

Maine Geological Survey  
John R. Rand, State Geologist

**THE GEOLOGY OF A SIX-MILE  
SECTION ALONG SPENCER STREAM,  
SOMERSET COUNTY, MAINE**

by

Arthur J. Boucot and John R. Griffin  
Massachusetts Institute of Technology

George H. Denton  
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and

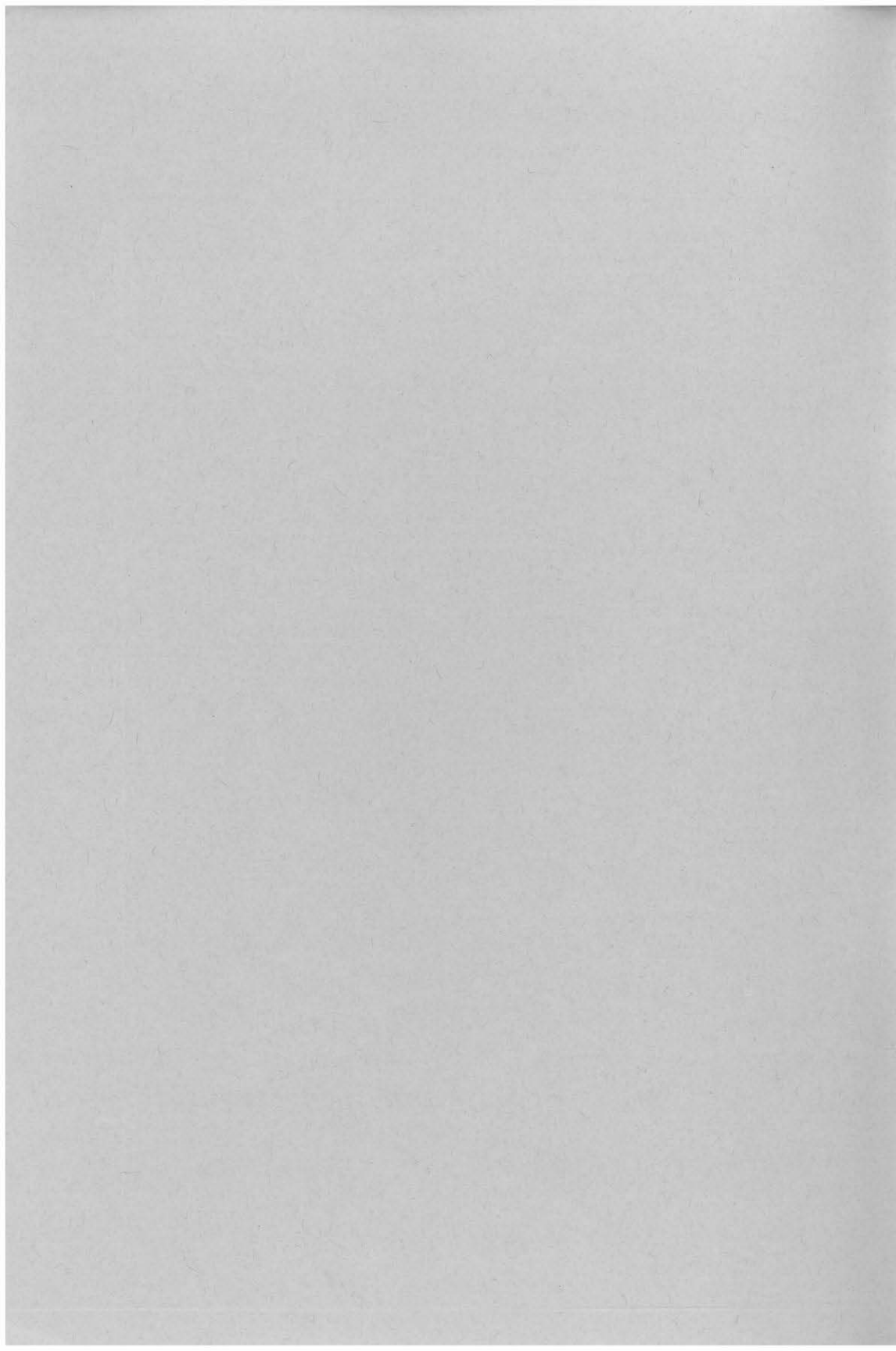
Philip S. Perry  
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Special Geologic Studies Series # 2

Department of Economic Development

Augusta, Maine

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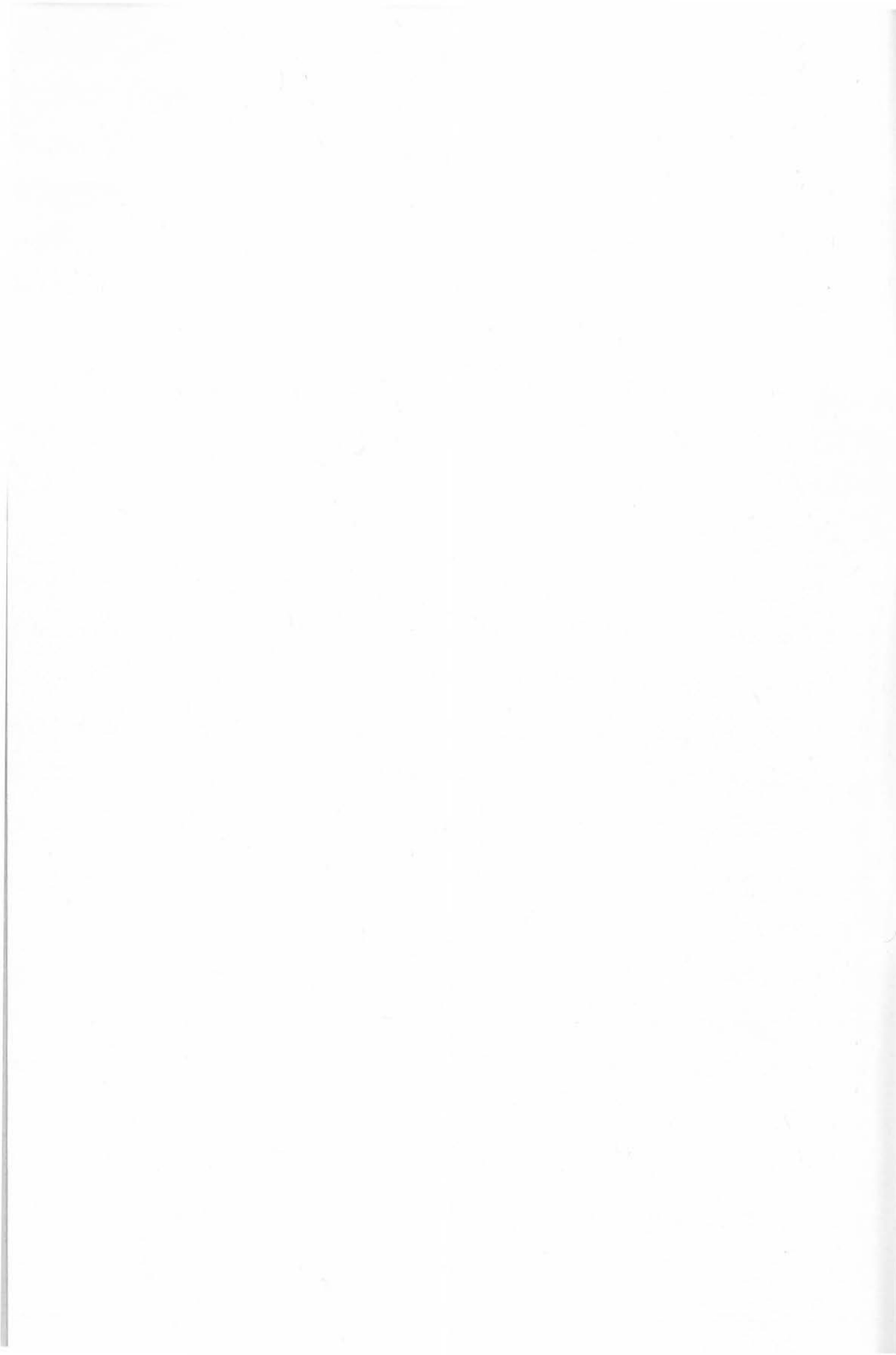
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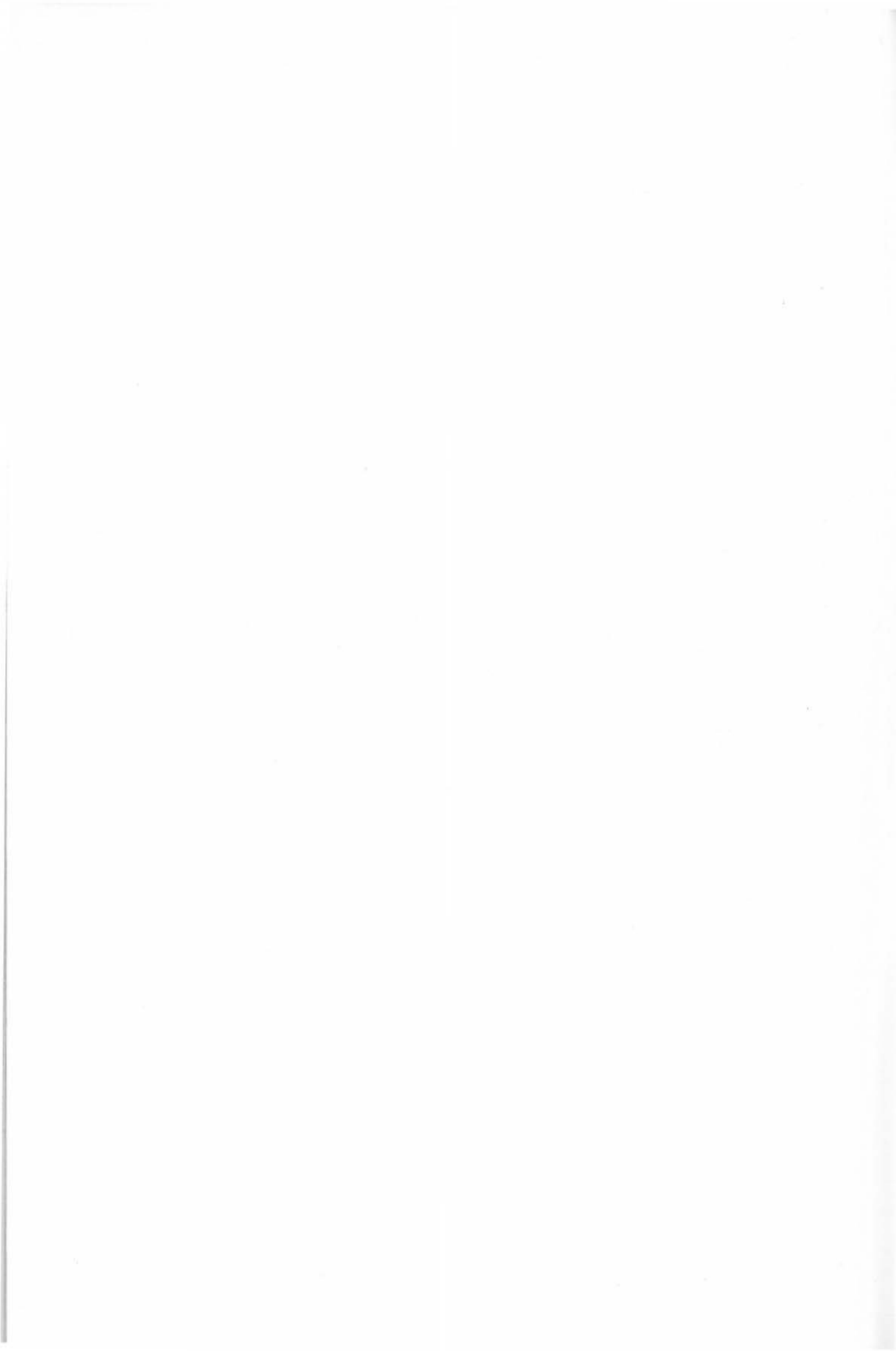
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## Introduction

This report concerns the geology of Spencer Stream from Spencer Dam (Long.  $70^{\circ}22'55''$  W., Lat.  $45^{\circ}19'5''$  N.) to Spencer Gut (Long.  $70^{\circ}17'50''$ , Lat.  $45^{\circ}18'35''$  N.) in T. 4, R. 5 and T. 3, R. 5, a distance of about 6 miles. This area is in the southeastern part of the Spencer Quadrangle, Somerset County (fig. 1).

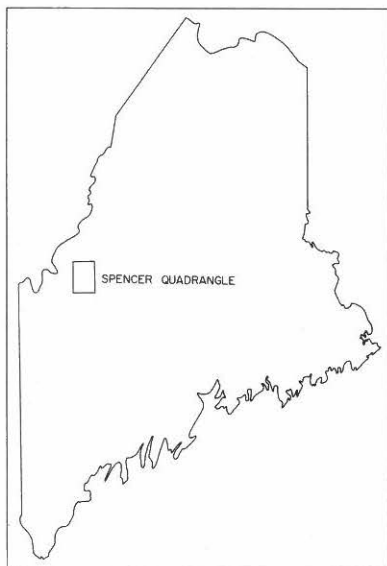


FIGURE 1—Index map for Spencer quadrangle, Maine

The purpose of this investigation was to work out the structure and stratigraphy of a section extending across the southeastern margin of the Moose River synclinatorium, which contains rocks of Siluro-Devonian age, and into the underlying Pre-Silurian rocks, including the relationship of the intrusives to the section. The stream was chosen because it has the most abundant outcrop in the area and might therefore be of value in working

out the geology of the rest of the quadrangle. The area has been previously mapped on an inch-to-the-mile scale by Boucot,

and the present study was undertaken in an attempt to check in detail the structural and stratigraphic conclusions reached in his work.

Tape and compass mapping was done on a scale of 50 feet to the inch, and all outcrops within 100 feet of the stream were mapped. The map was prepared by Denton, Griffin, and Perry under Boucot's supervision, and the Silurian and Lower Devonian stratigraphic units used are those previously defined by Boucot in a report to be published by the U. S. Geological Survey. The section on joints and cleavage was prepared by Perry.

The authors wish to thank Professor W. F. Brace, Massachusetts Institute of Technology, and Mr. John Rand, Maine State Geologist, both of whom visited the area and made helpful suggestions. The work was supported by the Maine Geological Survey.

## Stratigraphy

The sedimentary rock units along Spencer Stream are shown in the following stratigraphic column (top to bottom). Thicknesses were estimated from cross sections.

### Stratigraphic column

	<i>Feet</i>
Silurian and/or Lower Devonian	
Seboomook formation (top of section not seen)	
Slate	2200
Quartzite (fine-grained)	1000
Interbedded limestone and tuff	100
Interbedded limestone and slate	30
Interbedded limestone and tuff	100
Cambrian or Ordovician or both (top not seen)	
Red slate	20
Quartzite	360
Black slate	900
Limestone	80
Black slate (bottom of section not seen)	250+



## Silurian and/or Lower Devonian

### Seboomook formation

#### Slate

*Lithology.* — The slate is steel blue on fresh surfaces and light gray on weathered surfaces. Grains are of silt and clay size. The rock is highly cleaved, and cleavage surfaces are undulating. Sandy laminae are present between many of the slate beds, and in a few places the layers contain a limonite stain residual from the weathering of sand-size ankerite fragments. Pyrite crystals up to one-eighth inch long make up less than 1 percent of the rock and are scattered throughout the unit.

The top quarter of the slate contains thin beds with badly contorted fossils. These beds are slaty, brownish, and slightly limey. The fossils weather out, leaving subparallel cavities.

Near the top of the slate are two feldspar-rich beds (location LB, LD) with small spherical brownish areas of weathered pyrite 1 to 2 millimeters in diameter. These are probably tuffs. Beneath the tuff bands is a bed containing flattened and vesicular basalt bombs (location LC). The bombs are ellipsoidal and well rounded, the largest observed being 9 inches by 5 inches by 2 inches and the smallest pebble size. The bombs are fine-grained in texture, and field identification of the minerals was not made. In the hand specimen reflections are noted from the cleavage faces of an unidentified dark-colored mineral present throughout the bombs. The more weathered bombs are light bluish gray, the less weathered bombs are darker gray. Angular, subcubic vesicles up to 3 millimeters long are present throughout. The very porous outer shell is about half a centimeter thick. The bombs are badly weathered and can be easily separated from the slate in which they are embedded.

*Thickness.* — The thickness of the slate is about 2,200 feet.

*Lower contact.* — At location LJ three parallel dikes strike N. 72° E. The northwestern dike, which is 3½ feet wide, is in contact with the Seboomook slate on the northwest and with the Seboomook quartzite on the southeast. There appears to be no gradation from slate to quartzite, and both are typical of their respective units. This is the only place in the section studied where the contact is visible. East of the contact only the quart-

zite of the Seboomook formation is present, and west of it only the slate.

*Age.* — Fossiliferous strata were found at 14 localities (F1-14) in the slate. The material collected from localities F2, 3, 4, 5, 6, 8, 10, and 11 was too poorly preserved to be identifiable. From the remaining localities the following forms were recognized:

- Locality F1: *Platyorthis* cf. *planoconvexa*
- Locality F7: *Leptocoelia* cf. *flabellites*  
*Beachia* cf. *thunii*
- Locality F9: *Chonetes* cf. *canadensis*  
*Platyorthis* cf. *planoconvexa*  
*Leptocoelia* cf. *flabellites*  
*Leptostrophia* ? sp.
- Locality F12: *Platyorthis* cf. *planoconvexa*  
*Leptocoelia* cf. *flabellites*  
*Cornellites* ? sp.  
*Chonetes* cf. *canadensis*
- Locality F13: *Platyorthis* cf. *planoconvexa*  
*Leptocoelia* cf. *flabellites*
- Locality F14: *Beachia* cf. *thunii*  
*Chonetes* cf. *canadensis*  
*Leptostrophia* ? sp.

The presence of *Platyorthis* cf. *planoconvexa*, *Beachia* cf. *thunii*, and *Leptocoelia* cf. *flabellites* indicates that the slate is of Oriskany age.

## Quartzite

*Lithology.* — The quartzite is about 85 percent fine sand-size, subangular quartz grains and about 15 percent clay minerals. The unweathered rock is bluish-green, the weathered rock light gray to medium gray. Numerous prominent joints give exposures a blocky appearance. Bedding is marked by well-developed fine parallel laminations, many of which show graded bedding similar to that of the overlying slate, and the rock breaks very readily along the bedding planes. The laminations are more apparent on weathered surfaces than on unweathered surfaces.

*Thickness.* — The quartzite is about 1,000 feet thick.

*Lower contact.* — The lower contact of the quartzite with the underlying interbedded limestone and flinty tuff is not exposed

along Spencer Stream. However, this same contact is exposed about 8 miles to the northeast at the Parker Bog Ponds, where it is conformable. It is presumed that the contact at Spencer Stream is also conformable.

*Age.* — Fossils have not been found in the quartzite, but its position below the slate, which contains fossils of Oriskany age, and above the interbedded limestone and flinty tuff assure that it is of Silurian or Lower Devonian age.

### **Interbedded limestone and tuff**

*Lithology.* — The massive, flinty tuff is highly fractured by a network of sub-parallel cracks, giving it a blocky appearance. The rock is white on fresh and weathered surfaces. Beds of the tuff are from 6 inches to 4 feet thick, and the average thickness is 2½ feet.

Interbedded with the tuff is limestone that is white on fresh surfaces, gray and rough on weathered surfaces. Beds of the limestone are half an inch to 6 inches thick, have undulating surfaces, and contain crinoid columnals.

*Thickness.* — The interbedded limestone and flinty tuff is about 100 feet thick.

*Lower contact.* — The lower contact with the interbedded limestone and slate is conformable and sharp.

*Age.* — The presence of the brachiopod *Isorthis* sp. indicates a Silurian or Devonian age for this unit.

### **Interbedded limestone and slate**

*Lithology.* — Blue-gray on fresh surfaces and buff on weathered surfaces, the limestone is crystalline and forms layers half an inch thick. It contains a small percentage of fine quartz sand, grains of which are visible on weathered surfaces. Crinoid columnals are abundant, and small pyrite crystals up to an eighth of an inch long are scattered throughout. Interbedded with the limestone is a gray, highly cleaved, silty slate in layers 1 to 2 inches thick.

*Thickness.* — The interbedded limestone and slate is about 30 feet thick.

*Lower contact.* — The lower contact is not exposed.

*Age.* — Fossils have not been found in the interbedded limestone and slate, but its position conformable to the interbedded limestone and flinty tuffs shows that it is of Silurian or Lower Devonian age. Similar rocks elsewhere in northern Maine have yielded Silurian or Early Devonian fossils.

## **Cambrian or Ordovician or Both**

### **Red slate**

*Lithology.* — The slate is dark reddish brown on fresh surfaces and grayish brown on weathered surfaces. Several half-inch bands of coarse yellow siltstone were the only primary features observed. The slate is highly cleaved, and the cleavage surfaces have a silky appearance.

*Thickness.* — The red slate is 20 feet thick.

*Lower contact.* — The lower contact is not exposed, but the quartzite and the red slate crop out 5 feet apart, and they are structurally conformable.

*Age.* — No fossils were found in the red slate, but similar rocks elsewhere in northern Maine occur in the pre-Silurian.

### **Quartzite**

*Lithology.* — The quartzite is greenish white on both weathered and unweathered surfaces, massive, and coarse-grained. It contains 90 percent quartz, less than 10 percent feldspar, and less than 1 percent mica. The grains are sub-rounded and up to half a centimeter in diameter. Some of the quartz grains have a faint blue color. Bedding in the quartzite is not well developed, although graded bedding was observed. Interbedded with the quartzite are several green slate beds as much as 20 feet thick and with poorly developed cleavage.

*Thickness.* — The quartzite is 360 feet thick.

*Lower contact.* — The lower contact is not exposed.

*Age.* — No fossils were found in the quartzite, but similar rocks elsewhere in northern Maine occur in the pre-Silurian.

### **Black slate**

*Lithology.* — Black slate occurs both above and below a unit of limestone. Fresh surfaces of the slate are blue-black; weath-

ered surfaces are much blacker, with rusty brown stains. Cleavage is poorly developed, and the cleavage surfaces are undulating. The slate is almost entirely composed of clay-size material, but pyrite crystals up to a quarter of an inch in diameter form about 1 percent of the rock and are present throughout. In places concentrations of pyrite crystals along a bedding plane or in a lens have weathered more rapidly than the surrounding rock and have left a brownish-yellow stain. In the slate yellowish-brown layers up to three-quarters of an inch thick of fine silt-size fragments are presumably volcanic ash.

*Thickness.* — Above the limestone the black slate is 900 feet thick; below the limestone it is at least 250 feet thick.

*Lower contact.* — The section continued beyond the area mapped, and the lower contact of the black slate, below the limestone beds, was not observed.

*Age.* — No fossils were found in the black slate, but similar rocks elsewhere in northern Maine occur in the pre-Silurian.

## Limestone

*Lithology.* — A unit of interbedded black slate and limestone, with some flinty layers that appear to be felsitic tuffs, is exposed in Spencer Gut. Most of the limestone is grayish white, but some is light gray and porous, some is dark and massive, and a small amount is black. The limestone beds are 1 inch to 7 feet thick, the limey beds being badly contorted.

*Thickness.* — The limestone is 80 feet thick.

*Upper and lower contacts.* — The upper and lower contacts with the black slate are conformable.

*Age.* — No fossils were found in the limestone, but similar rocks elsewhere in northern Maine occur in the pre-Silurian.

## Conglomerate

*Lithology.* — In the black slate beds at the western entrance to Spencer Gut is a single bed of conglomerate 1 to 4 inches thick (location LE). The conglomerate contains white mica flakes and small, well-rounded pebbles up to one-quarter inch across of quartz, feldspar, quartzite, granodiorite, schist, and shale. The rock is cemented by orange-yellow limonite.

## **Intrusive rocks**

### **Diorite**

The section is cut by numerous diorite dikes 1 to 25 feet thick and some larger intrusive diorite bodies as much as 400 feet wide. Both dikes and intrusive bodies are holocrystalline. The unweathered rock is greenish, but on weathering it becomes whiter. This is due to the weathering of the feldspar grains and is more evident in the coarser-grained rocks. The grain size of the dikes is fine- to medium-grained, the grain shape anhedral to subhedral. The larger intrusive bodies have well-formed crystal grains up to a quarter of an inch across. The average mineralogy determined in the field is plagioclase 70 percent, hornblende 17 percent, pyrite less than 2 percent, and calcite less than 1 percent. The diorites have been considerably altered and contain 5 percent epidote and 5 percent chlorite as secondary minerals. The plagioclase is greenish, probably due to secondary epidote, and was presumably calcic.

Hornfels is present at the contacts of the larger dikes with the sedimentary rocks, and at some of the other contacts quartz and pyrite bands are present between the sedimentary rocks and the intrusive rocks. The fine-grained quartzite of the Seboomook formation has a baked appearance near contacts, especially near the large intrusives. The weathered surface of the baked material is brownish.

The altered nature of the diorite indicates a pre-Acadian age, i.e., the diorite is of Early Devonian age.

### **Teschenite**

Below Spencer Dam a spheroidally weathered teschenite dike 6 feet wide cuts the slate of the Seboomook formation. The rock is fine-grained and holocrystalline, with subhedral grain shape. In thin section the rock is seen to contain abundant laths of unaltered plagioclase feldspar, violet-colored pyroxene, and dark brown biotite. Less weathered surfaces are dark greenish-black, and more weathered surfaces are brownish-black. Fresh rock was not reached even after removing 3 feet of the exposed dike rock. The teschenite is of post-Acadian age.

Similar dikes have been seen at three other localities in northern Maine. At the first locality, in Franklin County, a dark,

spheroidally weathering teschenite dike 3 feet thick cuts gneiss. It occurs on the northeast side of the Chain Lakes, on State Route 4 about one-half mile southeast of Upper Farm (Chain Lakes quadrangle). The second occurrence is in Somerset County, on the southeast side of the northeast end of Grannys Cap (Pierce Pond quadrangle), where a black, spheroidally weathering teschenite dike 6 feet thick cuts Lower Devonian rhyolite. A third occurrence, in Aroostook County near Presque Isle, is described by Williams and Gregory.<sup>1</sup>

## Structure

The folds in the pre-Silurian rocks strike N. 50°-75° E. and plunge 26° to 54° N.E. Average strike is N. 63° E. and average plunge is 38° N.E. The folds are symmetrical, and the distances between crests and troughs range from 750 to 2,100 feet, the average being 1,000 feet. On the limbs of the folds there are many secondary folds, most of which have the proper drag sense for the major folds. The major folds repeat the section. The slate is plastically deformed with some beds folded tightly in minute folds an inch or less from crest to crest. In places slip-

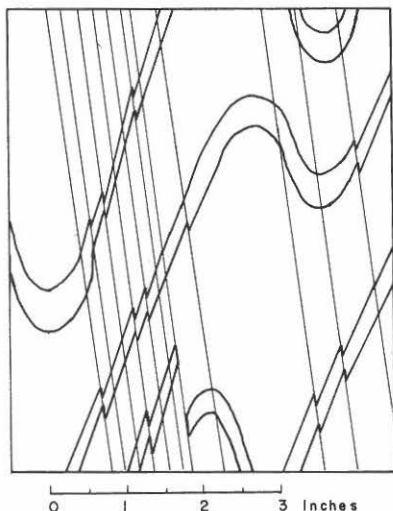


FIGURE 2—Sketch showing thinning, thickening, and displacement in the black slate of Cambrian or Ordovician age or both. Sketch was made at Location LA.

page and plastic deformation along cleavage planes have caused thickening, thinning, and displacement of beds (fig. 2). The more competent quartzite and limestone beds do not show small scale folding. In general, the cleavage is variable but average strike is N. 61° E. and average dip is 79° N.W.

There has been movement in the trough of the syncline that contains the pre-Silurian quartzite. A zone of fracture 6 to 18

<sup>1</sup> Williams, H. S., and Gregory, H. E., 1900, Contributions to the geology of Maine: U. S. Geol. Survey, Bull. 165, p. 179-186.

inches wide strikes parallel to the axis of the fold (N. 60° E.) and has an approximately vertical dip. The position of the beds on either side of this zone indicates that the downstream side moved up and to the south. About 80 feet downstream from the zone of fracture, a small fault in the quartzite shows the same relative movement as the fault upstream. The small fault strikes N. 2° E. and dips 72° W.

The pre-Silurian rocks lie above the Silurian or Lower Devonian rocks, and near the contact both units have about the same strike and dip. The older rocks have been thrust over the presumably overturned Silurian or Lower Devonian. The thrust fault is not exposed but is believed from the relationship of the units in the nearby outcrops to strike N. 60° E. and to have a shallow dip to the southeast.

The folds in the Seboomook trend N. 55° E. In the western part of the section they plunge about 15° S.W.; to the east they plunge about 40° N.E. with one exception where the plunge is 29° S.W. The western limbs of the anticlines are overturned about 15° to the northwest. The distances between the crests and troughs of major folds range from 600 feet to 3,600 feet and average 1,500 feet. Well-developed drag folds occur only on the western limbs of the anticlines. All the folds form part of the southeast limb of a larger syncline striking northeast.

The average cleavage in the Seboomook strikes N. 53° E. and dips about 74° S.E. The upper part of the Seboomook has crinkles — small bends in the cleavage up to ½ inch wide — which form planes striking about N. 37° E. and dipping about 32° S.W. Larger crinkles are also common, but their trends are random.

Small diorite dikes cut the section nearly vertically and for the most part strike 50°-70° N.E. They are marked by numerous blocky joints. Larger intrusives cut the section in two places. They strike N. 35° E. and have many well-developed joint sets.

### Joins and Cleavage

The orientation of joints and cleavage in the 5-mile stretch along Spencer Stream between Spencer Dam and the Augusta Lumber Company Camp was studied in order to determine the orientation of forces involved in the deformation of this part of the Moose River synclinorium. The attitudes of joints and cleavage were measured by compass in the field, and the poles of



these attitudes were plotted on the southern or lower hemispheres of equal-area projection nets. The nets have been contoured according to the number of points within 1 percent of the area of the nets, rather than by percentages of points, in order to obtain the greatest possible accuracy. The number of points plotted is shown in the legend for each figure, and in some instances percentages of points within contour intervals have also been indicated. Shear pairs are postulated from concentrations shown in the figures, not from field evidence of shear offsets.

In this report cleavage is considered to be subparallel divisional planes or surfaces 2 centimeters or less apart. Cleavage is of the slaty variety, being due to the parallel arrangement of platy minerals and/or ellipsoidal or flattened grains of such materials as sand, silt, and  $\text{CaCO}_3$ . Joints are defined as subparallel divisional planes or surfaces 2 or more centimeters apart along which there has been very little or no visible movement parallel to the planes and perpendicular to which there may have been movement resulting in open fractures.

The most numerous and prominent joints are nearly perpendicular to fold axes and plunges. These are called *ac* joints on the assumption that they are in the plane of the greatest and the least principal stresses.

*Stream control.* — For the most part Spencer Stream flows from west to east, but in several places it is controlled by joints and cleavage, which act together to modify the direction of flow locally. Between Spencer Dam and Gore Rapids there are 6 easily discernible places where the stream changes direction alternately between roughly the strike of the cleavage (N.  $63^\circ$  E.) and the strike of the prominent *ac* joints of the folds (N.  $24^\circ$  W.). At Gore Rapids the stream direction is modified by the strikes of the intrusives, which are nearly parallel to the fold axes, the strike of the proposed thrust plane, and the contact of the Silurian or Lower Devonian interbedded tuff and limestone.

In a few places the stream direction is definitely controlled by joints or cleavage for distances of more than 100 feet. At location LF the stream direction is controlled for almost 300 feet by the cleavage and bedding of the Seboomook formation. At this location the strikes of bedding and cleavage are nearly identical, and the dips are close to vertical.

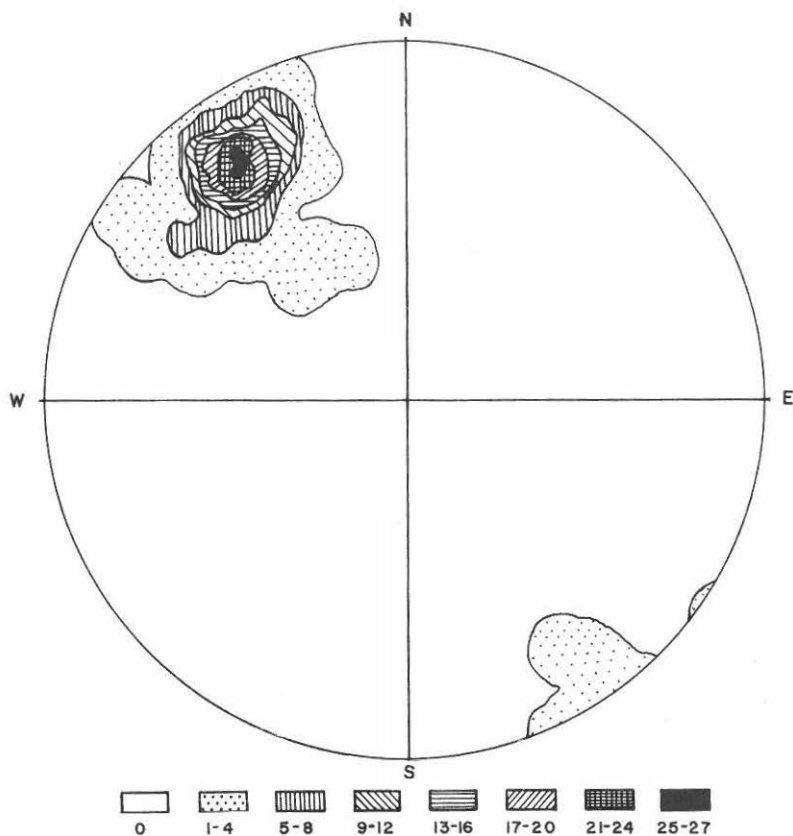


FIGURE 3 — Cleavage in the Seboomook formation (57 poles plotted).

*Cleavage.* — The cleavage in the area had been assumed to be axial plane cleavage by Boucot (oral communication, 1958), and observation of minor folds in the field agrees with that assumption. Bedding attitudes for the westernmost anticline and syncline plotted on an equal-area projection net show that the fold axis has the same strike (N.  $53^{\circ}$  E.) as the cleavage of the Seboomook formation plotted in Figure 3.

Cleavage orientation is illustrated in Figures 3 and 4. Figure 3 shows the cleavage in the slate and quartzite of the Seboomook formation, but the majority of the poles represent the slate as cleavage is poor in much of the quartzite. Figure 4 shows the cleavage in units older than the Seboomook formation, and most of the poles represent the pre-Silurian black slate, which is the most highly cleaved of the pre-Seboomook units. Figures 3 and 4, then, essentially provide a comparison between the cleavage

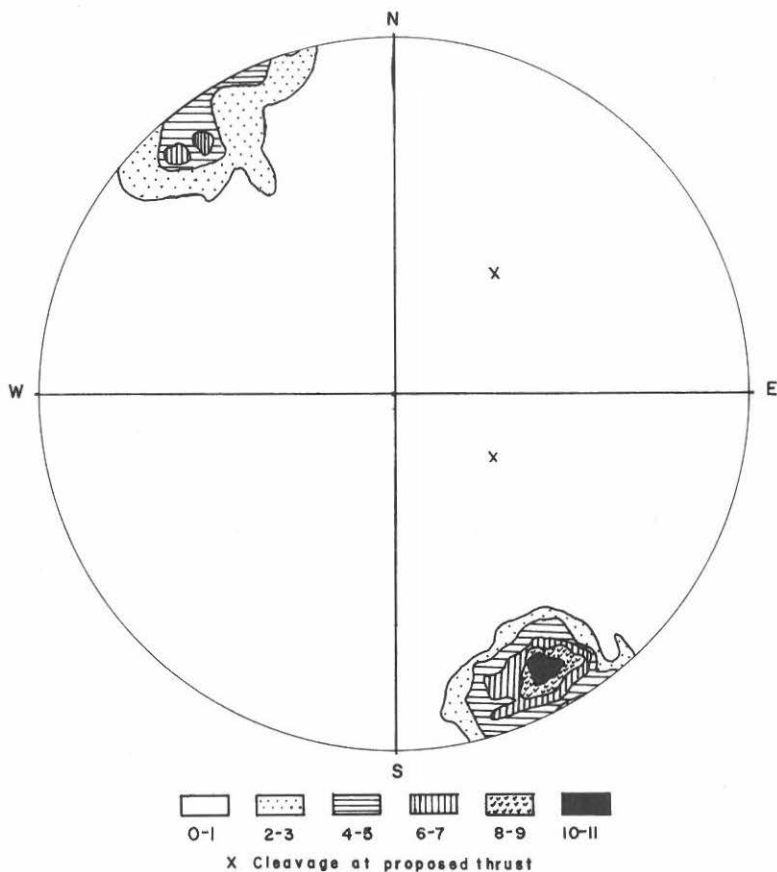


FIGURE 4—Cleavage in pre-Seboomook units (36 poles plotted).

of the slate in the Seboomook formation and that in the pre-Silurian slate, the former being exposed in the westernmost part of the section and the latter in the easternmost part. The strike of cleavage is almost identical in each (N.  $53^{\circ}$  E. in the Seboomook; N.  $61^{\circ}$  E. in the pre-Seboomook), but the average dips differ by 27 degrees ( $74^{\circ}$  S.E. in the Seboomook;  $79^{\circ}$  N.W. in the pre-Seboomook). The difference may be accounted for in three ways:

1. Two periods of folding, in which pre-Seboomook cleavage was formed during the first but was not obliterated during the second. The high degree of folding in the Seboomook formation makes this theory seem unlikely.

2. Two areas some distance apart have been sampled, and the variation is due to the presence of a cleavage fan. Boucot has found that cleavage fans are fairly common in the area.

3. Cleavage orientation is the result of the most recent period of folding, but emplacement of the large intrusive produced uplift that inclined the Seboomook cleavage more to the south and the pre-Seboomook cleavage more to the north (fig. 4a). The strikes of the fold axes of the entire area are close to parallel, the folds have similar widths, and the plotted cleavage poles of the pre-Seboomook do not show the girdle effect. Only two poles of pre-Seboomook cleavage (marked X in fig. 4) differ greatly from the greatest concentration, and both are from the Silurian or Lower Devonian interbedded limestone and slate in the area of all the intrusives.

*Igneous rock joints.* — Figure 5 shows the poles of the joints of all the intrusives. Separate plotting and contouring of the joints of the large intrusives alone showed so random an orientation that the figure is not included. The intrusives contain more numerous and more closely spaced joint sets than the sedimentary formations. Most of the joints are continuous and regular, al-

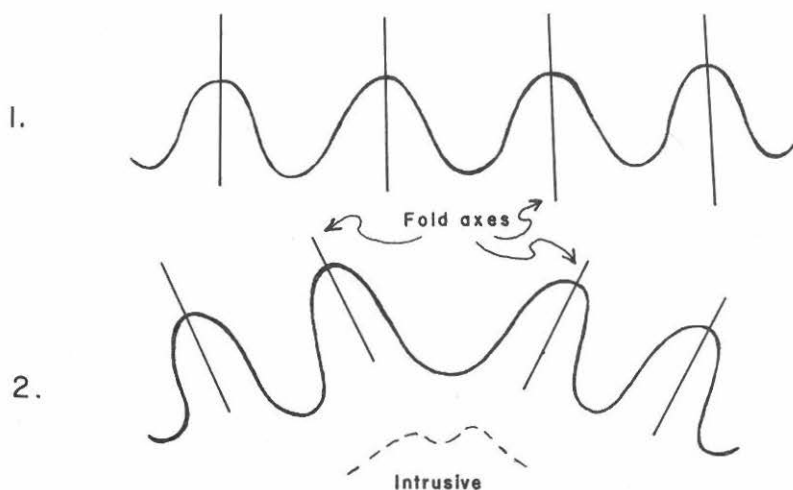


FIGURE 4a — Diagrammatic interpretation of the existing cleavage relationships as a result of uplift caused by emplacement of the large intrusive.

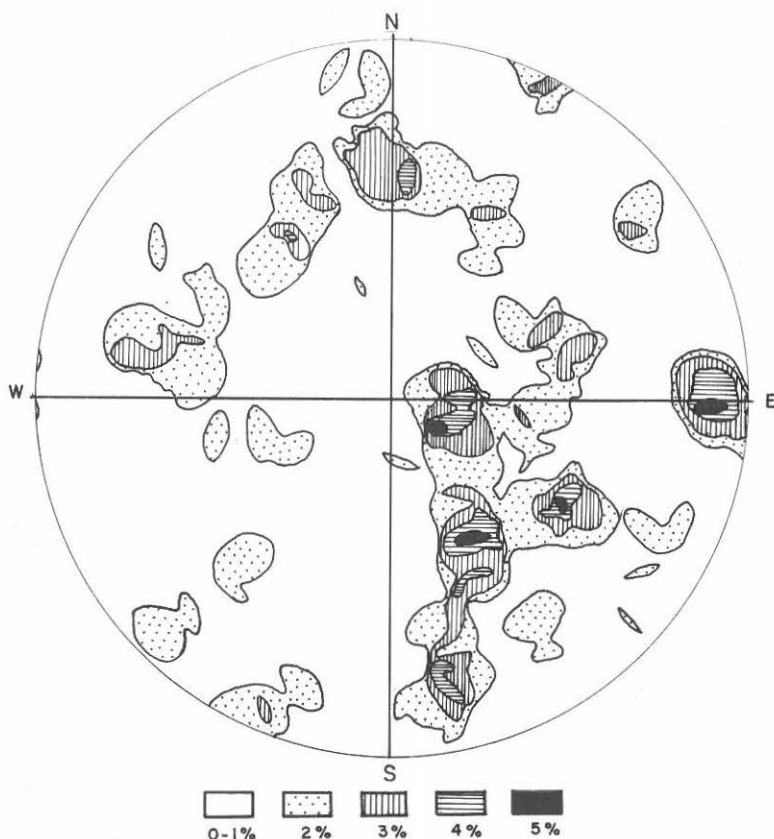


FIGURE 5—Joints in the igneous rocks (99 poles plotted).

though a few are curved due to the irregularity of some dike contacts.

The majority of the dikes were intruded near the crests or troughs of the folds. From the sedimentary-igneous contacts exposed it may be assumed that most of the dikes were intruded within 25 degrees of the strike and dip of cleavage. The 4 greatest concentrations of igneous joints all strike to the northeast and dip to the northwest, and each represents only 5 percent of the total igneous joints. The variation in dike attitudes is great enough so that Figure 4 should not be expected to show high concentrations. The forces responsible for the igneous joints can be determined only through separate analysis of each joint.

No columnar or transverse joints were observed, and very few joint sets are perpendicular to the contact planes. Two such sets are well developed at location LH, where they occur only in

the chilled zones at the edges of the dike, which strikes N. 68° E. and dips 75° N.W. Although they do not show conclusive evidence of displacement, these two sets (strike N. 69° W., dip 47° N.E. for one; strike N. 2° W., dip 39° S.W. for the other) could be a shear pair indicating maximum compression striking N. 31° W. and dipping 60° N.W.

The scarcity of joints perpendicular to contacts indicates that the forces responsible for the formation of most igneous joint sets were more complicated than simple shrinkage upon cooling of the emplaced dike bodies, which would have resulted in columnar

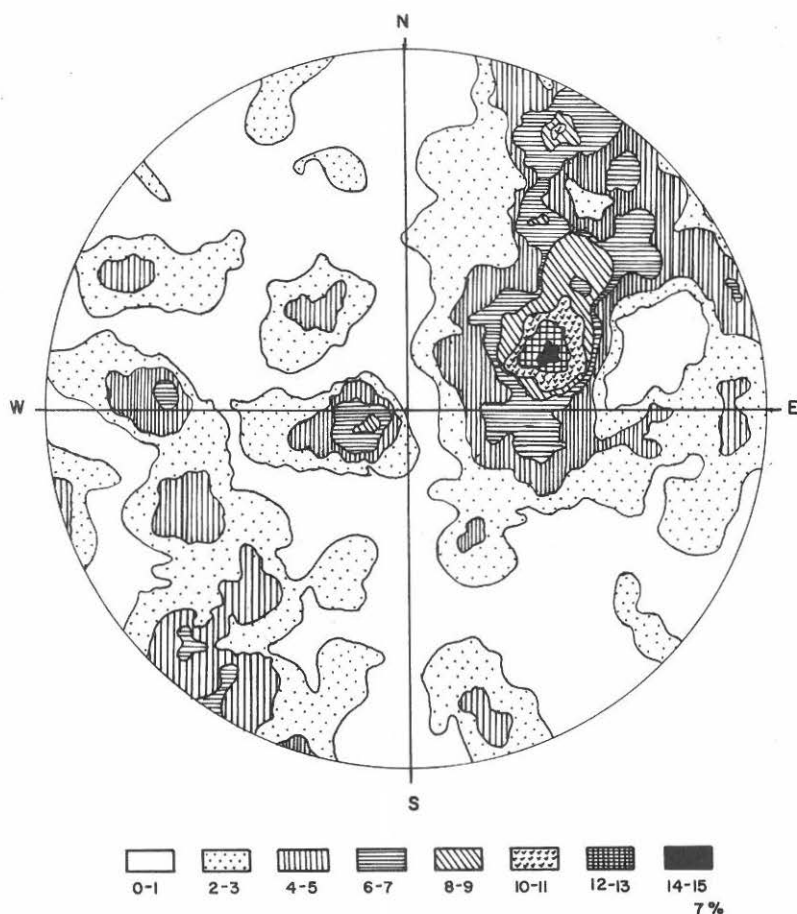


FIGURE 6—Total joints in the sedimentary rocks (214 poles plotted).

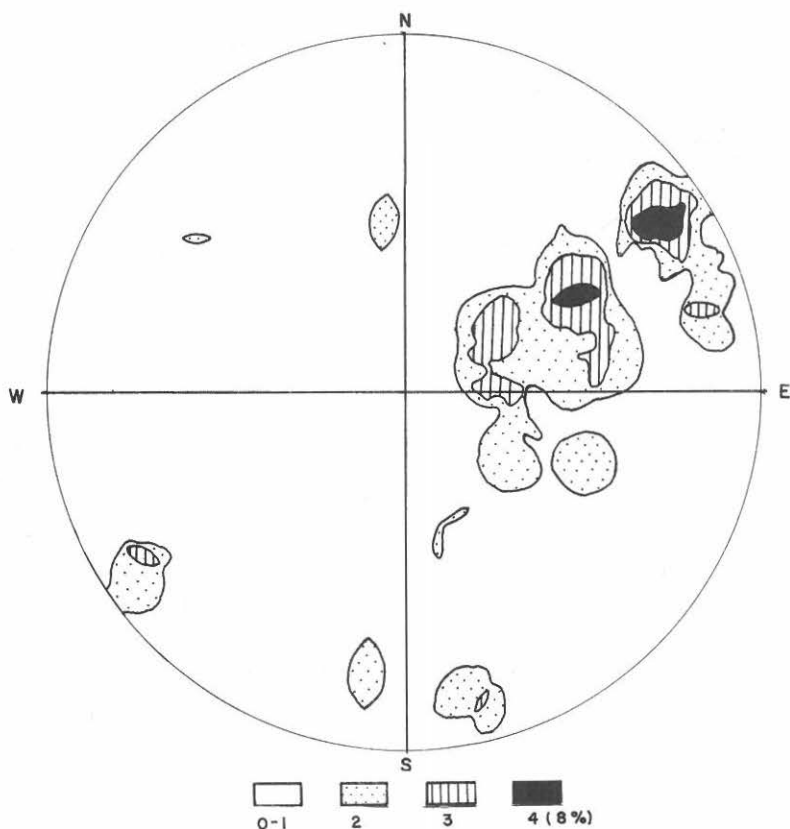


FIGURE 7 — Most prominent joints in the sedimentary rocks (48 poles plotted). or transverse joints, or shear sets symmetrically arranged normal to the contacts.

*Total sedimentary rock joints.* — Figure 6 represents all the joints recorded in sedimentary units, and it shows that the majority of the joints strike northwest and dip to the south or steeply to the north. The concentrations may be interpreted by separate analysis of the Seboomook formation and the pre-Seboomook units. Conclusions drawn from analysis of the total sedimentary joints present a false picture because of the overlap of concentrations from the two principal units.

*Most prominent sedimentary rock joints.* — Figure 7 shows the most prominent sedimentary joints. Prominent sedimentary joints were determined as follows:

1. In outcrops containing only one joint set, that set was considered prominent if it was repeated often enough to be characteristic of the outcrop.

2. In outcrops which had two or more joint sets, a prominent joint was regarded as one that was better developed or more often repeated than the other set or sets. There are two 8-percent concentrations of prominent sedimentary joints, each formed perpendicular to the fold axes and representing the *ac* joints of the folds. One strikes N. 30°-37° W. and dips 71°-86° S.W., and the other strikes N. 26°-32° W. and dips 44°-58° S.W. The former represents joints from the pre-Seboomook units, and the latter joints from the Seboomook formation. They are nearly perpendicular to the axial lines of the folds and to the plunges indicated by the intersections of the bedding and cleavage, and thus they provide evidence that the pre-Seboomook folds plunge more steeply to the north than the Seboomook folds. In the Seboomook formation the major fold axes have an average strike of N. 54° E. and plunge of 15° S.W., and the minor fold axes have an average strike of N. 55° E. and plunge of 40° N.E. All minor folds plunge to the northeast. In the pre-Seboomook units the major fold axes have an average strike of N. 62° E. and plunge of 39° N.E., and the minor fold axes have an average strike of N. 65° E. and plunge of 37° N.E.

*Seboomook formation joints.* — The joints of the slate and quartzite of the Seboomook formation are contoured in Figure 8. The joints in the quartzite are more numerous and better developed than those in the slate. Curved, poorly formed, shallow-dipping joints in the slate are presumably release fractures.

The only concentration greater than four percent is an 8 percent concentration that strikes N. 20°-25° W. and dips 39°-44° S.E. This represents the *ac* joints of the northeast-plunging minor folds.

The joints of the westernmost syncline and anticline in the section show three trends. One, striking N. 40° W. and dipping 85° S.W. to 80° N.E., is the *ac* joint nearly perpendicular to the fold axes, which strike N. 53° E. The other two, one striking N. 10° E. and dipping 80° N.W. and the second striking N. 10° E. and dipping 38° N.W., may each represent half of a shear pair in which the other half is not developed.

Dikes that intrude the quartzite of the Seboomook formation have joints that are continuous into the quartzite. Thus at location LG three well-developed joint sets, one a bedding plane joint and the other two the most prominent joint set from each of the two largest dikes, are continuous through the three dikes



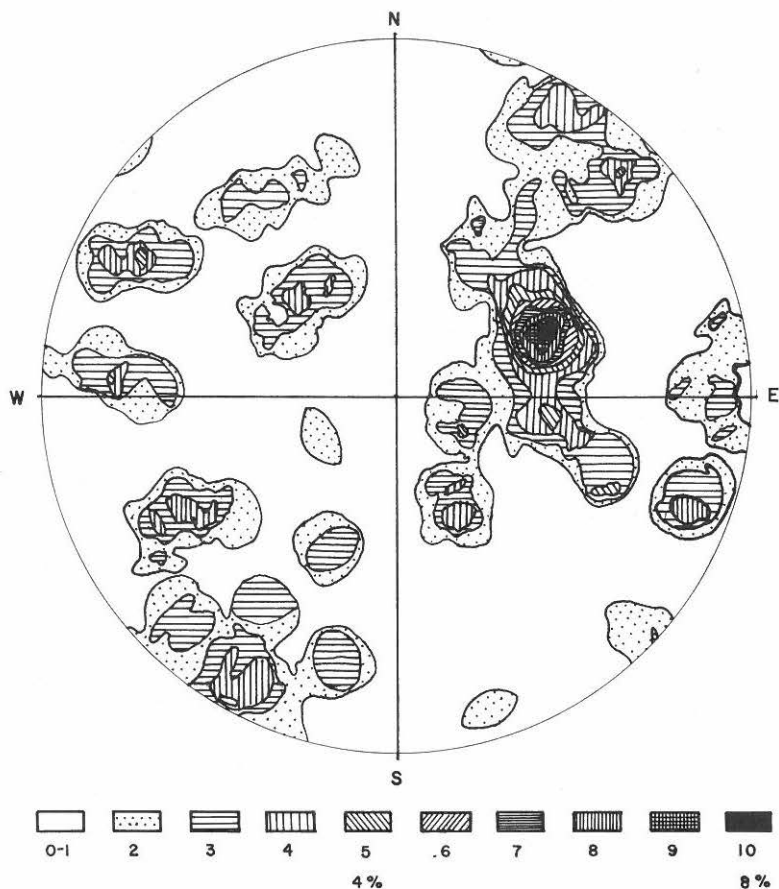


FIGURE 8—Joints in the Seboomook formation (125 poles plotted).

and the intervening quartzite. The most prominent joint here varies 13 degrees in strike and 21 degrees in dip. Some of the concentrations in Figure 8 may be attributed to the continuation into the sediments of dike joints.

The slate of the Seboomook formation and the pre-Silurian black slate are not influenced as much by the dike joints as the quartzite of the Seboomook.

*Thrust zone joints.*—The Silurian or Lower Devonian interbedded limestone and tuff and interbedded limestone and slate

are stratigraphically between the Seboomook and the pre-Silurian units and are in the area of the thrust fault. The bedding in the area strikes approximately N. 50° W. and is overturned to the southeast. The 19 recorded joints show 4 trends: strike N. 25° W. and dip 70° S.W.; strike N. 50° W. and dip 70° N.E.; strike N. 20° E. and dip 30° S.E.; and strike N. 80° E. and dip 85° N.W. The first two trends, which are from the southwest part of the thrust area, may be a shear pair indicating maximum compression from N. 37½° W., provided that least compression was in a horizontal northeast-southwest direction. The last two trends predominate in the northeast part of the thrust area. The small

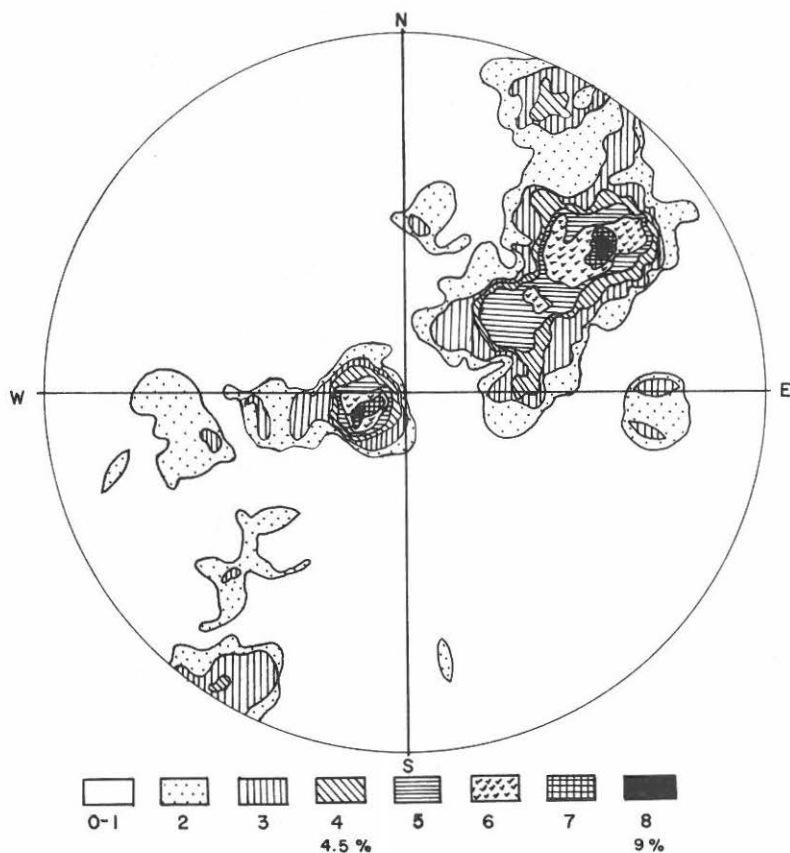


FIGURE 9—Joints in the pre-Seboomook units (89 poles plotted).

number of joints from the thrust zone makes their analysis uncertain, and the trends are included here only because so little significant evidence was gathered in the zone.

*Pre-Seboomook joints.* — Figure 9 represents the joints of the units older than the Seboomook, primarily the pre-Silurian black slate. Two 9-percent concentrations are present. The largest, striking N. 34°-38° W. and dipping 60°-64° S.E., represents the *ac* joints of the folds, which have an average plunge of 38° N.E. The strike differs from that of the Seboomook *ac* joint concentrations by 13 degrees, and the dip by 21 degrees. The second great concentration of joints strikes N. 25° W. and dips 13° N.E. The absence of joints striking northeast indicates that the older rocks reacted very differently from the Seboomook formation.

## Summary

A 6-mile section along Spencer Stream, Spencer quadrangle, Somerset County, was mapped on a scale of 50 feet to the inch. The youngest sedimentary rocks in the section are Lower Devonian slate and fine-grained quartzites belonging to the Seboomook formation. Below the Seboomook are units of Silurian or Lower Devonian age, consisting of an interbedded limestone and tuff and an interbedded limestone and slate. Pre-Silurian rocks downstream from the Silurian or Lower Devonian rocks consist of black, rusty-weathering slate, limestone, quartzite, and brownish-red slate. The older rocks, of Cambrian or Ordovician age or both, have been thrust over the younger rocks. Dioritic intrusives cut the whole section.

Folds in the Silurian or Lower Devonian rocks strike about N. 55° E. and are overturned about 15° to the northwest. The average distance from crest to trough is about 1,500 feet. These folds are part of the southeast limb of a large syncline. Folds in the pre-Silurian rocks strike about N. 63° E., plunge 38° N.E., and are not overturned. The average distance from crest to trough of the pre-Silurian folds is about 1,000 feet.

The cleavage of the Seboomook formation and the black slate of Cambro-Ordovician? age have nearly identical strikes, but their dips differ by 27 degrees.

The most common joints in the sedimentary units are *ac* joints, nearly perpendicular to the fold axes. The Seboomook formation

and the black slate of Cambro-Ordovician? age have different joint orientations. The joints of the dikes are presumably shear pairs and must be interpreted separately for each dike.

Stream direction is controlled by joints and cleavage for short distances.



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### **Note on Plate 1**

Because Spencer Stream is to some degree sinuous, it has been necessary to "straighten" it for reproduction in map form. In this respect, please note that the compass bearing depicted in the upper left corner of Plate 1 refers only to the Spencer Dam area. Following the stream diagram to the southeast, note that the diagram has been cut in eleven different places to effect the straightening. By joining the match lines at the eleven places, the stream will appear as it was originally surveyed on the ground.

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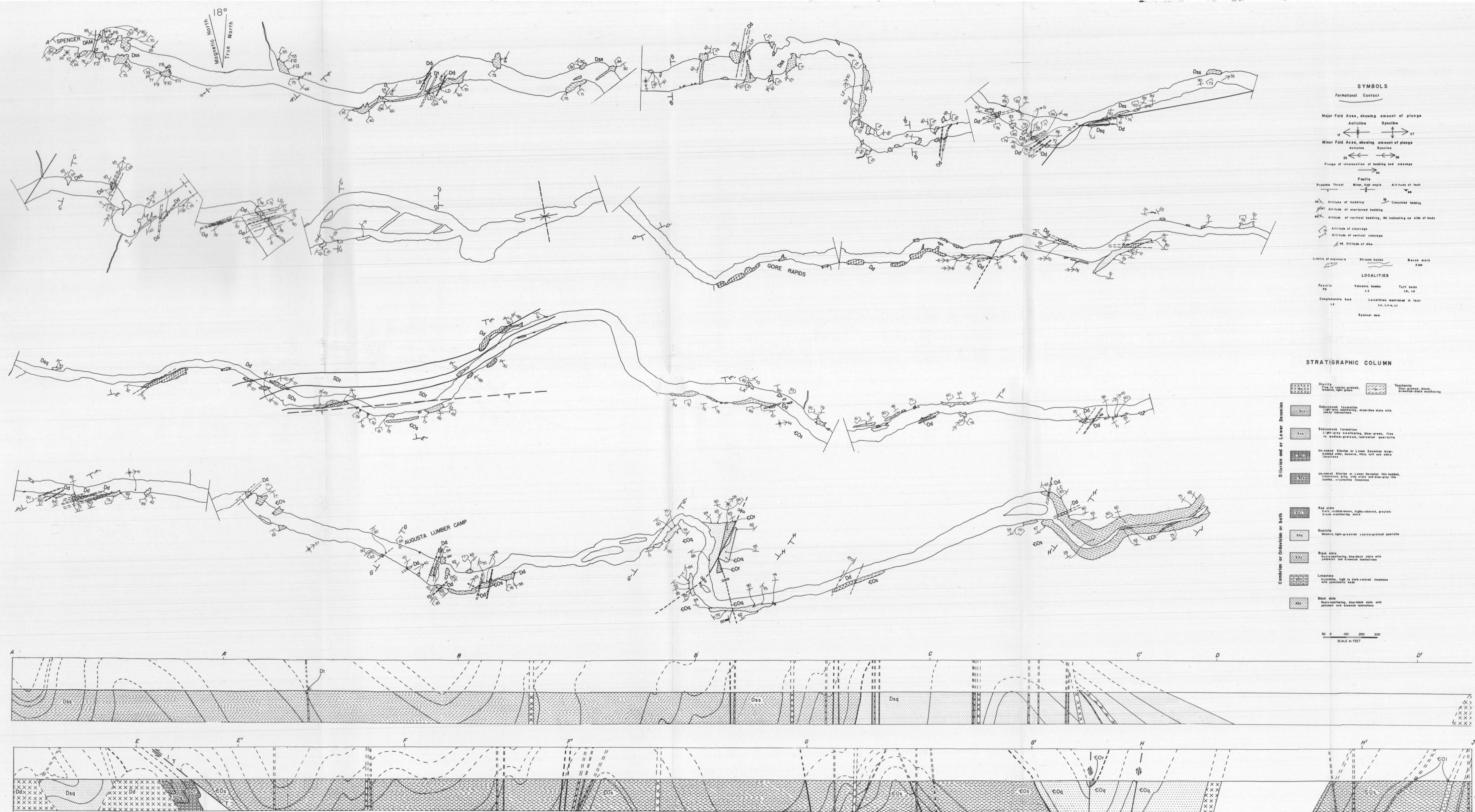


PLATE 1. Geologic Map and Structure Section along Spencer Stream.

Tape and compass mapping by G. H. Denton, J. R. Griffin, and P. S. Perry, July-August, 1958.