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Pre-Silurian Flysch Relict Structures in Cordierite-K-Feldspar Granofelses, Long Falls of Dead River, Somerset County, Western Maine

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Introduction

The youngest pre-Silurian stratigraphic unit in the Little Bigelow Mountain and Pierce Pond quadrangles consists of Mg-rich metapelite and metagraywacke.[1] The unit is informally designated here as the Dead River Formation. It has been subjected to a wide range of metamorphism, from chlorite-grade to the north and east, to K-feldspar-cordierite grade at Long Falls and elsewhere to the west, along the north margin of the Flagstaff igneous complex (Fig. 1). At chlorite grade the metapelite is characteristically green to silvery greenish gray, and commonly pin-striped with quartz-rich laminae parallel to cleavage and bedding. Axial plane cleavage and, in some examples, a weak mimetic bedding-plane schistosity generally obscure primary depositional structures in the low-grade chlorite-rich phyllites. Where the formation is wedged between the Pierce Pond gabbro and Lexington batholith, recrystallization at higher metamorphic ranks has partly destroyed the cleavage and enhanced the visual contrast between pelitic beds, laminae, and lithic fragments of slightly different composition. Along the strike of the Dead River Formation in this structural wedge, the metapelitic interbeds of the formation range from schistose hornfelses with weakly developed mimetic bedding schistosity in the eastern part of the wedge, to gneissose granofelses, to the west, where again, the geneissosity appears to be a dominantly mimetic feature. With local exceptions, the parts of the formation that have been subjected to medium- to high-grades of metamorphism have experienced very slight penetrative deformation. Because of logistic constraints, we will confine our observations to the upper part of the Dead River Formation in the vicinity of Long Falls. Fortunately, despite (or more likely because of) the high metamorphic grade, relict depositional features are exceptionally well preserved here, and the stream-worn surfaces in the gorge of Long Falls provide the control in three dimensions for adequate structural interpretation for detailed, as well as large scale features.

Acknowledgements

The mapping was carried out as part of an ongoing program supported by the Maine Geological Survey. I thank the many colleagues,

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[1] The Dead River Formation is traced along regional strike southwestward into, and is correlated with the Albee Formation (see Boone and others, this volume, p. 12).

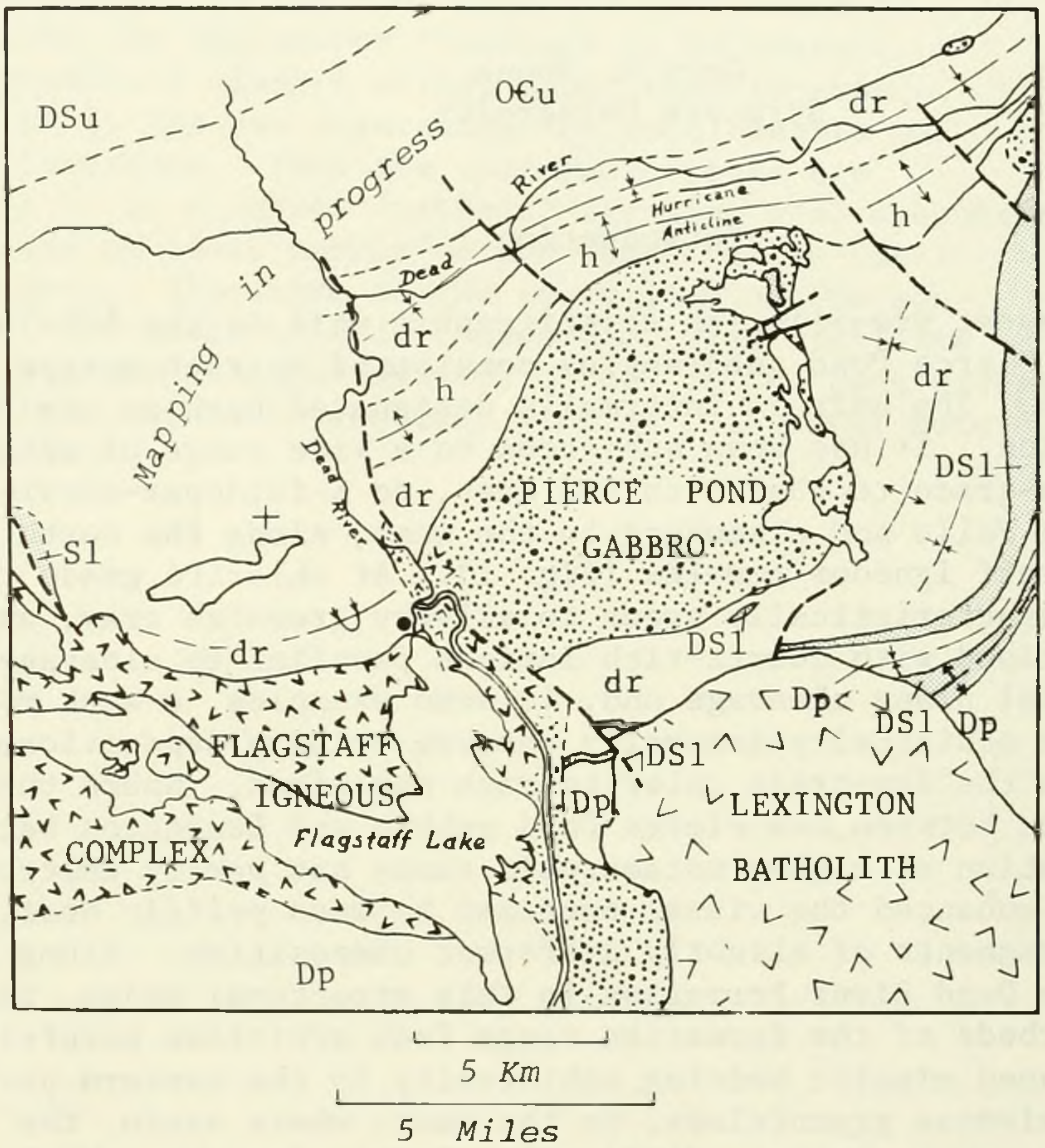


Fig. 1. Generalized geologic map of eastern part of Dead River drainage basin, southeastern Spencer and southern Pierce Pond quadrangles, northeastern Stratton (A. Griscom, unpublished data), and northern Little Bigelow Mountain quadrangles. (+ : quadrangle corners.) Paved access road shown near east shore of Flagstaff Lake; area of detailed map (Fig. 2) shown by dot at end of road. Two youngest pre-Silurian formations, from older to younger: h = Hurricane Formation; dr = Dead River Formation (informal designations). Siluro-Devonian units: p = metapelite; l = limestone and calc-silicate rock; u = undifferentiated metasedimentary units.

too numerous to list here, whom I have subjected to discussion of these features. Dr. R.B. Neuman, U.S. Geological Survey, kindly examined calc-silicate rock thought to contain a fossiliferous shelly fauna. I also thank Mr. and Mrs. J. Arthur Haskell for their help and cooperation during my mapping in this area.

Sequence of
Metamorphic and Igneous Events

These events are summarized before discussing the sedimentology, in order to document and discriminate the later deformational and metamorphic features from those that are primary and depositional.

The trend of major folds in the vicinity of Long Falls is east-northeasterly, parallel to the contact zone of the Flagstaff igneous complex, but normal to the south west margin of the Pierce Pond gabbro (Fig. 1). The major folds are refolded locally (Fig. 2). They appear unsystematic with regard to orientation of the secondary axial surfaces, but the limbs tend to conform to local trends of intrusive contacts. Intrusion-tectonics thus appears to be responsible for the secondary open folding shown on the detailed map. The major folds are overturned to the northwest and in this respect, they reflect the regional structure in the pre-Silurian beyond the thermal aureoles. Plunge of major folds here is variably gentle, probably averaging nearly zero. The final stage of folding involved flexural slip between layers of different competency; this produced locally strong 'a' lineation marked by small-scale grooves in quartz-feldspar-rich surfaces of the granofelses. These microcorrugations are not to be confused with relict flute- and groove-casts preserved in one section of the gorge. The metamorphic fabric is intimately involved and expresses the lineation; it is not similarly involved in the preservation of the flute- and groove-casts. There will be a discussion at one locality of the question of fossils acting as possible strain-gauges in an interbed of calc-silicate rock.

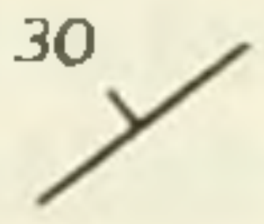
Large, gently southward-dipping sheets of fine-grained diabasic gabbro represent the first stage of igneous activity. They appear sill-like in plan, and are approximately concordant to the orientation of axial surfaces of the major folds, but are discordant to fold limbs (see composite cross-section, Fig. 2). Where their contacts against the granofelses of the Dead River Formation are unmodified by later intrusion of quartz monzonite, the contacts are microscopically sharp. No evidence of assimilation or metasomatic alteration is evident, nor are any xenoliths of the granofels to be found in the mafic sheets. Despite abundant cordierite in the granofels, none has been detected in stained sections of the gabbro at the contact. This in fact is expectable in terms of the thermal divide on the liquidus between normal gabbroic, and mafic aluminous rock compositions discussed by Chinner and Schairer (1962), which would prevent mixing by

Figure 2 Explanation

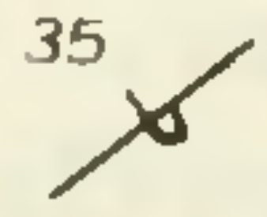
Igneous and Metamorphic Rocks

Post-Acadian	▨	Medium- to coarse-grained, porphyritic quartz monzonite of Flagstaff Igneous Complex. Inclusions of metagabbro shown schematically where abundant.
Late Acadian	▨	Fine-grained, biotite-hornblende-bearing metagabbro of Flagstaff Igneous Complex. Apophyses of quartz monzonite shown schematically where abundant.
Lower Ordovician(?)	▨	Dead River Formation (informal designation); upper part. Cordierite-biotite-K-feldspar-plagioclase-quartz granofels and metagraywacke; subordinate zoisite-bearing, biotitic quartzite. Thin- to medium-bedded relict graded sets in lower parts of local section. Relict graded, wavy, and flaser bedding with veins, dikes and sills of metagraywacke common. Local sequences of climbing-ripple sets.

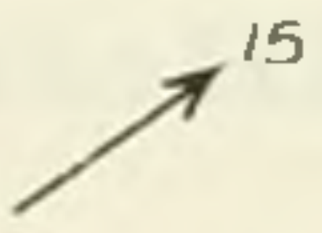
Structure Symbols



Strike and dip of normally facing beds



Strike and dip of overturned beds



Bearing and plunge of fold axes


Anticline


Syncline


Overturned anticline


Overturned syncline


Crestal trace

Trough surface trace

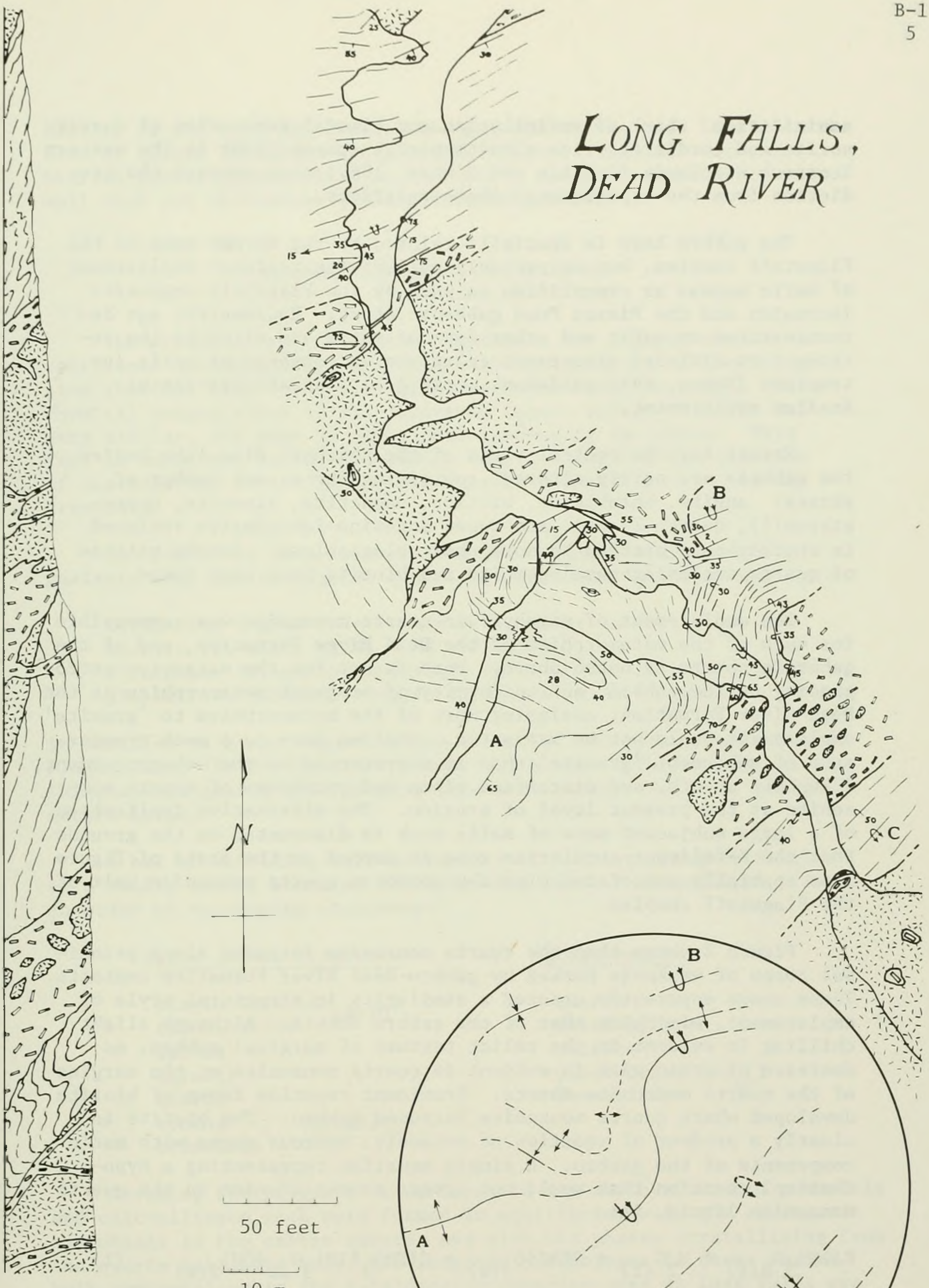


Fig. 2. Geologic map of Long Falls, Little Bigelow Mountain quadrangle. Structural relations projected into N - S section.

assimilation. Lack of assimilation and bimodal separation of quartz norite and cordierite-rich aluminous rock compositions in the eastern Scottish Highlands (Gribble and O'Hara, 1967) also support the prediction from the experimental phase relations.

The gabbro here is spatially related to the border zone of the Flagstaff complex, but is probably part of the regional emplacement of mafic magmas as exemplified in part by the Flagstaff composite intrusion and the Pierce Pond gabbroic stock. Radiometric age determinations on mafic and other igneous rocks are cited in the introductory article; structural relations at contacts of mafic intrusives (Boone, this guidebook, trip A-2) indicate pre-latest Acadian emplacement.

Except for the central parts of the thickest dike-like bodies, the gabbros are partly altered, containing the excess number of phases: augite, hornblende, biotite, magnetite, ilmenite, hypersthene(?), quartz (rare), and zoned andesine-labradorite replaced in checkerboard pattern by more sodic plagioclase. Sparse patches of quartz enclosing cummingtonite and biotite have been found.

The emplacement of porphyritic quartz monzonite was responsible for much of the metamorphism of the Dead River Formation, and of the gabbroic sheets as noted above. Were it not for the extensive retrograding of the gabbro, and uniformity of prograde metamorphism in the Dead River Formation, assigning most of the metamorphism to 'granite' emplacement would not be warranted. Implied here is a much greater mass of subjacent 'granite' than is represented by the sub-concordant, dike-like sheets, and discordant pipes and apophyses of quartz monzonite at the present level of erosion. The alternative implication of a large subjacent mass of mafic rock is discounted on the grounds that the K-feldspar-cordierite zone is mapped on the scale of Figure 1 as spatially associated with the northern quartz monzonite unit of the Flagstaff complex.

Figure 2 shows that the quartz monzonite intruded along principal zones of weakness marked by gabbro-Dead River Formation contacts. These zones apparently created a similarity in structural style of emplacement, mimicking that of the gabbro sheets. Although slight chilling is evident in the relict texture of marginal gabbro, no decrease of grain-size is evident in quartz monzonite at the margins of the quartz monzonite sheets. Prominent reaction zones of biotite developed where quartz monzonite intruded gabbro. The biotite is clearly a product of reaction of potassic, hydrous magma with mafic components of the gabbro. A simple equation representing a hypothetical reaction that would not create excess alumina in the quartz monzonite liquid, is:

$$\mathrm{KALSi_3O_{8(l)} + H_2O_{(l)} + 3FMSiO_{3(s)} \rightarrow K(FM)_3AlSi_3O_{10}(OH)_{2(s)}}. \qquad (1)$$

components in qtz-monzonite liquid	hypersthene in gabbro	biotite reaction zone at contact

Biotite is the sole mafic silicate that was stable with liquid at the time of quartz monzonite emplacement. Sparse almandite-rich, Mn-bearing garnet crystallized in the quartz monzonite in contact with wall rock and inclusions of Dead River granofels.

Metamorphism of the Dead River Formation

The granofels at Long Falls represents the highest rank in a continuous metamorphic progression across the strike of the formation that has been documented from muscovite-chlorite grade. Bulk chemical compositions of the aluminous layers across isograds are very similar, and show no detectable systematic variation. This fact is important in the discussion below, regarding the question of anatexis and the origin of the quartzofeldspathic veins in the granofels.

The granofels is a 'clean'-textured, equigranular, slightly gneissic rock containing the quartz-bearing equilibrium assemblage:

cordierite (Mg/Mg + Fe + Mn = 0.62, molar ratio)
biotite (Ti-rich, Mg/Mg + Fe ≈ 0.45)
K-feldspar (slightly perthitic; Or/Or + Ab + An ≈ 70 mole%)
plagioclase (slightly zoned; An/Or + Ab + An ≈ 35 mole%)

in addition to minor magnetite and traces of retrograde muscovite in plagioclase. Proportions of phases vary across thin laminae and thin, subtly-graded beds ranging from a millimeter to a few centimeters thick.

A bed of sulfidic, calc-silicate rock bearing probable remains of a shelly fauna, contains the following mineral assemblages, listed in order of decreasing abundance:

white lithic fragments	green matrix
plagioclase (An_{60-70})	quartz
clinozoisite	ferrosalite
salite	zoisite
calcite	plagioclase (An_{60})
quartz	Fe-sulfide
sphene (minor)	
tremolite	

Assuming the prograde assemblages in the mafic-aluminous granofels and calc-silicate rock were formed in equilibrium with the retrograde assemblage in the gabbro sheets, and with the phases crystallizing from the quartz monzonite melt, the isograde assemblages in these varied bulk compositions in the K-feldspar-cordierite zone at Long Falls are

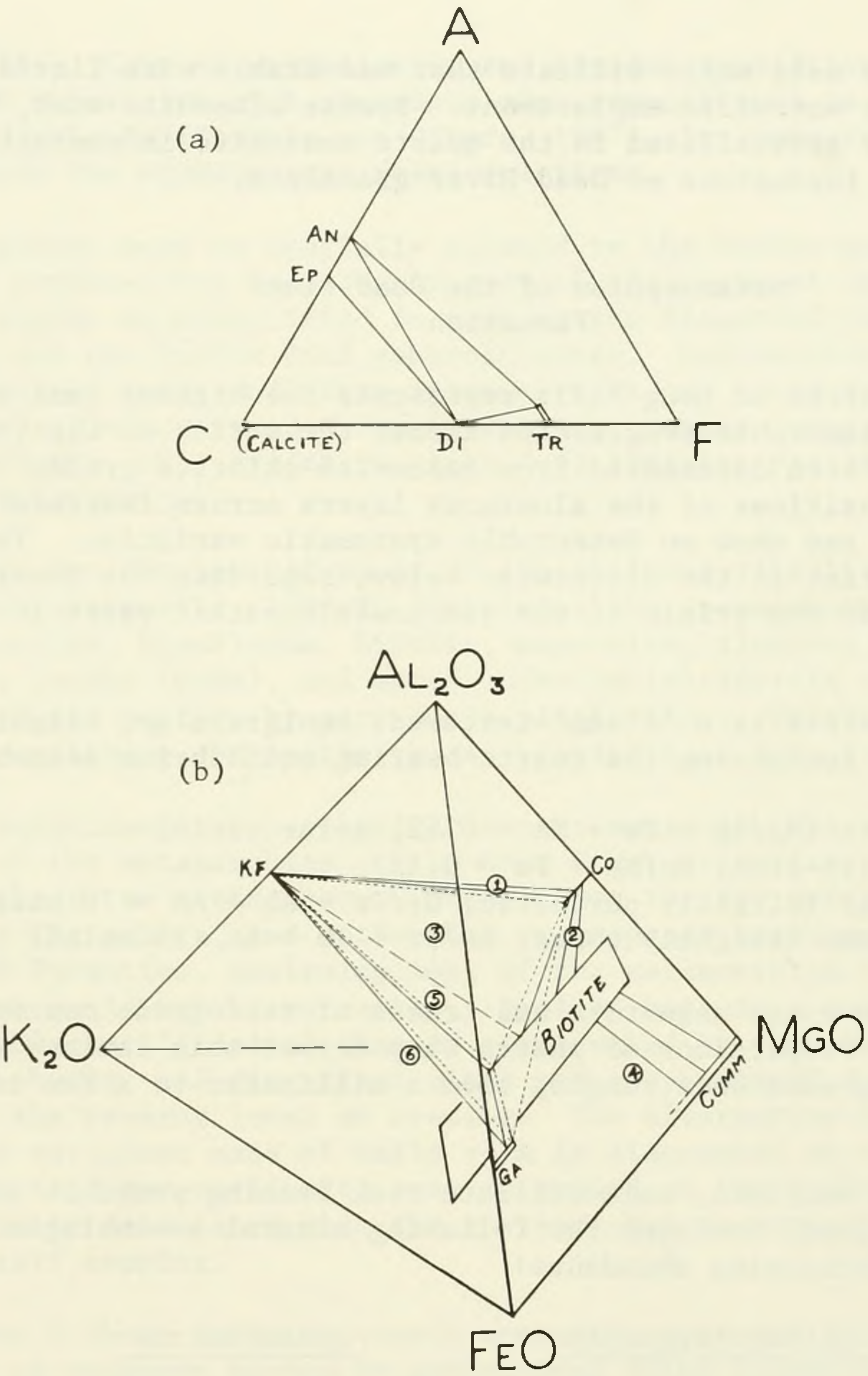


Fig. 3. Assemblages of the K-feldspar - cordierite zone, Long Falls and Round Mountain. (a) ACF plot for calc-silicate assemblages. (b) AKFM tetrahedral plot of 2-, 3-, and 4-phase assemblages (excluding sodic plagioclase and quartz) for: (1) to (3) Mg-rich pelitic granofels and metagraywacke; (4) cummingtonite-biotite-quartz patches in metagabbro; (5) K-feldspar-cordierite-almandite-biotite granofels (dotted lines), Round Mountain; and (6) almandite-rich garnet in quartz monzonite in contact with wall-rock and inclusions of pelitic granofels.

shown in Figure 3. Minor calcite persists with quartz in the calc-silicate system in which all alumina is fixed in associated phases; this suggests that CO_2 did not readily escape from the central parts of the thickest (10 cm) layers. Wollastonite has not been found.

Pelitic compositions sufficiently rich in Fe^{2+} to form the assemblage biotite + cordierite + almandite + K-feldspar have not been found at Long Falls, but this assemblage has been documented in Fe-rich, pelitic granofels three miles to the south, and is included in Fig. 3.

Muscovite is a characteristic mineral in the formation at lower metamorphic grades and persists throughout the sillimanite zone in the structural wedge of the formation east of Long Falls. At K-feldspar-cordierite grade, muscovite was probably consumed in reactions summarized by the following equation:

$$\text{biotite}_a + \text{muscovite} + \text{sillimanite} + \text{quartz} + \text{magnetite} + \text{hydrogen} \xrightarrow{} \text{biotite}_b + \text{K-feldspar} + \text{cordierite} + H_2O.$$

$$KFe_{1.5}Mg_{1.5}Al_{1.5}Si_{2.5}O_{10}(OH)_2 + KAl_3Si_3O_{10}(OH)_2 + Al_2SiO_5 + 4SiO_2 + 2/3Fe_3O_4 + 2/3H_2 \longrightarrow$$

$$KFe_{2.83}Mg_{0.17}Al_{1.5}Si_{2.5}O_{10}(OH)_2 + KAlSi_3O_8 + Mg_{1.33}Fe_{0.67}Al_4Si_5O_{18} + 1\ 2/3\ H_2O. \qquad (2)$$

The equation approximates the composition of cordierite at Long Falls, and reflects the direction of change of Fe/Mg in biotite, as well as the modal relationship of biotite and magnetite in granofelses at muscovite-sillimanite and K-feldspar-cordierite grades.

Pressure-temperature conditions of metamorphism are deduced to have been in the range of 650° to 700°C at total pressure less than 4, but greater than ~2.5 kb (see location of highest P-T plot (Boone, trip A-2, Fig. 4) in which disappearance of muscovite occurs within the stability field of sillimanite, but at pressures within the stability range of biotite + cordierite + almandite).

Pinstripe laminae and cross-cutting veins contain the same minerals as do the surrounding pelitic layers, but they are much richer in plagioclase and quartz. A bimodal spectrum of thickness ranges from laminae to thick beds. Veins commonly thicken where they mutually intersect. The veins and laminae contain small, somewhat variable proportions of cordierite and biotite, and K-feldspar is invariably sparse. Plagioclase compositions in different laminae and veins vary from An_{18} to An_{31} mole percent.

The structural and metamorphic environment exhibits most, if not all the prerequisites for a high-level, low pressure anatectic paragenesis of the quartzofeldspathic laminae and veins. The locally lower An-content of plagioclase, as compared to most of the pelitic layers, would favor this interpretation. With regard to compositions of low-melting granitic fractions, however, the anatectic model fails. Although K-feldspar (Or_{50-70}) is present, the proportion of plagioclase is 90-95 percent of total feldspar, well outside the range of plagioclase/K-feldspar ratios in low melting anatectic fractions (see Winkler's summary of experimental anatexis and studies of corresponding natural systems (1967, Chap. 16)). In other words, the trondhjemitic compositions of the laminae and veins (excepting cordierite) could be produced anatectically only at temperatures much above the granite solidus, in which case we would not expect to find K-feldspar, indeed high proportions of it, in the crystalline residue surrounding the veins. Minor concentrations of biotite line the surfaces of some of the laminae parallel to relict bedding, and indicate that at least some metamorphic differentiation has accentuated compositional differences across the relict bedding.

Some may wish to argue that the rocks are injection-migmatites by proposing a trondhjemitic, plagioclase-rich melt infiltrating the granofels. The cordierite and biotite in the trondhjemitic veins would require special explanation, as no larger masses of rock of such composition have been found in the region. Evidence to the contrary, however, lies in the similar chemical compositions of pelitic layers between quartz- and plagioclase-rich laminae and veins in rocks of the formation throughout the entire range of metamorphism. Thin sills and cross-cutting dikes of typically porphyritic Flagstaff quartz monzonite in the granofels at Long Falls appear to silently settle this issue.

The structural geometry and compositions that the laminae and veins display are more fully and simply explained by processes in the depositional environment. Therefore, we may now consider the primary origin of these and other features in the Dead River Formation.

Deposition of the upper part of the Dead River Formation

The Dead River Formation is approximately 2500 feet (~760 meters) thick, of which roughly 200 meters of interbedded metapelite and metagraywacke constitute the upper part.

The characteristically thin to medium, parallel beds of the lower and middle parts of the formation become progressively interrupted in the upper part by zones, up to 20 meters thick, of wavy bedding, climbing-ripple sets, and flaser bedding in chaotically-deposited portions. Small-scale slumps overlain by undisturbed beds also become commoner. Pull-apart structure, and convolute laminae possibly marking flow-rolls, are exposed in thicker beds in the upper part of the gorge at Long Falls.

Graded beds occur in many parts of the formation from the base to the highest exposed part (where it is disconformably overlain by Siluro-Devonian calc-silicate rock, or where intruded by the Flagstaff Igneous Complex). The grading is commonly difficult to detect, however, owing to slight compositional change across graded sets, or to thin bedding complicated by shearing. The latter problem is particularly met with in the lower metamorphic zones. Chips and lumps of pelitic rock fragments are common in beds of metagraywacke, and sparse occurrences of quartzwacke blocks, up to a few meters in length, in pelitic host rock (argille à blocs) have been noted west of Long Falls. Sole-markings at the base of quartz-rich beds have rarely been observed, probably because of the interplay of rock structure and erosion. Well-preserved examples, however, are exposed in the 'calcareous sands' (calc-silicate-bearing, biotitic quartzite) in the upper (southern) part of Long Falls.

Sufficient description has been introduced here to warrant turning to flysch sedimentology to account for many, if not all the relict structures and compositional assemblages. No attempt is made to review or redefine the meaning of flysch. The term is used here to connote a tectonic-sedimentologic synthesis. In brief, the entire formation, and that part of it in particular exposed at Long Falls, meet all twelve of the criteria (both inclusive and exclusive) of the diagnostic features of flysch discussed by Dzulynski and Walton (1965). The protolith of rock here termed metagraywacke was likely feldspathic, chlorite-rich sandstone that contained variable amounts of potassic micas. In the chlorite zone, graywacke interbeds in the formation contain roughly a percent of detrital K-feldspar (coarsely twinned microcline). The chlorite-rich matrix is matched at higher grades of metamorphism by equivalent proportions of cordierite and biotite. A relatively small proportion of the metagraywacke beds are calcareous (calc-silicate-bearing above the biotite isograd), but calcium-rich beds and lenses are rare. The chemical composition of the mafic aluminous metapelite that constitutes most of the formation is discussed below in regard to provenance and paleotectonic setting.

Where we enter the gorge, the flysch sequence is exposed in several overturned folds. Sections approximately parallel and transverse to paleocurrent directions can be studied. Parallel and wavy bedding predominate in this part of the gorge, but on the east side, near the old log-work crib overlooking the channel, excellent examples of sets of climbing ripples are exposed in an overturned section. At this locality linguoid ripples of two sets indicate current sources in the approximate range of N40°W - N70°W, after structural restoration. Sole markings (flute casts) at the base of overturned, dark gray biotitic quartzite beds in the upper part of the falls indicate current source from the SSE.

Some of the climbing-ripple sets in this part of the Dead River Formation are similar in form and scale to those produced by McKee (1965) in wave-tank experiments; others, however, are of much larger wavelength and stacked in thicker sets. Ripple-drift with sediment added from suspension is favored for the origin of these climbing-ripple sets. In the exposure mentioned above, climbing-ripple sets merge into parallel beds. The low angle between the ripple foresets and the planes bounding the sets suggests that current velocities in the lower flow regime were occasionally high (McKee, ibid., p. 80).

Many of the depositional sequences duplicate the truncated base cut-out sequences described by Bouma (1962), and enhance the hypothesis that the upper part, if not most of the Dead River Formation was deposited by repetitive influx of sediment from turbidity currents. Slumping and small-scale mass movement of semi-coherent sediment is also recorded in the upper 100 to 200 meters of the formation. Here, the abundance of 'sand' (metagraywacke) dikes and sills cutting across, and connecting parallel or wavy interbeds of metagraywacke lends a migmatitic appearance to the rocks. The 'sand' dikes commonly intersect each other in intervening beds of metapelite (granofels). No major compositional differences can be detected between veins, dikes, and the interbeds they connect. The dikes and veins are on the scale of "minor features" as described by Dzulynski and Walton (1965, p. 162). Many of the dikes and veins are deformed into simple curvilinear, or complex ptygmatic shapes. Because of the compositional similarity to the more extensive, parallel beds of metagraywacke, and because the axes of the contorted veins and dikes are not systematically related to the primary or secondary folds, their origin is assigned to the depositional environment of relatively deep-water flysch. The structures of many of the veins superficially resemble similar features described by Smith (1968) in the Belt-Purcell succession, which he attributes to a shallow-water organic origin. The forms also resemble those of veins in metamorphic parageneses, as described by Shelley (1968). Veins that are unquestionably of metamorphic origin, however, commonly are compositionally different than the host layers or bounding interbeds.

Convolute lamination is not abundant, nor, as Dott and Howard (1961) point out, is it unique to flysch, or to turbidity-current-deposited sediment. Many small-scale, 'chaotic' folds in restricted sections, however, resemble similar structures associated with deeply load-casted flutes (Kuenen, 1957, fig. 16) in turbidity current deposits.

Lastly, we may inquire if the Dead River Formation is characterized by redeposited material from turbulent suspensions associated with gravity-propelled density currents, and whether much of its detritus may first have accumulated on shelves or upper portions of continental or island rises. Aside from shale chips, occasional sandstone blocks, and pervasive, relict poor sorting in graywacke beds in the chlorite zone, two features deserve mention. The first is local, the second is formation-wide.

Table 1. Weight-proportions of critical oxides in shale - basalt mix required to approximate the composition of pelitic granofels, Long Falls

	Average Paleozoic shale[1]		Mg-rich metapelite, Long Falls	Basalt glass, Volcanics, Hound Island Alaska[2]	
SiO_2	63.7	0.8	60.48	0.2	47.95
TiO_2			1.28		1.75
Al_2O_3	17.5	0.4	17.05	0.6	16.91
FeO*	7.0	0.5	8.69	0.5	9.95
MnO	tr		0.21		0.17
MgO	2.5	0.8	4.22	0.2	7.04
CaO	1.5	0.95	1.83	0.05	11.09
Na_2O	1.1		2.00		2.47
K_2O	3.8		3.02		0.52
H_2O+			1.76		1.58
			100.54		

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[1] Clarke's average; from Pettihohn, 1949, Table 61, p. 344.

[2] Muffler and others, 1969, Table 1, p. 198.

*Total iron expressed as FeO.

A thin, boudinaged bed of dark green calc-silicate rock in the gorge at Long Falls contains white calc-silicate 'calcareous mud' chips and fragmented organic remains. Some of the forms are suggestive of internal molds of small brachiopod shell fragments. Others closely resemble accretionary lapilli (Moore and Peck, 1962), but their epidote-plagioclase assemblage represents an unlikely volcanic composition.

Secondly, the chemical composition of metapelite layers throughout the formation differs noticeably from "average Paleozoic shale" (Pettijohn, 1949) and from many analyses of pelitic slate, schist, and gneiss (note comments at beginning of preceding section on metamorphism). Analyses of several pelitic layers in the formation from chlorite grade to K-feldspar-cordierite grade indicate that combined total iron (as FeO) and MgO are higher than the average shale, CaO is somewhat higher, even though carbonates are lacking, and SiO_2 is lower than average. Mafic and other volcanic rocks are absent in the formation, but the differences mentioned above with regard to Dead River metapelite lie in the direction that would be expected if mafic volcanic detritus were mixed with 'average shale' (Table 1). Table 1 shows, for comparison, the proportions of oxides from fresh basaltic glass to be mixed with those of average shale to approach the percentages in the Dead River metapelite. The mixing-proportions for the basaltic oxides are not equivalent, nor should we expect them to be. Widespread availability of fresh basaltic detritus would have required a regional distribution of aquagene tuff throughout the time of deposition of the formation. This requirement is unrealistic. The differences in the mixing proportions in Table 1 imply a chlorite - iron oxide-rich source. The well-altered products of mafic andesite and basalt, plus small proportions of silt could have constituted this source. Rather uniform mixing by resedimentation could have been achieved by basinward dispersal of suspensions involving the two types of source material. Provenances of maturely weathered, continental debris, and basaltic crust or volcanic islands are considered. One stage, or cycle, of transportation and deposition from one or more sources seems incapable of producing the uniformity of magnesian pelitic composition on a regional scale. The single stage hypothesis is also inadequate in accounting for the compositional range of the coarser clastic fractions that gave rise to quartzwacke and graywacke associated with the pelite in the resulting flysch.

The increasing activity of slope and basin tectonics reflected in the primary sedimentary structures of the upper part of the Dead River Formation, represents a penultimate stage of sedimentation thought to be antecedent to the Taconian orogeny.

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Trip B-1
Road Log

Trip will leave from the Rangeley Inn at 8:00 a.m., and proceed east on Rt. 4 to Phillips; at Phillips, on Rt. 142 to Kingfield. We then follow Rt. 16 east from Kingfield to North New Portland, then north into the Little Bigelow Mountain quadrangle, following the unmarked, paved road to Long Falls. The total distance is 72 miles, allowing ample time for reading the text and loading geological guns. Weather and time permitting, a brief stop will be made at the height of land where the road crosses the northwest margin of the Lexington batholith. Several major geologic features can be perceived to advantage from here.

We will then proceed directly to Long Falls. The one formal "stop" is the 700 feet of continuous exposure across the structure in the gorge of Long Falls. The preceding text is devoted mainly to this section and the great variety of features it exposes. Therefore the descriptive material of the text serves as the log of our passage southeastward up the course of Long Falls.

The trip will conclude allowing for sufficient time to return to Rangeley for the annual dinner.