidic metapelite and very minor calcareous rock types. In the Kingsbury quadrangle, the carbonaceous metapelite and coarser clastic rocks are nearly equal in abundance, and may be readily observed along Route 151 south of Brighton and on hills northeast of Burdin Corner. The Smalls Falls Formation is as heterogeneous as the Sangerville, but the different rock types which comprise it are interbedded on too small a scale to permit separation on the geologic map. Of the different lithologies found in the formation, only the ribbon metalimestone does not exhibit a rusty to sluggy weathering color.

Lithology: Thick-bedded (5 cm to >1m) dark gray sulfidic rusty-

weathering metasandstone and metasilstone form a large part of the Smalls Falls Formation. They are commonly associated with carbonaceous and non-carbonaceous metapelites, but generally do not display the graded bedding common in the Sangerville Formation. Most beds are massive and show few turbidite bedding features. Some subordinate non-sulfidic metagraywackes are associated with the sulfidic types.

Massive, non-graded granule metaconglomerate similar in outcrop appearance to non-graded Sangerville metaconglomerate crops out extensively, particularly along Crow Hill at the eastern edge of the quadrangle and along strike in the Guilford quadrangle to the east. Quartzose and polymictic types have been observed. The metasandstones and metaconglomerates comprise nearly 50% of the formation.

Sulfidic, highly carbonaceous metapelites make up approximately 50% of the formation, and occur either interbedded with the coarser clastic metasedimentary rocks described above or as the dominant rock type in horizons with minor (10-20%) fine grained metasilstone interbeds. The 2-4 mm thick laminae of sulfidic metasilstone are more resistant to weathering than the pelite and form small ribs on outcrop surfaces. In these interlaminated rocks, graded bedding is generally well developed.

Two types of calcareous rocks are found in the Smalls Falls Formation, but are relatively rare. They amount to less than 1% of the observed outcrops. One, found sparsely but throughout the formation, is a thinly bedded (1-4 cm) highly calcareous sulfidic metasilstone which has a characteristic slaggy weathering rind. Because of preferential solution it is outlined in outcrop as low bands between carbonaceous pelite or metasandstone layers. The other type is a ribbon metalimestone indistinguishable in the field or in thin section from the Sangerville metalimestones. It occurs only at the upper

contact with the Madrid Formation in the Kingsbury Stream at the eastern margin of the quadrangle.

Pyrite is the most common sulfide mineral, occurring as recrystallized euhedral cubes in some metapelite, and as elongate blebs or skeletal grains in other rock types. Pyrrhotite occurs in the higher metamorphic grades, and pyrite-pyrrhotite assemblages have been identified in a few exposures in the Skowhegan quadrangle.

Most of the rock types described above are similar to those which make up the Sangerville Formation. Indeed, the very subordinate carbonaceous metapelite of the Sangerville is essentially the same as that which forms nearly half of the Smalls Falls Formation in the Kingsbury quadrangle. Similar environmental conditions obviously existed during deposition of the two formations. Only relative proportions of rock types, probably reflecting varying durations of these conditions, are different. In many instances there is difficulty in distinguishing the two formations from single outcrops, but some differences have been noted in the coarser grained rocks. The matrix of Smalls Falls metaconglomerate is generally even less argillaceous than that of Sangerville counterparts, consisting of fine grained quartz and plagioclase. As a result, Smalls Falls metasandstones and metaconglomerates tend to be gray whereas Sangerville types would be greenish or purplish due to chlorite or biotite in the matrix. Further, although nearly all clast types found in the Sangerville Formation have also been identified in the Smalls Falls, the latter is characterized by dominance of siliceous clasts--quartz, chert, and quartzite.

Internal stratigraphy and contact relationships: Reconstruction of the internal stratigraphy of the Smalls Falls Formation is complicated by the intense folding and by the tendency of the carbonaceous metapelite to be smeared out in shear zones. The contact with the

regularly bedded, strongly-laminated metagraywacke and metapelite of the uppermost Sangerville Formation is sharp and is drawn at the first sulfidic, thick bedded metapelite or metasandstone (as along the dirt road north from Wellington). There is often some shear along this contact, as in the vicinity of Huff Mountain due to the contrast in competence between the two formations.

The lower part of the Smalls Falls Formation is characterized by the thick bedded metasandstones, with only minor carbonaceous pelite and calcareous metasiltsstones. Bedding thickness decreases and carbonaceous metapelite gradually increases in abundance upward so that these phyllites dominate the upper part of the formation. Granule metaconglomerate occurs as lenses throughout the formation but is most abundant near the base. Ribbon metalimestone appears only near the uppermost part of the formation. The upper contact is a zone of approximately 75 meters of interbedded sulfidic metasiltsstone and metapelite and non-sulfidic massive metasandstone of the Madrid type (see below), with the contact placed at the uppermost sulfidic lithology.

Lateral variations: The Smalls Falls Formation in the Kingsbury quadrangle contains more coarse clastic rocks and less carbonaceous pelite than correlative rocks in the southern part of the Skowhegan quadrangle. This appears to be part of a regional eastward-fining trend which also affects the Sangerville Formation and reflects increasing distance from a source area in the western part of the state (Ludman and others, 1972; Pankiwskyj and others, 1976).

Age and correlation: Graptolites collected from five localities in the Kingsbury quadrangle are poorly preserved, and yielded little age-diagnostic evidence (Appendix I). Well-preserved specimens from the Guilford quadrangle just east of the Crow Hill, however, are clearly of Ludlow age (Appendix I), and the relationship with the underlying

Sangerville Formation indicates a range of Middle Wenlock to Early Ludlow for the formation.

Detailed mapping by Newell (1978) in the adjacent Bingham quadrangle demonstrated the continuity of rocks similar to those of the Kingsbury quadrangle with those in the type locality of the Smalls Falls Formation of western Maine. Although bands in the Kingsbury quadrangle are not continuous with those in Bingham, structural reconstructions suggest that the rocks are indeed the same. The name Smalls Falls Formation is thus applied to this unit, replacing the term Parkman Hill Formation for reasons of prior usage. Analogous arguments support the same change in nomenclature in the Skowhegan quadrangle to the south. The faunal evidence indicates that the Smalls Falls Formation in the Kingsbury quadrangle is equivalent to the uppermost horizons of the Waterville and Sangerville formations in their type localities. The demonstrated equivalence of Kingsbury rocks with those of the Smalls Falls Formation in the Rangeley-Phillips area provides an age for the unfossiliferous rocks to the west.

#### Silurian (?) and/or Devonian (?) Rocks

Madrid Formation (Fall Brook Formation of Pankiwskyj and others, 1976)

The Madrid Formation crops out extensively near the axis of the Merrimack Synclinorium, and underlies a large portion of the Kingsbury quadrangle. It has only been observed there in biotite and higher metamorphic grades, but bedding features are well preserved so that correlation can be made with less recrystallized rocks to the east. The formation is relatively homogeneous when compared with the underlying Sangerville and Smalls Falls formations. Exposures on hills in and near Brighton, on and south of Foss Mountain near Hilton Ponds, and in the extreme northwestern part of the quadrangle provide excellent

examples of Madrid lithologies.

**Lithology:** Three distinctive lithologic assemblages make up nearly all of the Madrid Formation. The vast majority of exposures (70%) are of a buff-weathering, variably bedded (4 cm to over 2 m), pale-purplish gray, variably calcareous metasandstone. Bedding thickness appears to be bimodal; 4 to 10 cm thick interbeds of metasandstone and a slightly finer grained metasilstone are abundant and are characterized by a ribbed weathering habit in which the finer grained rock weathers more deeply than the coarser. This is due to the development of cleavage in the metasilstone which permits deeper solution of the calcite. Many exposures are composed of beds which appear to be massive (40 cm to 2 m), and many beds are indeed thicker than 1 m. Careful inspection of fresh surfaces, however, reveals paper thin pelitic partings in the thicker beds. It is not clear whether these partings represent primary layers or transposed pelitic material moved along cleavage. Much of the metasandstone is calcareous, and calc-silicate pods, stringers, and beds are commonly intercalated with less calcareous beds. Most beds are of homogeneous grain size (fine to medium sand) and graded bedding is rare. Cross-bedding, defined by concentrations of biotite flakes, is common in the thicker beds. A feature unique to these metasandstones is the scarcity of pelitic interbeds and the nearly total absence of muscovite from the matrix. Thin phyllite beds are present, but are extremely rare in these metasandstones.

In thin section, these metasandstones are a mosaic-textured aggregate of quartz and untwinned plagioclase feldspar, with unfoliated red-brown biotite porphyroblasts. Stained thin sections reveal up to 35% plagioclase content; unstained sections appear to be of quartz and biotite only. Actinolite and grossularite are found in the calc-silicate rocks along with calcite, quartz, plagioclase, and a phlogopitic biotite.

Approximately 20% of the Madrid Formation in the Kingsbury quadrangle consist of very regularly (4-15 cm) and rhythmically interbedded fine-grained argillaceous metasandstone and biotite-muscovite-quartz phyllite. In contrast to the more massive metasandstones described above, these beds are generally very well graded and contain laminations parallel to bedding planes rather than cross-laminations. Muscovite is an abundant constituent of the matrix of these metasandstones, calc-silicate material is generally absent, and the metasandstone is non-calcareous. Large (3 mm) bronze-weathering biotite porphyroblasts oblique to the dominant foliation occur in both phyllite and metasandstone. These thinner and more regularly bedded rocks have not been separated from the more massive rocks on the map as they are intimately interlayered.

Variably bedded coarse-grained calcareous and non-calcareous metagraywacke and biotite-muscovite-quartz-plagioclase phyllite displaying partial Bouma sequences occur in the uppermost part of the Madrid Formation and comprise perhaps 5% of the unit. In coarseness of grain size, poor sorting, and presence of turbiditic features like sole markings, scour-and-fill, and graded beds, these rocks closely resemble Sangerville types, but contain bedded calc-silicate unlike that seen in the Sangerville.

Two other rock types are found in the Madrid Formation but are subordinate to those described above. Sulfidic carbonaceous metapelite described in the formation in the Skowhegan quadrangle, however, has not been observed in Kingsbury. A unique zone of intraformational coarse blocky breccia is developed in the thick-bedded metasandstone and is best observed in the southwest corner of the quadrangle in woods west of Moody Corner, and in the adjacent Bingham quadrangle. Randomly oriented blocks of metasandstone up to 2 m on a side are engulfed in a

matrix of identical metasandstone. Such rocks appear to be restricted to a single stratigraphic horizon and may represent the front or base of a major soft-sediment slump mass (see below).

Internal stratigraphy and lateral variation: The lower part of the Madrid Formation in the Kingsbury quadrangle consists almost entirely of the massive metasandstones. The regularly interbedded metasandstone and phyllite gradually increase in abundance upward in the section, but decrease again near the top. The uppermost 100 m consists of the turbiditic metasandstone and metapelite, and these rocks grade upwards with a decrease in bedding thickness into the massive dark gray slates of the basal Carrabassett Formation. Excellent facing evidence at this contact is visible at and west of Mayfield Corner on Route 15.

Unlike the older units, there does not seem to be much interfingering of rock types within the Madrid Formation, and it is apparently uniform throughout its outcrop belts within the Kingsbury quadrangle. Across strike in the Skowhegan quadrangle, correlative rocks are somewhat more calcareous and less thickly bedded. Within the Kingsbury quadrangle, symmetry is well preserved across synclinal structures involving the Madrid, except where faulting has removed parts of the formation, as in the fault through Kingsbury Pond.

Age and correlation: No fossils have been found in the Madrid Formation in the Kingsbury quadrangle, or, for that matter, in any of its outcrop belts in west-central Maine. Its position, as demonstrated by primary sedimentary features, requires that it be younger than the Smalls Falls Formation and older than the Carrabassett Formation. An age of Late Silurian (Post-Early Ludlow) to Early Devonian (?) is indicated by these relationships.

Lithologies similar to those of the Madrid Formation crop out

extensively throughout western, southern, and southeastern Maine and portions of adjacent New Brunswick. Based on similarity of lithology, bedding, and stratigraphic sequence, the following units are considered here to be correlative with the Madrid Formation: Bucksport, Berwick, and Flume Ridge Formations. Relationships with the similar rocks of the Vassalboro Formation in the Waterville quadrangle (Osberg, 1967) are unclear at this time.

#### Devonian (?) Rocks

Carrabassett Formation (Solon Formation of Pankiwskyj and others, 1976)

The Carrabassett Formation crops out in the keels of four synclinal structures in the Kingsbury quadrangle, and can be traced continuously to the northeast to Monson (Greenville quadrangle) and Brownville Junction (Sebec quadrangle) where it was extensively quarried for slate in the past. The best exposures of the formation in the Kingsbury quadrangle are in the Piscataquis River in the northeast corner, on Crockett Ridge in the north-central part, and on Route 16 near the western edge.

**Lithology:** Most of the Carrabassett Formation consists of a medium to dark gray weathering dark gray slate or phyllite. The basal part of the formation in particular is a dense homogeneous slate with little interbedded coarser clastic material. Only a few thin light gray weathering metasilstone laminae and pulled-apart beds occur in the lower slate and are aligned in the dominant cleavage. About 100 m above the base, light gray weathering metasilstones and metasandstones appear as laminae and then as thin beds in the slate (5 cm thick), but amount to less than 10% of exposures in which they occur. Further upward in the formation, horizons of well graded gray metasandstone and metapelite in units 4 cm to 25 cm thick (as at Whetstone Pond) and

rocks on strike or clearly correlative with it in adjacent areas. Expenshade and Boudette (1967) reported fragments of a primitive plant (Psilophyton?) from similar slates mapped as "Devonian pelite" in the Greenville quadrangle to the north, and poorly preserved brachiopods (Howellella (?) or Acrospirifer (?)) in the Sebec Lake quadrangle. Although not age-specific, these flora and fauna are in accord with the Early Devonian age suggested by the stratigraphic position of the Carrabassett above the Madrid.

Slates of the Carrabassett Formation can be traced continuously toward the northeast, and they underlie large portions of the Guilford, Sebec, and Sebec Lake quadrangles where extensive quarrying had led to the designation of the region as the Central Maine Slate Belt. To the west, the Carrabassett is traced by Newell (1978) to the type section established by Boone (1973) in the Little Bigelow Mountain quadrangle. The Carrabassett is correlated with the lower part of the Seboomook Formation as defined by Boucot (1967) and described in western Maine by Moench (1971).

#### Seboomook Formation

Cyclically interbedded metasandstone and slate mapped as Seboomook Formation crop out in the northeastern part of the quadrangle, and are best exposed in cliffside exposures north of Route 16 just west of Cole Corner. In most of its restricted outcrop belt, only pavement exposures are available, and in these it appears to be a well cleaved sandy slate. Only in the good three-dimensional exposures can bedding, often perpendicular to the cleavage, be clearly observed. The formation may underlie a larger part of the Kingsbury and adjacent quadrangles, but identification without adequate exposures is impossible.

The Seboomook Formation in the Kingsbury area is composed of

massive metasandstone (as at the unnamed hill south of Route 16 at the western edge of the quadrangle) become important but still subordinate to the slate. Small lenses of feldspathic granule metaconglomerate form a minor part of the formation, and are most prominent near the upper contact.

The Carrabassett Formation is exposed in the biotite, garnet, chloritoid, staurolite, and andalusite metamorphic zones, but not until the staurolite zone does recrystallization of muscovite produce more than a slight phyllitic sheen. Garnet, chloritoid and staurolite porphyroblasts are commonly less than 2 mm in diameter but are generally euhedral. Chloritoid porphyroblasts up to 2 cm on a side, and pinkish andalusite crystals up to 7.5 cm long have been found in the formation near Mayfield Corner and Russell Mountain respectively.

The lower contact with the Madrid Formation is exposed at Mayfield Corner, on the unnamed ridge north of Kingsbury Pond, and in several places in the northern part of the quadrangle. Graded bedding at these contacts clearly demonstrates that the Carrabassett is younger than the Madrid. The contact with the Sebocmook Formation is covered, but Boone (1973) demonstrated continuous sedimentation across this contact in the Little Bigelow Mountain quadrangle, and the two formations are probably conformable in the Kingsbury area.

Although a general idea of the internal stratigraphy of the formation has emerged, poor outcrop control has prevented a more detailed picture from evolving. Little can be said concerning the continuity of the well graded rocks like those near Whetstone Pond, and rather than present a potentially misleading picture of discontinuous lenses, these rocks have not been mapped separately.

Age and correlation: Fossils have not been found in the Carrabassett Formation in the Kingsbury quadrangle, but have been reported in

distinctive dull gray weathering dark gray metasandstone and slate that occur in well developed graded beds. Although bedding thicknesses for the entire formation are quite variable, the bedding at single outcrops tends to be remarkably uniform. Most graded sets are composed of nearly equal amounts of metasandstone and metapelite ranging from 5 to 15 cm in thickness. Very thick beds (up to 1 m) contain as much as 65% metasandstone. Thinly interlaminated metasandstone and slate (2 mm to 1 cm) form thin horizons in several parts of the formation, but appear to be of minor importance.

The regularity of bedding, extensive development of graded beds, and equal proportion of metasandstone and slate distinguish the Seboomook Formation from the underlying Carrabassett.

Age and correlation: Based on its high position in the stratigraphic section and its strong similarity to the Seboomook Formation of northern Maine, an Early Devonian age is postulated for the formation in the Kingsbury quadrangle. The cyclically bedded rocks closely resemble those described by Boone (1973) as the lowest member of the Seboomook Formation in the Little Bigelow Mountain quadrangle, and their position in the section is comparable.

#### Stratigraphic Summary

The five stratigraphic units described above provide a clear record of post-Taconic, pre-Acadian events in a sedimentary basin surrounded by unstable highlands on the active margin of the Paleozoic North American continent. Three different types of sedimentary regimes are represented by the stratified rocks, reflecting changes in tectonism outside the basin.

From Early Llandovery through Early Ludlow times, erosion of Taconic highlands to the west caused debris to be shed into the

sedimentary basin. The Sangerville Formation represents an intermediate turbiditic lithofacies, with the Rangeley Formation and eastern facies of the Waterville Formation being the proximal and distal facies respectively. Evidence for an eastern source area (Ludman and Griffin, 1974) indicates that the basin was two-sided, an elongate sedimentary trough, and that the rocks in the Kingsbury quadrangle lay on the western side of the trough axis. The instability of the marginal highlands is indicated by the lithologic heterogeneity and complex interfingering of the Sangerville Formation.

Most deposition within the trough was by downslope-moving turbidity currents, but some material was apparently deposited by axial contour currents. The ribbon metalimestones of the Sangerville and eastern facies Waterville Formations (Ludman, 1977) are concentrated near the axial region of the trough. Similar lithologies are absent from the western flank in the sections described by Moench (1971) and Boone (1973), and from the eastern flank (Larrabee and others, 1965). These metalimestones were probably derived from the northeast from the Aroostook-Matapedia Platform with axial currents bringing the lime muds into deeper parts of the trough.

From Middle Wenlock through Early Ludlow times, significant lowering of the western margin had been achieved, as indicated by the predominance of siliceous clasts in the Smalls Falls Formation, probably reflecting increased chemical weathering in the source areas. During this time an euxinic environment was developed on the western flank of the trough (Smalls Falls Formation), but did not extend to the axial region or eastern flank. Continued instability is reflected by the variable and interfingering nature of the rock types in the Smalls Falls Formation.

With the onset of deposition of the Madrid Formation and its

equivalents in post-Early Ludlow time, sedimentary regime changed markedly. Lithologic heterogeneity and abrupt vertical and lateral intraformational variations that characterized the older Silurian formations were replaced by a relatively homogeneous, laterally uniform blanket of metasandstone. This blanket, composed of the Madrid Formation and its equivalents, exhibits no systematic lithofacies variation and is of an unknown source. This change marks the end of the western area as a source of sediment for the trough. Boucot (1961) and Boone and others (1970) demonstrated that the Somerset Geanticline, presumed source of the earlier Silurian sediment, had been covered by shallow water sediments by Early Ludlow time.

Another major change in sedimentation is indicated by the deposition of the Carrabassett and Seboomook Formations. Deposition of a thick sequence of these flyschlike units suggests general subsidence of the sedimentary trough, and probably marks the initial disturbances of the Acadian orogenic event.

#### STRUCTURAL GEOLOGY

The stratified rocks described above have been subjected to several deformational events of varying intensity, scale, and style, including some deformation that accompanied deposition. Response to deforming stresses was highly variable, depending on the competence of the lithology or group of lithologies involved. Thus, thick sections of relatively homogeneous rocks in the northern part of the quadrangle occur in relatively simple folds, whereas numerous faults and minor shear zones indicate much more complex response by the far more heterogeneous rocks in the south. Deformational complexity is greatest in areas underlain by the Smalls Falls Formation where thick zones of incompetent carbonaceous metapelite have served as loci of faults.

Nearly all rocks in the quadrangle are steeply dipping and trend northeast to east-northeast.

#### Soft-sediment deformation

Evidence of small-scale deformation contemporaneous with deposition has been observed in the Sangerville and Madrid formations. Distinction between soft-sediment and regional isoclinal deformation is difficult because the two are essentially coaxial in the Kingsbury area, but can be made in many instances using the criteria enumerated by Griffin and Lindsley-Griffin (1974). Slump folds characterized by welded contacts, blunt fold noses, highly variable hinge lines, and small-scale fine-grained sedimentary breccia were produced by plastic flow of partially lithified turbidites. The breccias, generally no coarser than 1 cm, represent disaggregation of somewhat more lithified beds in a more plastic, water-saturated sequence.

Regional scale pre-metamorphic slump folds and faults may have occurred in the upper part of the section in the Kingsbury quadrangle in a manner analogous to that suggested by Moench (1970) for rocks of western Maine. The chaotic coarse sedimentary breccia of the Madrid Formation contains metasandstone blocks in a metasandstone matrix. This horizon may represent large scale prelithification deformation, but the boundaries of a large slump mass have not been identified. Regional scale slumping has been recognized by Moench (1970) in western Maine and by Pankiwskyj and Moench (written communication, 1976) in central Maine. The central Maine localities are on strike with the outcrop belts of the Carrabassett Formation in the Kingsbury quadrangle. Poor outcrop control, the difficulty in distinguishing Carrabassett from Seboomook rocks in two dimensional outcrops, and the occurrence of late brittle deformation in the outcrop belts involved prevent

conclusive evidence of soft-sediment faulting from being gained. If the Madrid sedimentary breccia was produced during such faulting, it is possible that the Seboomook and portions of the Carrabassett may have been emplaced while still partly lithified. In the absence of firm evidence, an interpretation based only on post-lithification deformation is shown on the geologic map.

#### Post-lithification deformation

Three periods of post-lithification ductile deformation ( $F_1$ ,  $F_2$ ,  $F_3$ ) have been recognized in the adjacent Skowhegan quadrangle (Ludman, 1977). The first two of these are observed in Kingsbury, but the third does not seem to occur as regularly as in rocks to the south and may be a local disturbance. In both areas, the first deformation was the most intense and is responsible for most of the outcrop pattern shown on the map.

$F_1$ : The earliest post-lithification deformation recognized in the quadrangle produced upright isoclinal folds which have affected all stratigraphic units. These folds trend northeast to east-northeast, plunge gently to the northeast or southwest, and have hinge surfaces which are either vertical or overturned slightly to the northwest. A strongly penetrative axial plane cleavage ( $S_1$ ) is associated with these folds, and in some instances a foliation defined by muscovite, chlorite, and biotite flakes parallels this cleavage. Deformed clasts in coarse metasandstones and granule metaconglomerates are aligned with their longest axes in the plane of  $S_1$ . Pressure solution of Sangerville ferroan carbonates has produced strain shadows and zones of insoluble residue clearly related to the production of  $S_1$ .

$F_1$  folds of several orders of magnitude have been recognized in the map area, ranging from microscopic to regional. Outcrop-scale

$F_1$  folds are visible throughout the Skowhegan and Kingsbury quadrangles and large exposures typically reveal several folds. Reversals of facing as indicated by primary sedimentary bedding features indicate small scale mesoscopic  $F_1$  folds with wavelengths of 0.75 to 1.8 km, and the folds outlined by Carrabassett and Madrid rocks in the northern part of the quadrangle have a 5-6 km wavelength. These folds all seem to be parasitic to the major structure in central Maine, the Merrimack Synclinorium.

$F_2$ : Throughout the Kingsbury quadrangle, a well developed closely-spaced fracture cleavage cuts both bedding and  $S_1$  in slates. This second cleavage ( $S_2$ ) trends more northerly than  $S_1$  ( $355$  to  $015^\circ$ ), and dips steeply to both east and west. Small-scale folds associated with this cleavage are exposed only rarely in the Kingsbury quadrangle, but may be observed in Carrabassett slates west of Mayfield Corner and in the adjacent Guilford quadrangle north of Abbott Village.  $F_2$  folds are well displayed at Harmony in the Skowhegan quadrangle (Ludman, 1977). They are upright, very steeply plunging dextral asymmetric folds.

$S_2$  is strongly developed throughout much of central Maine (Ludman and Griffin, 1974) so that its regional extent is clearly demonstrable even though there is little indication of major folding associated with it. Complex strain shadows in some ferroan carbonate grains and a weak muscovite foliation in some pelitic rocks appear to be related to  $S_2$ .

Regional trends of bedding and  $S_1$  change from  $030^\circ$  in the Skowhegan quadrangle and southern parts of the Kingsbury quadrangle to  $055^\circ$  and  $080^\circ$  in the east and northeast. This flexure is clearly post- $F_1$ , but is also older than  $F_2$  since  $S_2$  maintains its attitude throughout the region.

### Faulting

Northeast-trending faults cut intensely folded rocks of the Sangerville and Smalls Falls Formations in a highly sheared zone nearly 3 km wide. Gouge, mylonite, aligned topographic lows, springs flowing through aligned fractures in dense bedrock, and abrupt stratigraphic discontinuities have been used to identify and trace the individual faults, but it is probable that those shown on the map are but a small fraction of those present in the disturbed zone. The faults parallel or cross bedding at a small angle, and seem to be nearly vertical. Displacement, indicated by slickensides, drag folds, and sense of stratigraphic offset, has been of a dip-slip nature in most instances. Strike-slip movement was associated with some of the faults east of Huff Corner.

Faulting in this zone appears to have accompanied  $F_1$  deformation in areas where competence contrasts were extreme. Thus, Smalls Falls carbonaceous metapelite underwent extreme ductile deformation during  $F_1$  but the more competent metaconglomerates and massive metasandstones could not and responded brittly. The disturbed zone has considerably shortened the northwest-facing limb of a mesoscopic  $F_1$  fold, the Chapman Ridge Anticline.

Competence contrasts and different behavior during  $F_1$  may also explain other major faults such as those separating Carrabassett slates from massive Madrid metasandstones in the central and northern parts of the quadrangle, and Sangerville metagraywacke and metalimestone in the south.

### Age of deformation

$F_1$  and  $F_2$  appear to have been separate pulses of the Acadian Orogeny.  $F_1$  folding affects rocks of the Seboomook Formation,

indicating a maximum age of Early Devonian for the deformation. In the Skowhegan quadrangle, the Middle Devonian Hartland Pluton cuts  $F_1$  folds. The age of  $F_1$  is thus clearly bracketed within a narrow time span.

Andalusite porphyroblasts produced by metamorphism associated with emplacement of the Russell Mountain Pluton (see below) cut  $S_2$  cleavage in Carrabassett Formation rocks at Whetstone Pond, indicating that the plutonic events in the Kingsbury quadrangle are post- $F_2$ . Radiometric ages of the Kingsbury plutons are not available, but most plutons dated in central Maine are of Middle Devonian age and it is likely that this age is appropriate for the Russell Mountain body.  $F_2$  would thus also be a pulse of the Acadian Orogeny.

#### IGNEOUS ROCKS

Two small granitic plutons intrude the Carrabassett and Madrid formations in the northern part of the map area. The more easterly of the two, here named the Russell Mountain Pluton, was previously unreported and is not shown on previous geologic compilations of the state (Keith, 1933; Doyle and Hussey, 1967). The Bald Mountain Stock occupies the northwest corner of the quadrangle and has its maximum extent in the adjacent Bingham and The Forks quadrangles. Detailed mapping has revised its contact with host rock from that shown by Doyle and Hussey (1967).

Both plutons intrude tightly folded Devonian and Siluro-Devonian rocks and are post-kinematic Acadian intrusives. Both are smaller than the Hartland Pluton in the Skowhegan Quadrangle, and show little of the textural and mineralogic variability of that body (Ludman, 1977).

#### Russell Mountain Pluton

The southern half of Russell Mountain, Little Russell Mountain and the unnamed hills surrounding Punchbowl Pond are underlain by the Russell Mountain Pluton. This body is composed of relatively uniform buff-weathering gray biotite-muscovite granodiorite. Most specimens are medium to coarse grained, with the finer grained varieties constituting a slightly chilled margin around the coarser grained core. All specimens are hypidiomorphic granular; neither foliated nor porphyritic varieties have been observed.

In thin section, there appear to be two different generations of plagioclase feldspar. The dominant type is slightly zoned, has sharp, clear grain boundaries, and is only slightly altered to clay minerals. The other, apparently older one, has somewhat irregular ragged grain boundaries, and is extensively altered to sericite. Both display weak zoning. Microcline is the potassic feldspar and it occasionally displays a myrmekitic texture at contacts with plagioclase. Biotite is deep red-brown and contains abundant inclusions of zircon surrounded by pleochroic haloes.

The Russell Mountain Pluton intrudes folded ( $F_1$  and  $F_2$ ) rocks of Devonian (?) age, and by analogy with the radiometrically dated Harland Pluton of the Skowhegan quadrangle, is probably of Middle Devonian age.

#### Bald Mountain Stock

The southeastern extension of the Bald Mountain Stock in the Kingsbury quadrangle underlies a low swampy area with little bedrock exposure except for the hornfels rim at Foster Ridge. Rocks in the few outcrops within the quadrangle are biotite-muscovite granodiorites very similar to those of the Russell Mountain Pluton. The Bald Mountain rocks are somewhat more diverse, however, in the occurrence of

porphyritic varieties in addition to the dominant hypidiomorphic granular rocks. Petrographically, the rocks of the two bodies are nearly identical. Only plagioclase phenocrysts up to 4.0 cm long in the Bald Mountain body are unique. Field relationships suggest a similar age as well.

A four mile wide band of low-grade metasedimentary rocks separates the two plutons. Thus, although the two are petrographically, geographically, and almost certainly genetically related, their contacts with host rock in the intervening area are steep.

#### METAMORPHISM

The Kingsbury quadrangle lies in the transition zone between those rocks of eastern and northeastern Maine that have been only slightly affected by regional metamorphism and those of west-central and western Maine that have been intensely recrystallized during regional metamorphism. Most of the quadrangle is underlain by rocks subjected to conditions of the green-schist facies (chlorite, biotite, and garnet zones), but staurolite-bearing assemblages marking conditions of the amphibolite facies have been observed in a small area just south of Route 16, west of Mayfield Corner. Sharply defined contact aureoles surround the two plutons in the quadrangle and were superimposed on the regionally metamorphosed terrain.

#### Regional metamorphism

Metamorphic recrystallization has for the most part not destroyed primary sedimentary features, although there has been some modification of texture. Coarse clasts in the metaconglomerates and metasandstones are identifiable at all metamorphic grades in the quadrangle, but the finer grained matrix minerals are recrystallized to form a

mosaic texture at the higher grades. Recrystallization of muscovite and the generation of biotite significantly coarsens the pelitic rocks and produces a phyllitic sheen throughout the Carrabassett Formation. Most of the rocks in the quadrangle are psammitic and do not display well developed schistosity, but a weakly defined foliation is present in them, caused by alignment of flattened clasts and matrix minerals, interstitial mica and chlorite flakes, and pressure solution of ferroan carbonates.

Chlorite, biotite, chloritoid, garnet, and staurolite occur as porphyroblasts in the pelitic rocks. Most occur as small grains, less than 2.5 mm in diameter, but larger crystals are found in some exposures. Euhedral chloritoid crystals up to 2.0 cm on a side are found in Carrabassett slates 0.5 to 1.25 km north of Route 16 in Bigelow Brook, and in Bottle Brook south of Route 16. Staurolite crystals 3-4 cm long were found on the unnamed hill south of Route 16, 3 km west of Mayfield Corner.

Biotite is apparently produced by several reactions, but a single isograd is drawn on the map representing its first appearance in the rocks regardless of reaction. It forms at the lowest temperatures in pelites and psammites of the Madrid and Sangerville formations by a reaction between ankerite or siderite and muscovite. Unique prograde pseudomorphs containing biotite develop after the carbonate in some Sangerville lithologies (Ludman, 1975). In rocks devoid of ferroan carbonate, biotite appears by the reaction between chlorite and phengitic muscovite. Regardless of the reaction involved, the transition from chlorite to biotite grade is striking, as it is indicated by a change in color from gray-green to pale purple. In areas where ankeritic and non-ankeritic rocks are intercalated, biotite occurs in the formerly carbonate-bearing horizons whereas the carbonate-

free pelitic or psammitic horizons contain only chlorite. This phenomenon is particularly well displayed in hills south of Thanksgiving Pond in the northwest part of the quadrangle.

The occurrence of staurolite porphyroblasts at the expense of chloritoid in Carrabassett slates represents what is believed to be the highest regional metamorphic grade attained in the quadrangle. The area underlain by staurolite zone rocks is small but is apparently unrelated to any plutonic activity. Similar small local metamorphic highs are also found to the west in the Bingham quadrangle (Newell, 1978).

#### Contact metamorphism

The effects of contact metamorphism are clearly shown by the andalusite isograds surrounding the Bald Mountain and Russell Mountain plutons. Andalusite crystals in the Carrabassett Formation are typically pale pink in color and many are chiastolitic. These crystals decrease in size away from the plutons, and reach a maximum length of 7.5 cm near the contacts. Staurolite crystals accompany andalusite on Foss Mountain, just south of the Russell Mountain Pluton, and are apparently a contact metamorphic product.

The sequence of regional index minerals and the presence of local hot-spots suggests a moderate depth and moderate to locally high geothermal gradients for the regional metamorphism. Both regional and contact metamorphism were of Acadian (Middle Devonian) age in this area.

#### SUMMARY OF GEOLOGICAL HISTORY

Throughout most of Silurian time, erosion of highlands produced during the Taconic Orogeny to the west of the study area produced

debris that was shed eastward into a large trough. Occasional influxes of calcareous muds from the northeast contributed a minor amount of sediment. Gradual lowering of the highlands during Wenlock through Early Ludlow times resulted in an increased amount of pelitic debris and coincided with establishment of an euxinic environment in the basin. Late Silurian and Early Devonian tectonic activity outside and within the basin led to changes in sedimentary regime, apparently producing sediments from different sources than those of the older rocks. Flyschlike deposits suggest early pulses of the Acadian orogenic event.

Northwest-southeast compression, perhaps while some of the rapidly deposited rocks were still partially unlithified, produced tight isoclinal folding in the region after Early Devonian time. Regional metamorphism to staurolite zone accompanied this major pulse of the Acadian Orogeny. Two small felsic plutons intruded the deformed sedimentary rocks toward the end of the orogenic episode.

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## APPENDIX I - FOSSIL LOCALITIES AND FAUNAL ASSEMBLAGES

SANGERVILLE FORMATION

Location: 100 feet west of dirt road, 0.8 miles south of Burdin Corner.

Fauna: Cyrtograptus (?) sp.; Monograptus sp.

Age: Silurian, possible late Llandoveryan through Wenlockian.

Location: Higgins Brook 0.2 miles south of junction with tributary that flows through Wellington.

Fauna: Cyrtograptus sp. (probably C. perneri); Monograptus flemingii (?); Monograptus pseudodubius; Monograptus sp.

Age: Middle Wenlockian.

SMALLS FALLS FORMATION

Location: East side of dirt road 1.75 miles north of Wellington.

Fauna: Monograptus sp. (of M. dubius group); Monograptus sp. (similar to M. flemingii (Salter)); Monograptus sp. (hooked thecae); Monograptus sp.

Age: Silurian, probably Wenlockian.

Location: A few hundred feet south of Route 154 at Trout Pond.

Fauna: Vague impressions of graptolites.

Age: Ordovician or Silurian.

Location: Top of 1,192' hill, 1.25 miles west of Huff Corner.

Fauna: Vague impression of graptolites; possible monograptids.

Age: Possibly Silurian.

Location: West side of road from Kingsbury to Huff Corner, a few feet north of junction with side road to southwest.

Fauna: Monograptus sp. (possibly M. vomerinus type).

Age: Silurian, possibly Late Llandoveryan to Wenlockian. If large member of M. vomerinus group is present as suggested by rhabdosome size, age is probably Wenlockian.

Location: West side of Route 151, 15 feet south of power pole.

Fauna: Monograptus sp. (M. priodon (Bronn)?); Monograptus sp.; possible cyrtograptid fragments.

Age: Silurian, most likely late Llandoveryan or Wenlockian.

Location: Bend in dirt road 0.5 miles east of junction of road with Route 154, approximately 1 mile east of Trout Pond.

Fauna: Monograptus sp. (M. dubius group); Monograptus sp. (M. uncinatus?)

Age: Silurian, possibly Ludlovian.

Location: GUILFORD QUADRANGLE, in dirt road .19 miles east of Crow Hill crest.

Fauna: Monograptus bohemicus (Barrande); Monograptus cf. M. dubius (Suess); Monograptus sp. (M. nilssoni Barrande?); Monograptus sp. (uncinate thecae).

Age: Early Ludlovian.

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# GEOLOGIC MAP OF THE KINGSBURY QUADRANGLE

by  
ALLAN LUDMAN

1978

Division of Physical Geology  
Maine Geological Survey  
Department of Conservation  
Augusta, Maine 04333

R. G. DOYLE  
State Geologist

W. A. ANDERSON  
Assistant State Geologist

### PLUTONIC ROCKS

**DEVONIAN (7)**  
[Dg] Biotite-muscovite granodiorite of the Austin Pond and Russel Mtn. plutons.

### STRATIFIED ROCKS

**DEVONIAN**  
[Dseb] SEBOOMOOK FM.: Cyclically and regularly bedded medium gray sandstone and dark gray slate.

[Ds] SOLON FM.: Massive gray slate and phyllite with subordinate sandstone and well graded sandstone and slate.

**SILURO-DEVONIAN**  
[DSf] FALL BROOK FM.: Variably bedded calcareous sandstone and siltstone; subordinate rhythmically interbedded sandstone and pelite; well graded sandstone with minor pelite.

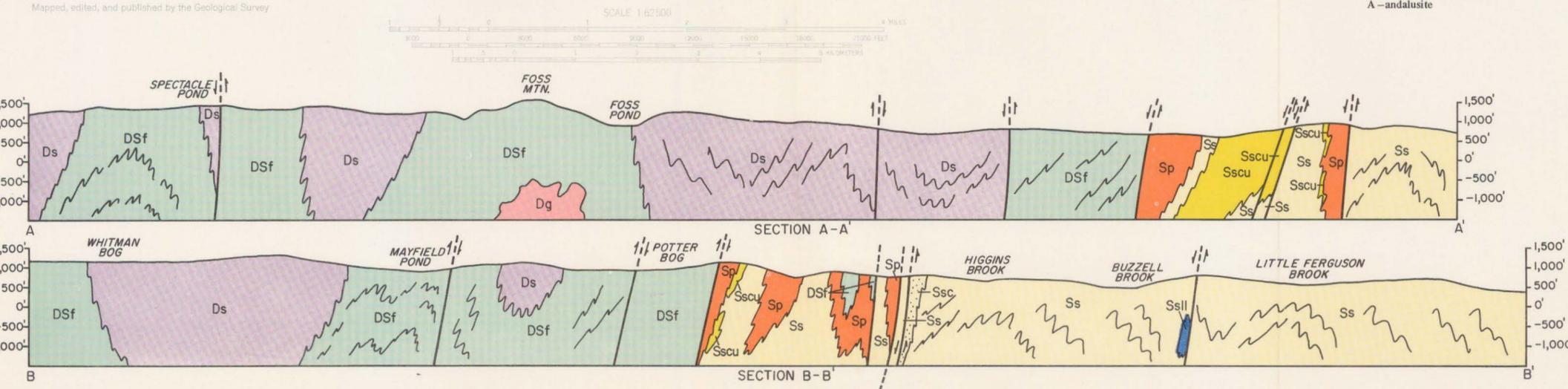
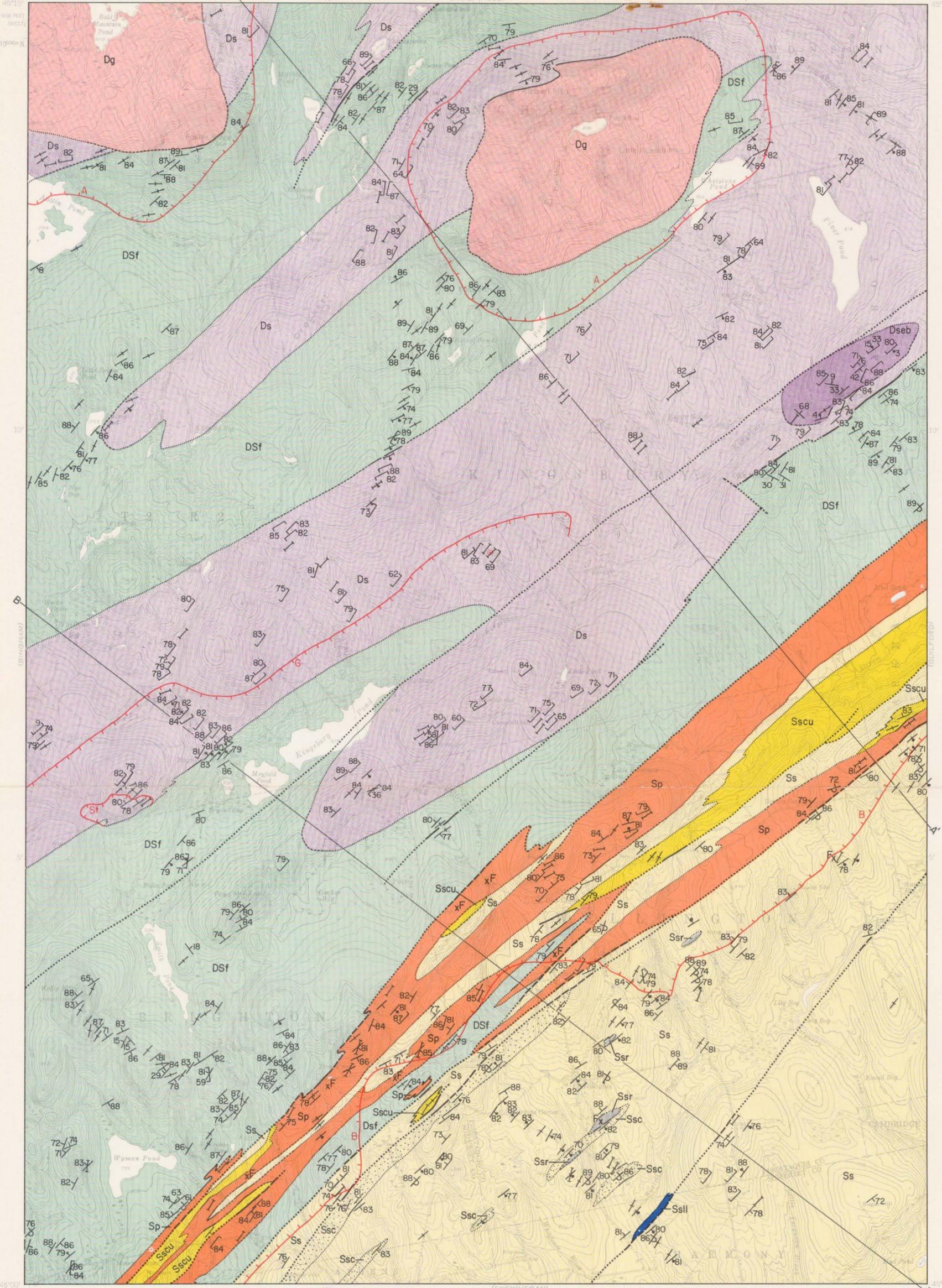
**LUDLOW**  
[Sp] PARKMAN HILL FM.: Carbonaceous sulfidic pelite, sulfidic sandstone, granule conglomerate, siltstone; minor calcareous mudstone and ribbon metalimestone.

**SILURIAN WENLOCK**  
[Sscu] SANGERVILLE FM.:  
[Ss] Ss : Well bedded and graded graywacke and slate, commonly ankeritic.  
[Ssr] Ssr : Upper polymictic granule conglomerate.  
[Ssc] Ssc : Lower polymictic granule conglomerate, massive or graded with dark pelite.  
**LLANDOVERY**  
[Ssl] Ssl : Upper ribbon metalimestone. (exposed in Skowhegan quad.)  
[Ss] Ss : Lower ribbon metalimestone.  
[Ssr] Ssr : Sulfidic carbonaceous pelite.

### SYMBOLS

- OBSERVED ROCK CONTACT
- - - COVERED ROCK CONTACT
- ..... INFERRED ROCK CONTACT
- OBSERVED FAULT
- - - COVERED FAULT
- ..... INFERRED FAULT
- ┌ INCLINED BEDDING, no facing direction indicated
- └ INCLINED BEDDING; facing direction indicated
- + VERTICAL BEDDING, no facing direction indicated
- + VERTICAL BEDDING, facing direction indicated
- ⊥ OVERTURNED BEDDING
- ┌ INCLINED CLEAVAGE
- └ VERTICAL CLEAVAGE
- └ INCLINED FOLIATION
- + VERTICAL FOLIATION
- ┌ INCLINED BEDDING AND CLEAVAGE
- + VERTICAL BEDDING AND CLEAVAGE
- x F FOSSIL LOCALITY
- B METAMORPHIC ISOGRAD, letter on high grade side

B - biotite  
G - garnet  
St - staurolite  
A - andalusite



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