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Title: Structural Analysis of the Guilford, Dover-Foxcroft, and Boyd Lake 15-Minute Quadrangles, South-Central Maine

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Contents: 22 page report

INTRODUCTION

Compilation of seismic epicenters by Boston Edison (1976) and Barosh (1978) revealed a wedge-shaped area of persistent, low-intensity seismic activity located north and west of Penobscot Bay in south-central Maine. The delineation of this region has been further enhanced by adding the data of Lepage and Johnston (1982) to that of Barosh (see Figure 1). During the summers of 1979, 1980 and 1981, the author conducted bedrock mapping and lineament analysis within this region to determine if any observable structural features may be related to the identified seismicity (Westerman, 1980 and 1981a). This report covers the results of work during the summer of 1981 in the Guilford, Dover-Foxcroft and Boyd Lake 15-minute quadrangles. This work was closely coordinated with that of Newberg in the three quadrangles to the north (see Newberg, 1983, this report).

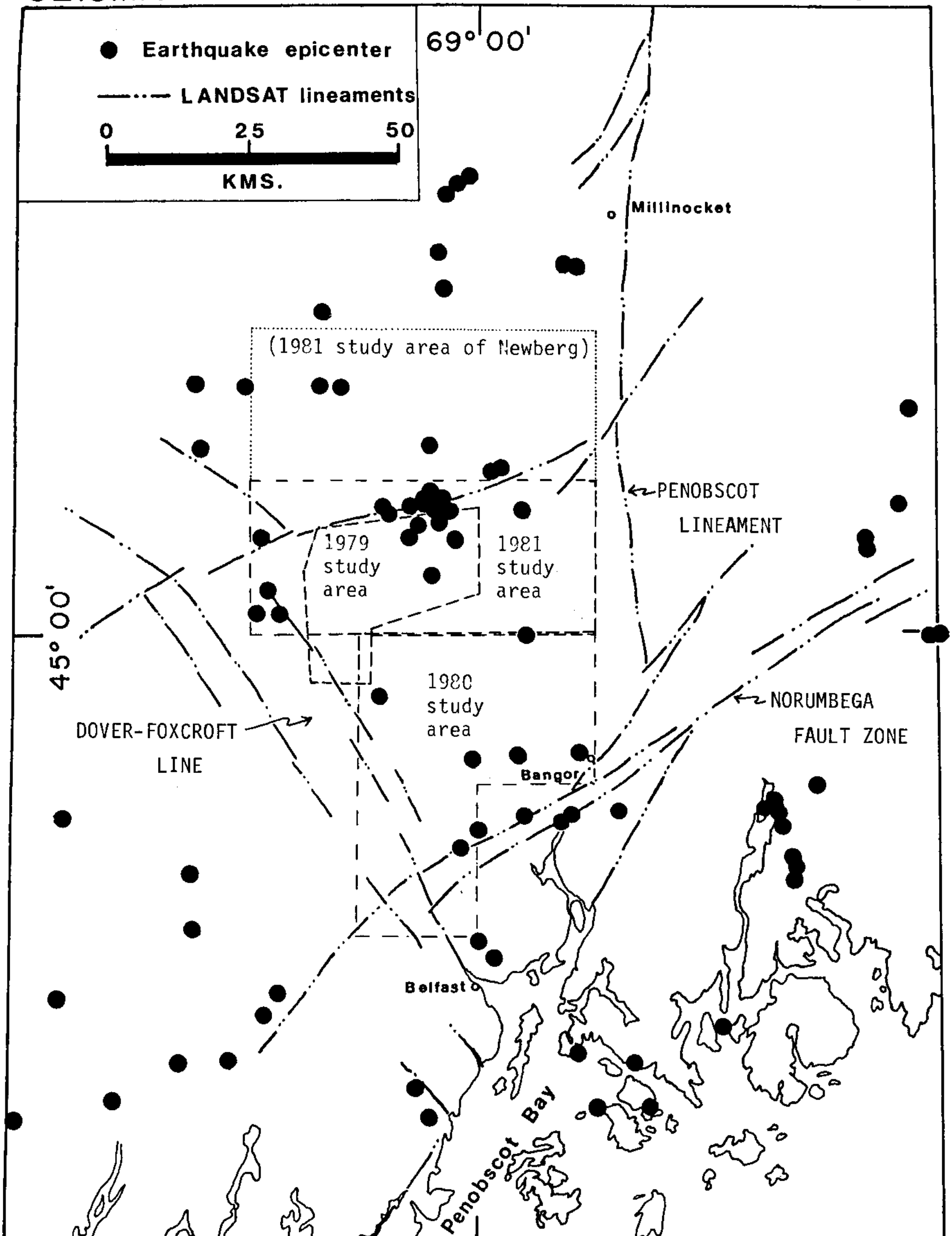
BEDROCK GEOLOGY AND LARGE-SCALE STRUCTURES

The most detailed mapping in this study area has been by Griffin (1973a) who published open-file 15-minute geologic quadrangle maps of the eastern two-thirds of the Guilford quadrangle, the entire Dover-Foxcroft quadrangle, and the western half of the Boyd Lake quadrangle (Griffin, 1973b,c and d). These maps provided the principle detailed source of information on which this project was based. It is unfortunate that outcrop locations were not included on the map of the Dover-Foxcroft quadrangle. The stratigraphic units delineated on Griffin's maps correspond closely with those discussed in considerable detail by Pankiwskyj and others (1976). Pankiwskyj (1979) published a report and map which included the northern half of the Guilford quadrangle. Although the stratigraphic nomenclature in that report corresponds well with the earlier work, Pankiwskyj reinterpreted the geology significantly.

The quadrangle to the west of the study area, the Kingsbury quadrangle, has been mapped in detail by Ludman (1978), but the Passadumkeag quadrangle to the east has been mapped only in reconnaissance by Griffin (1976a). Ludman's stratigraphy is essentially in correspondence with that of Griffin, but a gap between their maps extends from north to south along the entire western third of the Guilford quadrangle. Efforts to link these two maps proved unfeasible due to the complexity of the geology and the limited availability of outcrops and time. The principle problems were encountered with mapping individual members of the Sangerville Formation; this same problem of mapping members was encountered in the southeastern portion of the study area within the Waterville Formation. Both areas will be discussed later in this report.

In an effort to resolve the problems created by the complexity of the geology as seen when mapped in detail, the author has taken data from all available sources along with his own data from more than 700 outcrops in the three quadrangles and has produced Figure 2 showing distinctive lithologic terrains. These terrains are discussed below as numbered units, starting in the northwest with Unit 1 and proceeding southeast to Unit 6. Also shown in Figure 2 is the southern portion of the Sebec Lake pluton, the full outline of which, including the contact aureole, can be seen in Newberg (1982).

SEISMICITY AND SELECTED LINEAMENTS



(after Barosh (1979) and Lepage and Johnston (1982))

Figure 1: Location map showing study areas, epicenter locations and regional lineaments.

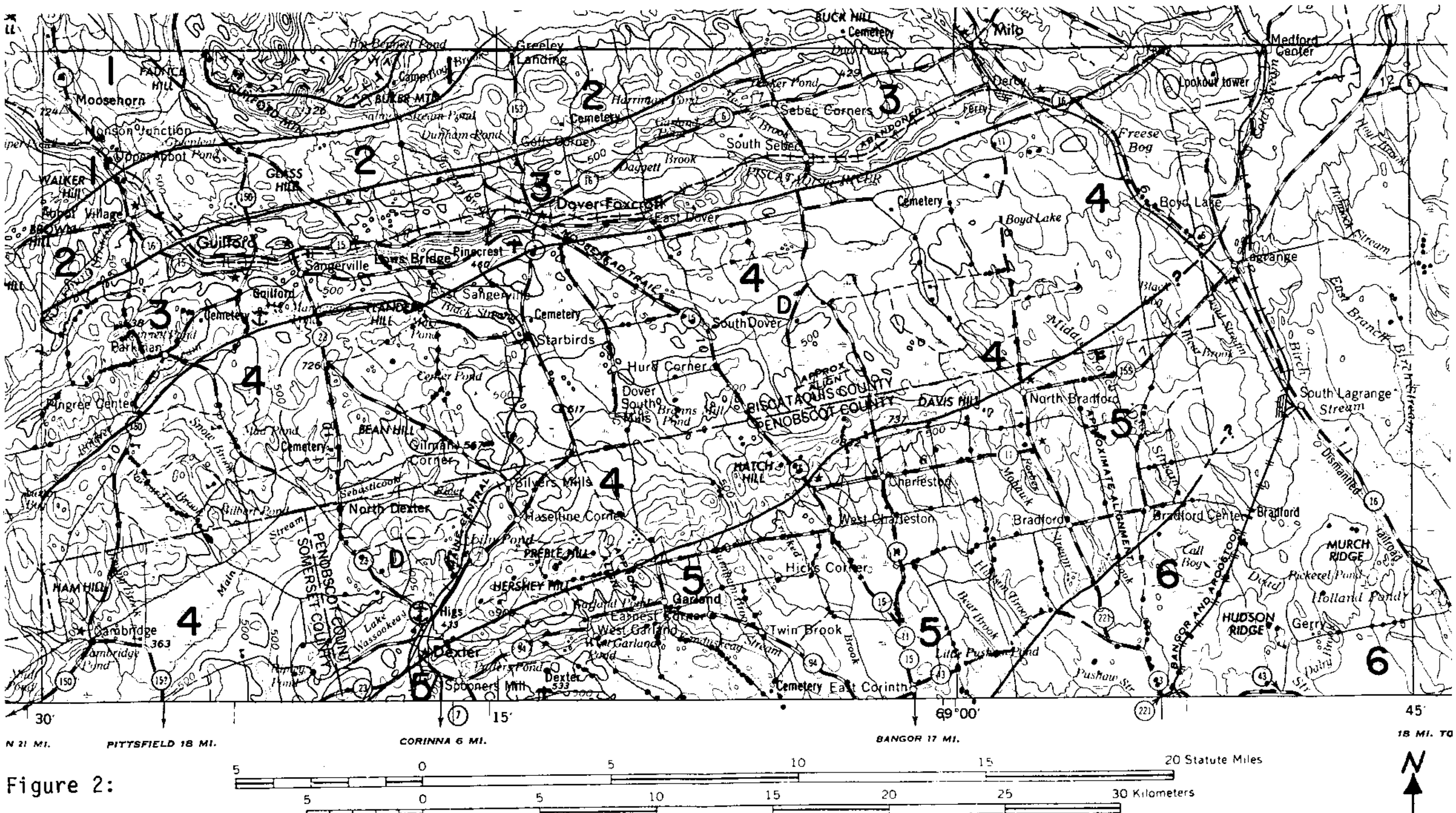


Figure 2:

DESCRIPTION OF LITHOLOGIC UNITS

UNIT 1: Dark gray slates and thinly bedded dark gray slates and siltstones

UNIT 2: Thickly bedded sandstones with minor pelitic horizons

UNIT 3: Granule conglomerates, ribbon limestones and graphitic, sulfidic pelites

UNIT 4: Thickly bedded sandstones generally graded; minor limestone, "grit" and pelite

UNIT 5: Thinly bedded siltstones and pelites with ribbon limestone and maroon/green slates

UNIT 6: Thickly bedded sandstones generally graded; minor thin-bedded siltstones and slates

D = outcrop of diabase • = outcrop location (symbol) = Sebec Lake pluton

Unit 1:

This unit, located in the northwest corner of the study area, consists predominantly of dark gray slates. It includes rocks of the Solon (Carrabassett) Formation along with rocks which Pankiwskyj (1979) correlated with the Seboomook Formation and interpreted as part of the Rumford Allochthon first recognized by Moench and Hildreth (1976). The western extension of the southern contact of this unit has been mapped in the Kingsbury quadrangle by Ludman (1978) as an observed fault near Cole Corner. In contrast, Griffin (1973b), Pankiwskyj and others (1976), and Newberg (1982) indicate that this contact between Units 1 and 2 is a conformable one with quartzites of the Fall Brook (Madrid) Formation on the south side underlying rocks of the Solon Formation. Pankiwskyj (1979) indicates that this contact is in part conformable and in part a fault.

Along Route 15 in the northwest corner of the Guilford quadrangle, rocks of the Solon Formation are exposed in the Piscataquis River at the Upper Abbot bridge near the contact between Units 1 and 2. These rocks are well bedded and show no evidence of tectonic disturbance parallel to the contact, but the rocks exposed on the south side of the contact 1 km. downstream do show such a history. This disturbance includes tectonic dismemberment, translation and rotation of bedding, suggesting that the contact may well be a fault. Unfortunately, no sense of motion could be confidently determined for this shearing which parallels the contact.

Unit 2:

The predominant lithologies of this unit are metasandstones and metasiltstones which are generally weakly calcareous and thickly bedded with thin pelitic interbeds. For the most part, these rocks have been previously mapped as the Fall Brook (Madrid) Formation (Griffin, 1973 b and c; Ludman, 1978; Pankiwskyj, 1979; Newberg, 1982) and metasandstones of the Sangerville Formation (Griffin, 1973b; Pankiwskyj, 1979). In addition, limited exposures of pelitic rocks have been included in this unit (Eddy Formation of Griffin, 1973b = Parkman Hill Formation of Pankiwskyj, 1979; Carrabassett Formation of Griffin, 1973c).

The northern contact of Unit 2 has been discussed above and is readily mappable on the basis of the sharp contrast in lithologies. The southern contact of Unit 2 does not correspond with any previously mapped boundary but has mappable criteria. The western extension of this southern contact has been readily delineated by Ludman (1978) as a fault between metasandstones of the Fall Brook Formation on the north side and carbonaceous and sulfidic pelites of the Parkman Hill Formation on the south side. This convenient lithologic contrast does not continue eastward into the Guilford quadrangle, so a new mappable criteria was used. This consisted of mapping the contact between predominantly metasandstones on the north side (Unit 2) and metapelite, metaconglomerate and ribbon metalimestone on the south side (Unit 3). The result is seen in Figure 2 where the contact is smooth and continuous.

The contact between Units 2 and 3 is thought to be a fault. The primary evidence suggesting this is the frequent change in lithology along the southern side of the contact.

Unit 3:

Three distinctive lithologies make up this unit: metalimestone, metaconglomerate, and carbonaceous and sulfidic metapelite. Scattered outcrops of metasandstone and metasiltstone are included since they remain subordinant to the distinctive lithologies mentioned above. As previously stated, Ludman (1978) mapped the northern contact of this unit as a fault between metasandstones of the Fall Brook Formation and metapelites of the Parkman Hill Formation. It should be noted that the Parkman Hill rocks are described by Ludman to include "sulfidic metasandstone, granule conglomerate, siltstone; minor calcareous mudstone and ribbon limestone".

Sufficient outcrop exists along the western margin of the Guilford quadrangle to test the mappability of the formations and members which Ludman (1978) and Griffin (1973b) show to line up in that area underlain by Unit 3. The results of detailed mapping show that all the lithologies of the Parkman Hill Formation and the members of the Sangerville Formation can be found within a matter of 10's of meters across strike, but the patterns can not be mapped with any consistency along strike. This author's interpretation is that extensive faulting has occurred within Unit 3, producing an irresolvable mixture of rock units which can only be reliably mapped as a single unit. It is perhaps significant that the greatest concentration of seismic events in the study area occurs near the town of Milo which is located along the central axis of Unit 3 (refer to Figures 1 and 2).

The boundary between Units 3 and 4 corresponds to the southern limit of predominance of conglomerate, limestone and pelite with a change to overwhelming dominance of thickly bedded metasandstones. This boundary corresponds with a fault mapped by Ludman (1978) in the Kingsbury quadrangle separating terrains within the Sangerville Formation marked by the lithologic differences noted above. This fault enters the western side of the study area parallel to Pingree Stream trending NE, bends to ENE and extends across the Dover-Foxcroft quadrangle along the southern side of the Piscataquis River. This boundary corresponds closely with a fault mapped by Pankiwskyj (1979).

<u>Unit 4</u>:

Metasandstones which are generally weakly calcareous and thickly bedded underlie the area mapped as Unit 4. Included in this Unit are rare and scattered outcrops of the lithologies of Unit 3 and two outcrops of diabase (indicated by the letter D in Figure 2). Also included are outcrops of thinly bedded phyllitic metasiltstone which are roughly aligned along regional strike and commonly exhibit dismemberment of bedding (Dover Member of the Sangerville Formation of Pankiwskyj et al., 1976). Within the area underlain by Unit 4, Griffin (1973b,c and d) distinguished between the metasandstones of the Sangerville Formation and those of the Vassalboro Formation. This author found that distinction to be unmappable, so massive metasandstones of both formations are included in Unit 4.

The southern boundary of Unit 4 is marked by the contact between thickly bedded metasandstones on the north side and thinly bedded metasiltstones on the south side. Well-developed mylonitic schists were observed close to the contact at the east end of Bull Hill in the Dover-Foxcroft quadrangle, but nowhere was the contact seen to be exposed.

<u>Unit 5</u>:

Rocks of this unit, like those of Unit 3, consist of an assemblage of lithologies which are locally unmappable as members due to the frequent repetition of rock types, their lack of continuity along strike, and the limits of outcrop exposure and time. Griffin (1973b,c and d) indicates two mappable horizons of ribbon metalimestone and one of green and maroon slate within the area underlain by Unit 5. Detailed field checking reveals that the distribution of these members is less simple than indicated by Griffin, and no effort is made in this report to subdivide Unit 5.

The dominant lithology in the western portion of Unit 5 is thinly bedded phyllitic metasiltstone (Waterville Formation) with subordinant ribbon limestone. As one traverses eastward across the area of Unit 5, the abundance of metalimestone is replaced by green and maroon slate (Pittsfield Member of the Waterville Formation of Griffin, 1973b,c and d; and of Pankiwskyj et al., 1976).

The nature of the northern contact of Unit 5 has been discussed above. The southern contact of Unit 5 is readily mappable due to the sharp contrast beteen the green and maroon slates exposed along the southern margin of Unit 5 and the thickly bedded metasandstones along the northern margin of Unit 6. This contact is exposed in Dead Stream one mile east of Bradford Center in the southern half of the Boyd Lake quadrangle. At this locality, the contact can clearly be seen to be a fault with a zone of gouge and quartz lenses about 2 feet thick. The sense of motion suggested by the chattery surfaces and weak lineations is right-lateral with the north side moving N37E and plunging at an angle of 25^{o}. Metasandstones of the Vassalboro Formation in Unit 6 on the southeast side of the fault exhibit graded beds oriented N52E, V,with tops facing to the north.

Unit 6:

The rocks of Unit 6 are predominantly thickly bedded metasandstones which are for the most part indistinguishable from those of Unit 4. Griffin (1973d, 1976b) and Pankiwskyj and others (1976) have correlated these rocks with the Vassalboro Formation. Along the northwest margin of this unit the rocks are formed from thickly bedded sands, but in the southeastern ninth of the Boyd Lake quadrangle considerable confusion results from the occurrence of several outcrops of thinly bedded metasiltstone (generally sheared) and one outcrop of green and maroon slate. Neither of these subordinant lithologies, both of which are characteristic of Unit 5, are mappable along or across strike since they occur as isolated outcrops surrounded by thickly bedded metasandstones. In addition, these rogue outcrops consistently occur along strong topographic lineaments trending NNE roughly parallel to the western contact of Unit 6, suggesting that they may have been emplaced by faulting.

Summary:

The large-scale interpretation of the study area presented by Pankiwskyj and others (1976) is that the region is located on the eastern limb of the Merrimack Synclinorium, a major structural feature extending from southern Connecticut (Dixon and Lundgren, 1968), through Massachusetts (Rodgers, 1970) and New Hampshire (Billings, 1956) and into Maine (Osberg and others, 1968). A stratigraphic sequence was established for south-central Maine based on field observations and paleontological data, and a series of anticlines and synclines was interpreted within the study area (see Pankiwskyj et al., 1976, Figure 2). Nearly all of the rocks in the study area in which beds can be recognized are now oriented near vertical, presumably due to the tight folding of the Acadian Orogeny during the Devonian. In the metasiltstones and finer grained rocks, an initial cleavage is generally observable which nearly parallels the bedding and was presumably developed during the folding which produced the mapped anticlines and synclines. No fold closures of this nature have been mapped by the author in the study area (or in the study area of the previous summer - see Figure 1). Nor have such large-scale folds been suggested by detailed mapping in areas where they are suggested by previous workers to occur. On the contrary, topping sense indicators, particularly graded bedding, show frequent alternations which are often inconsistent with previous interpretations of the structure.

The area underlain by Unit 3 presents an example of the problems encountered throughout this region. This area has been mapped differently by Griffin (1973b, c and d), Pankiwskyj and others (1976) and Pankiwskyj (1979). In each case, the worker (or workers) has taken the available data of rock type distribution and an existing stratigraphic model based on work in other areas, and has then attempted to make a map consistent with the data and the model. When more data is collected, the map becomes more complex, requiring more frequent transitions from one mapped unit to another and more bedding plane faults to resolve stratigraphic inconsistencies indicated by tops of bedding.

This author suggests that the entire study area has experienced extensive faulting parallel and at shallow angles to bedding planes, and that major large-scale faults occur within and along the borders of all six units shown in Figure 2.

SMALL-SCALE STRUCTURAL FEATURES

Folds and associated fractures:

Superimposed on the bedding and the initial cleavage which roughly paralles bedding are small-scale folds with axial-planar brittle-fracture cleavage. These structures are common and persistent throughout the study area, and they became a significant focus of the project. These folds can be divided into two types: those with an asymmetrical shape, curved hinges and a dextral sense (right-handed Z folds) and those with an asymmetrical shape, sharp hinges and a sinistral sense (left-handed S kinks). These features are not simply mirror images of each other but have their own distinctive shapes and frequencies of occurrence, the Z folds being significantly more common.

These small folds and their associated brittle fracture cleavage were first thought to be small-scale sympathetic folds associated with the larger-scale anticlines and synclines mapped in this area. This possibility was eliminated when the folds were found to exhibit no change in sense on the opposing limbs of the presumed large-scale folds, and when they were observed occurring together. They are, therefore, concluded to be features which have been imposed on the regional structure subsequent to the orientation of bedding at steep angles and the development of the regional distribution of the mapped units numbered 1 through 6.

The orientation and location of all observed brittle fractures which indicate right-lateral movement in the study area are illustrated in Figure 3. These fractures are dominantly fracture cleavage associated with observed Z folds, in the hinges of which dislocations on the scale of millimeters were commonly observed. The vast majority of all fracture cleavage associated with Z folds trends NO-20E and dips nearly vertical. Axes of these folds typically plunge steeply. Northeasterly trending brittle fractures shown in Figure 3 are

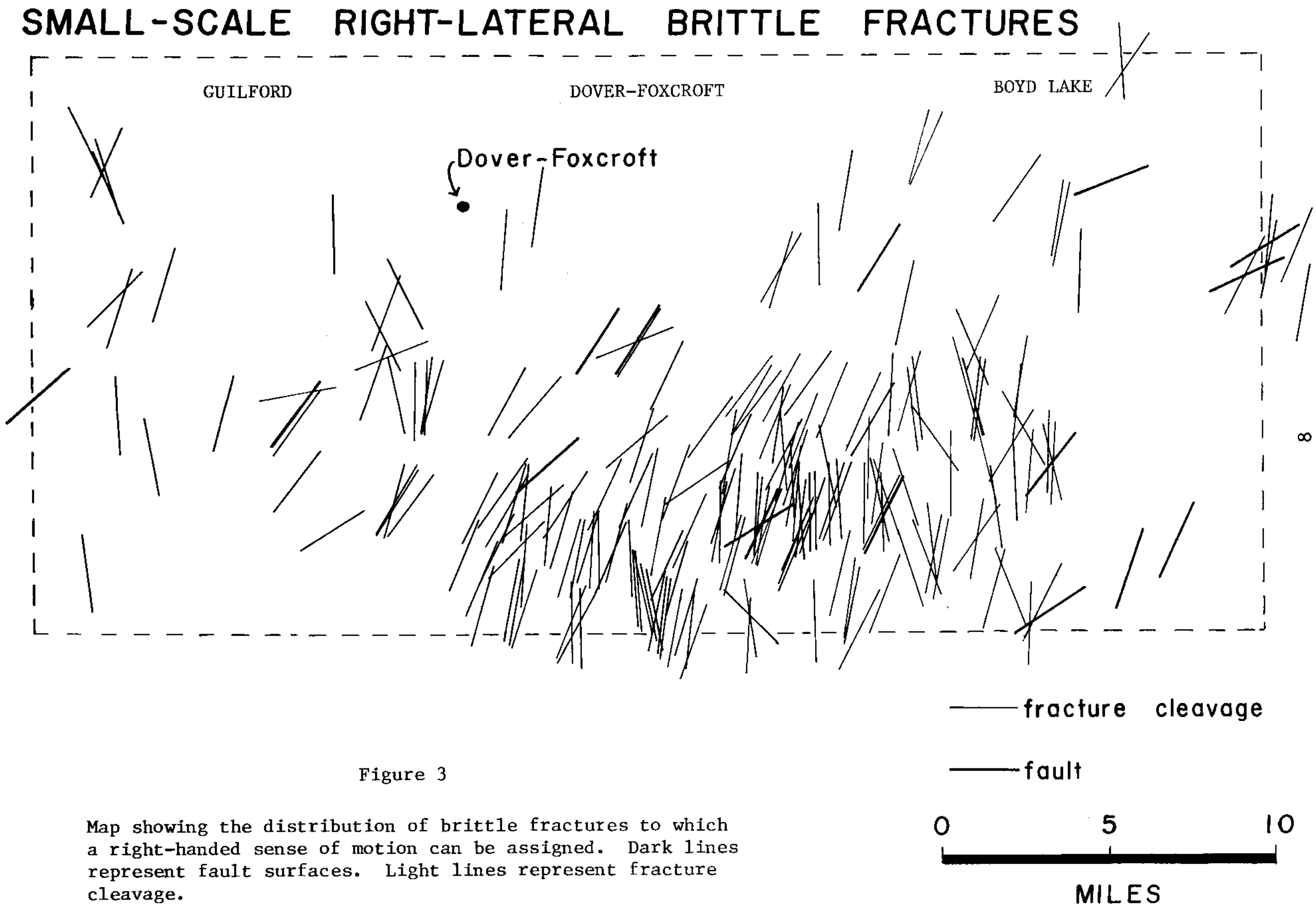


Figure 3

Map showing the distribution of brittle fractures to which a right-handed sense of motion can be assigned. Dark lines represent fault surfaces. Light lines represent fracture cleavage.

generally slickensided surfaces oriented nearly parallel to bedding.

Small-scale Z folds are most well developed in the finer grained and more thinly bedded rocks within the study area. These folds range in size from microscopic to folds with amplitudes of 20 meters or more. The fracture cleavage associated with these folds persists throughout the study area, even in the coarsest grained rocks where the folds may be too subtle or large to be seen. Figure 3 shows only those locations of brittle fractures where a right-handed sense of motion can be assigned, and Figure 4 shows the distribution of similar fractures for three quadrangles south of the study area.

Brittle-fracture surfaces which indicate a left-handed sense of motion are most commonly axial-planar to S kinks. These folds, unlike the Z folds described above, have sharp angular changes in the orientation of bedding at the hinges of the folds. As can be seen in Figure 5, the frequency of the S kinks is less than that of the Z folds, but as was the case described above, fracture cleavage with appropriate orientation for association with S kinks is often apparent even when the folds are not observed. The orientations of the S kinks appear to be bimodal and regionally variable, with dominant trends being E-W and NW-SE. The Bangor quadrangle shown in a portion of Figure 6 is an example of an area where a single orientation of left-handed brittle fractures dominates, in this case being oriented E-W.

It has been noted earlier in this section that both Z folds and S kinks can be observed occurring together. In these instances, the two sets of folds interfere and can not be separated by age, suggesting that they are contemporaneous throughout the region. Rosette diagrams showing the orientation of all measured fracture cleavage surfaces in the study area are shown in Figure 7. The patterns are best defined in the southern half of the Dover-Foxcroft quadrangle and the southwestern quarter of the Boyd Lake quadrangle where two thirds of all the measurements were made. These patterns suggest that the brittle fractures are a conjugate set whose development has been a mechanism for shortening of the region in response to compressional stress (Westerman, 1982). The question of the orientation of that stress is discussed below. Figure 8 shows the region south of the study area and differs from Figure 7. The rosettes in Figure 8 illustrate only fracture surfaces accompanied by indicators of movement direction, including fractures oriented parallel to bedding. Such bedding-plane fractures are prominent in the Bangor and Stetson quadrangles, consistently indicating a right-lateral sense of motion.

Paterson and Weiss (1966) studied the development of kink folds in phyllitic rocks compressed at various angles to their foliation. They found that compression parallel to the foliation produced a conjugate set of kinks with the direction of maximum compression asymmetrically bisecting the obtuse angle between the axial planes of the kink folds. An example of this response is illustrated in Figure 9A, a line drawing produced from Plate 2A of Paterson and Weiss (1966). This figure shows that the two angles between the direction of compression and the kink planes are 48° and 61°, both significantly greater than anticipated had the sample been homogeneous. Their experimental results further showed that as the angle between the direction of maximum compression and foliation was increased, one set of kinks became dominant and slip along the foliation was initiated.

An occurrence of two intersecting sets of kink folds observed in Unit 5 in the Dover-Foxcroft quadrangle is illustrated in Figure 9B. The angle be-

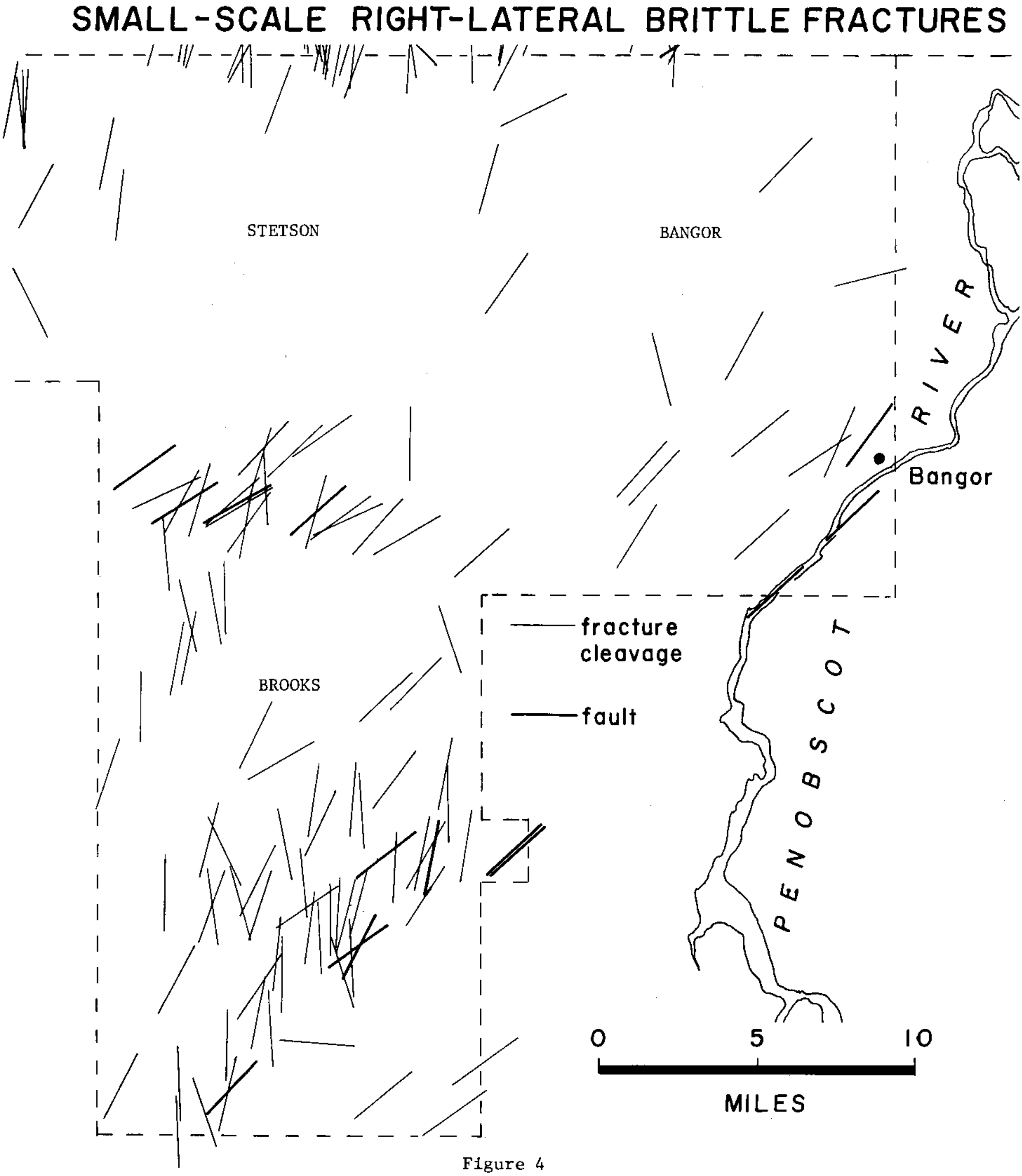


Figure 4

Map showing the distribution of brittle fractures to which a right-handed sense of motion can be assigned. Dark lines represent fault surfaces. Light lines represent fracture cleavage.

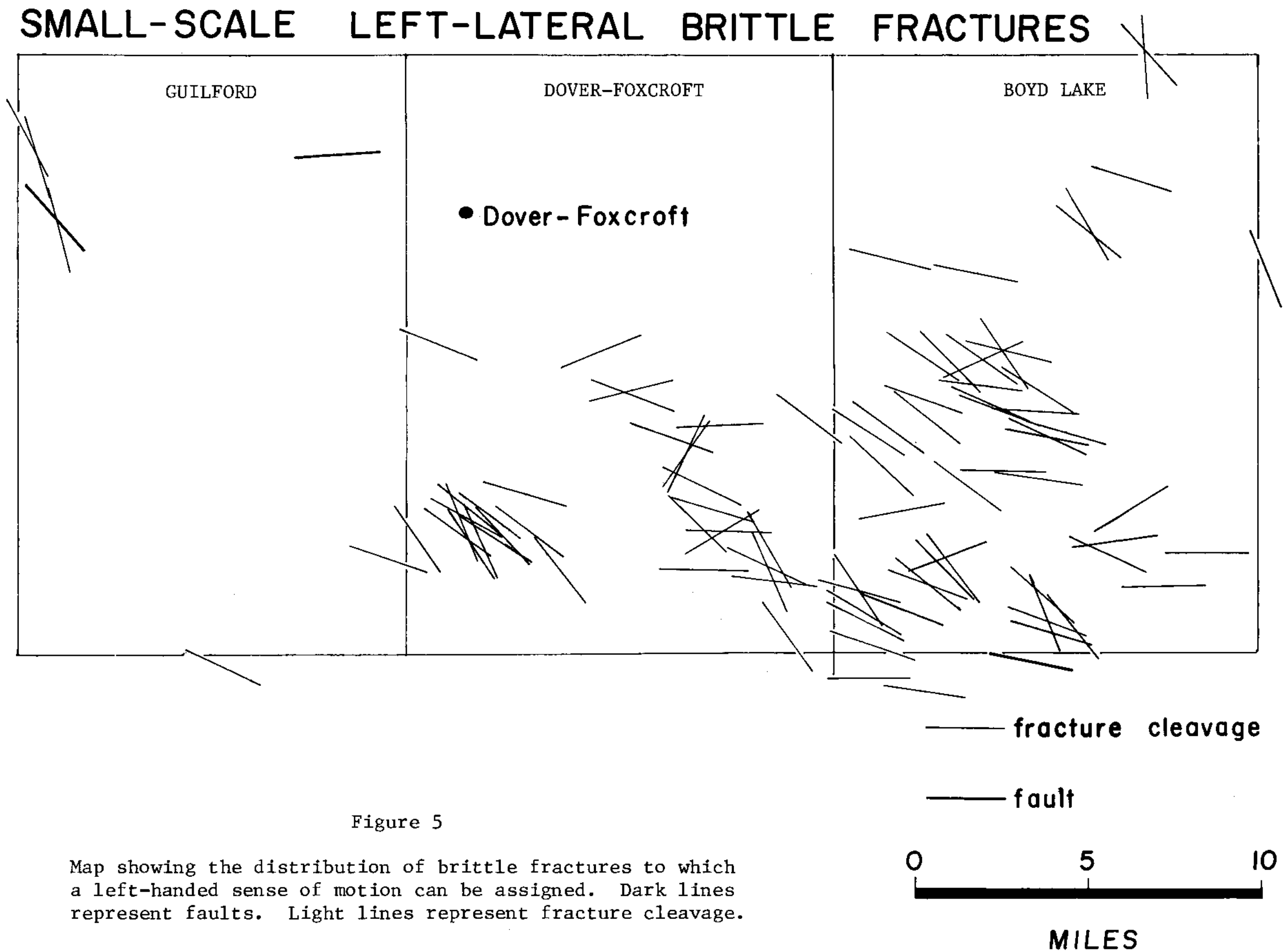


Figure 5

Map showing the distribution of brittle fractures to which a left-handed sense of motion can be assigned. Dark lines represent faults. Light lines represent fracture cleavage.

SMALL-SCALE LEFT-LATERAL BRITTLE FRACTURES

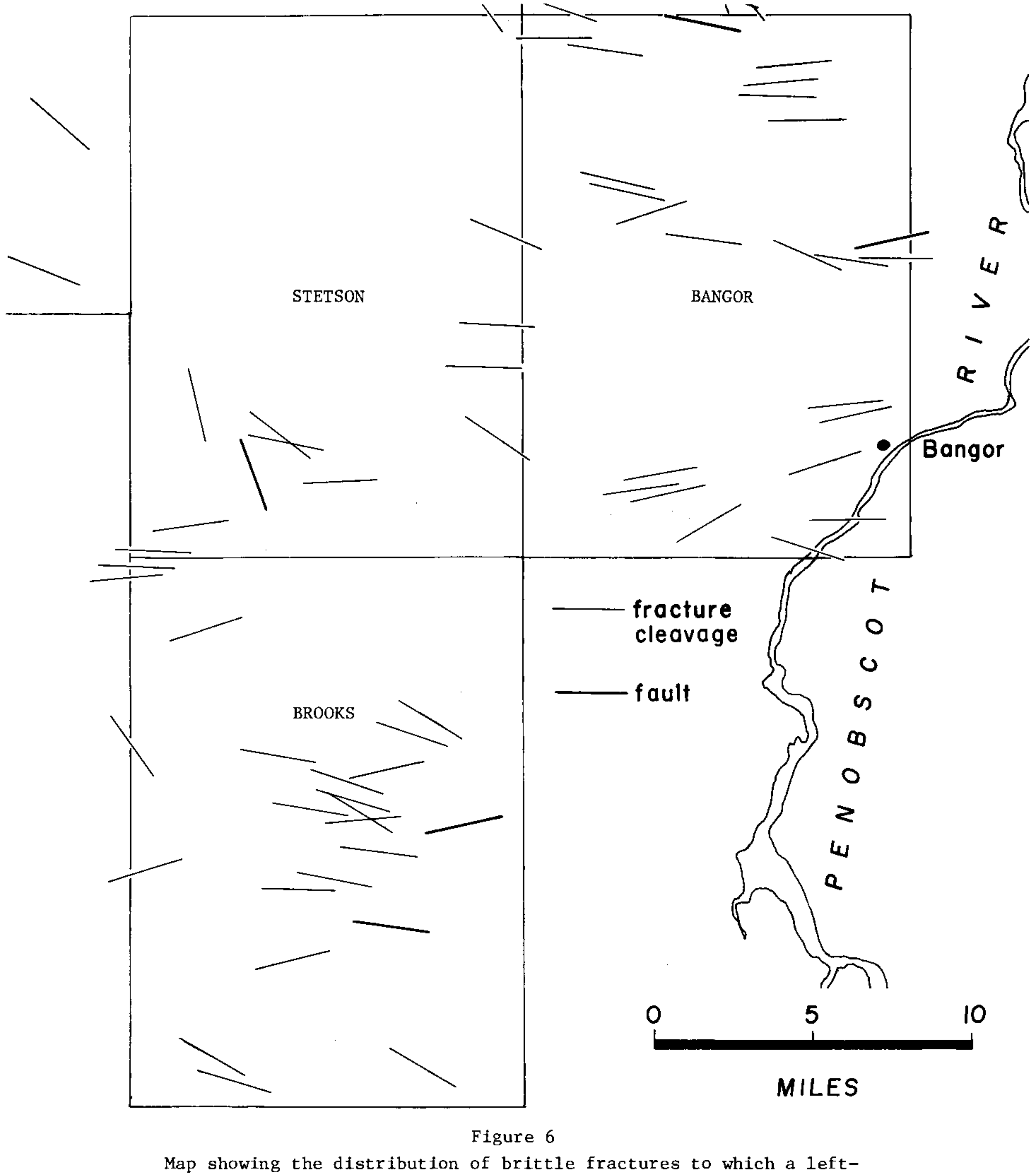


Figure 6

Map showing the distribution of brittle fractures to which a left-handed sense of motion can be assigned. Dark lines represent faults. Light lines represent fracture cleavage.

SMALL-SCALE BRITTLE FRACTURE ROSETTES

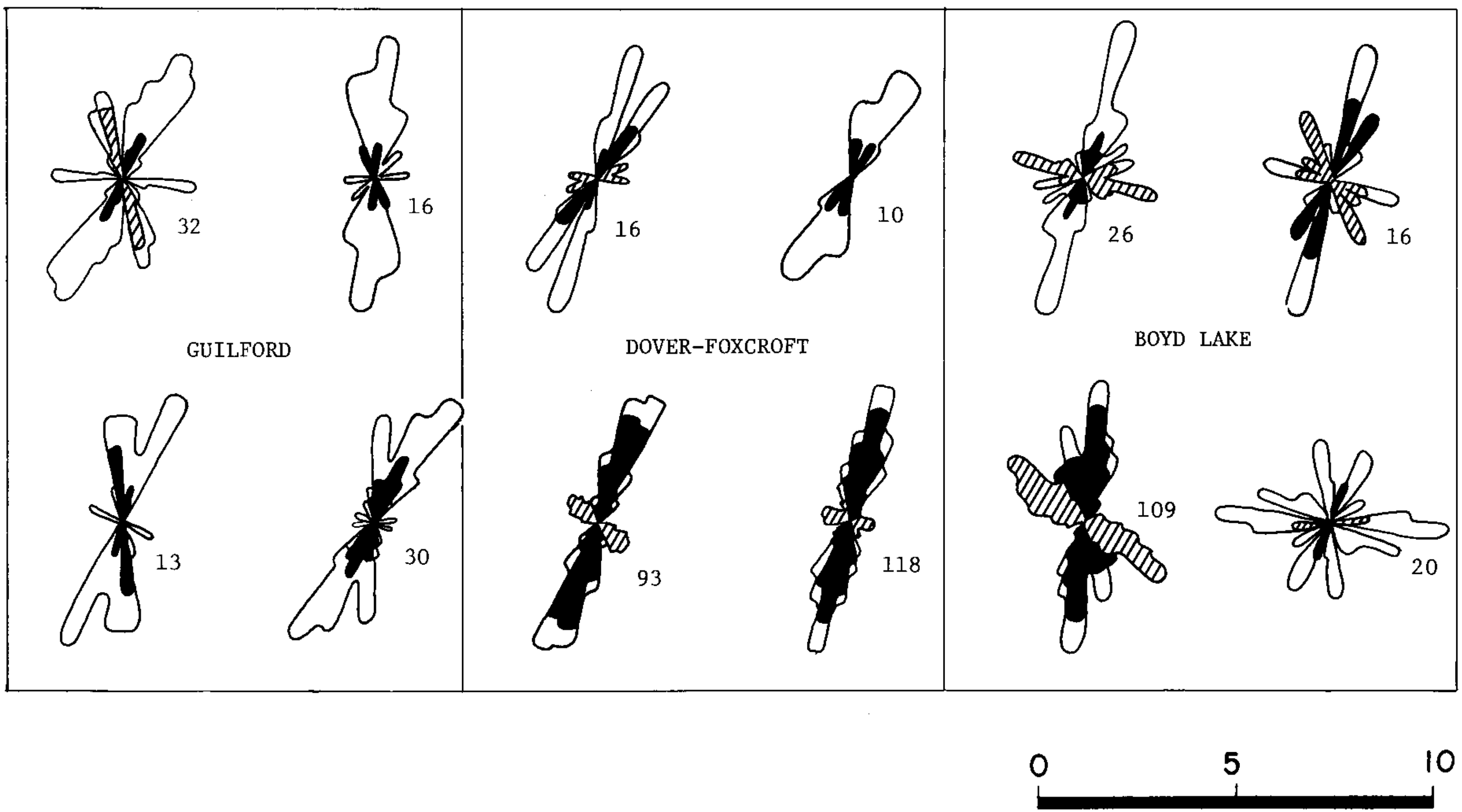


Figure 7

Orientations of fracture cleavage in the 1981 study area. Solid portion represents fractures with a right-handed sense. Diagonally lined areas represent fractures with a left-handed sense. Open areas represent fractures with an undetermined sense of motion.

SMALL-SCALE BRITTLE FRACTURE ROSETTES

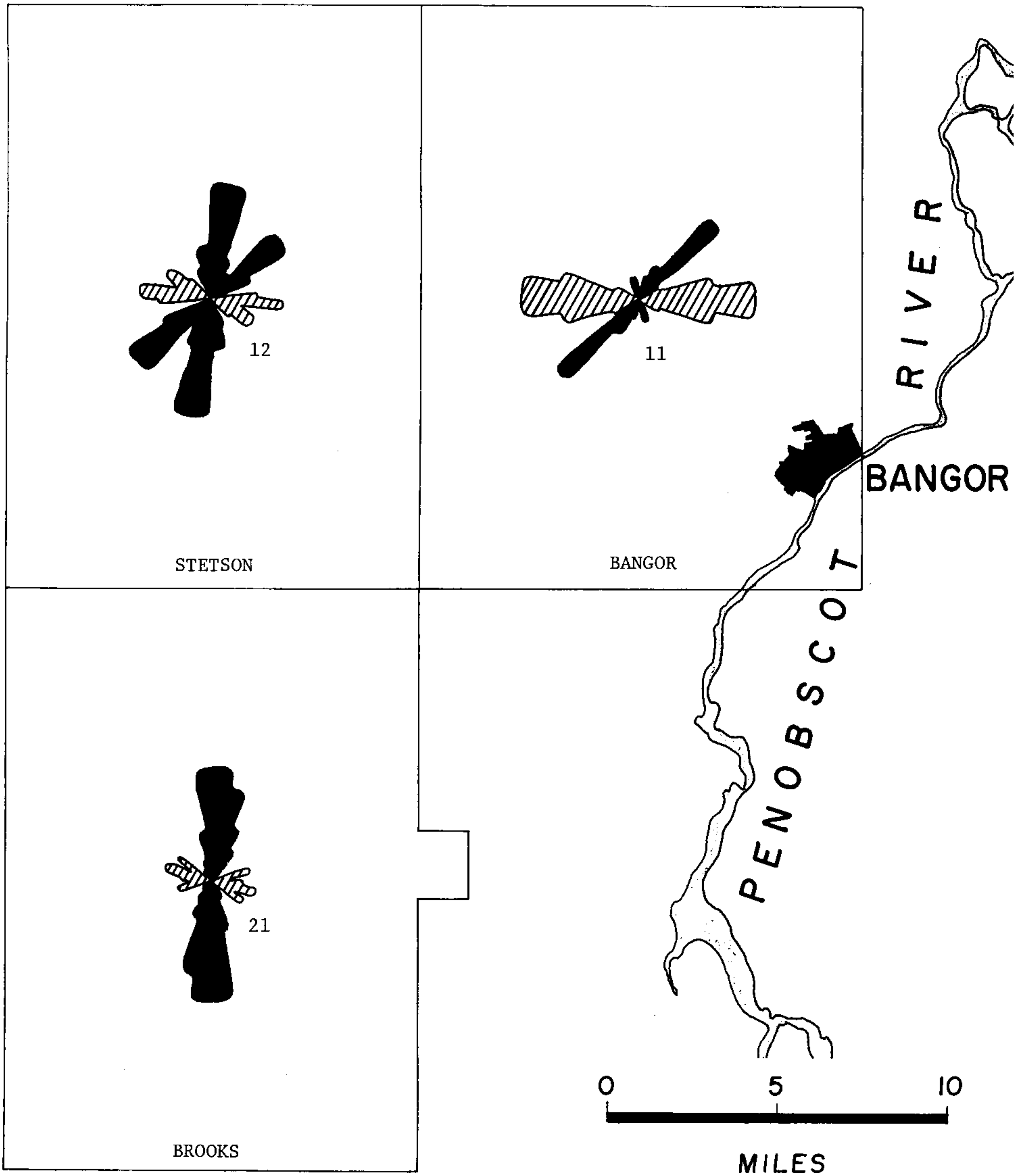


Figure 8

Orientations of brittle fractures having a right-handed sense of motion (solid) and a left-handed sense of motion (diagonally lined). Area was studied in 1980.

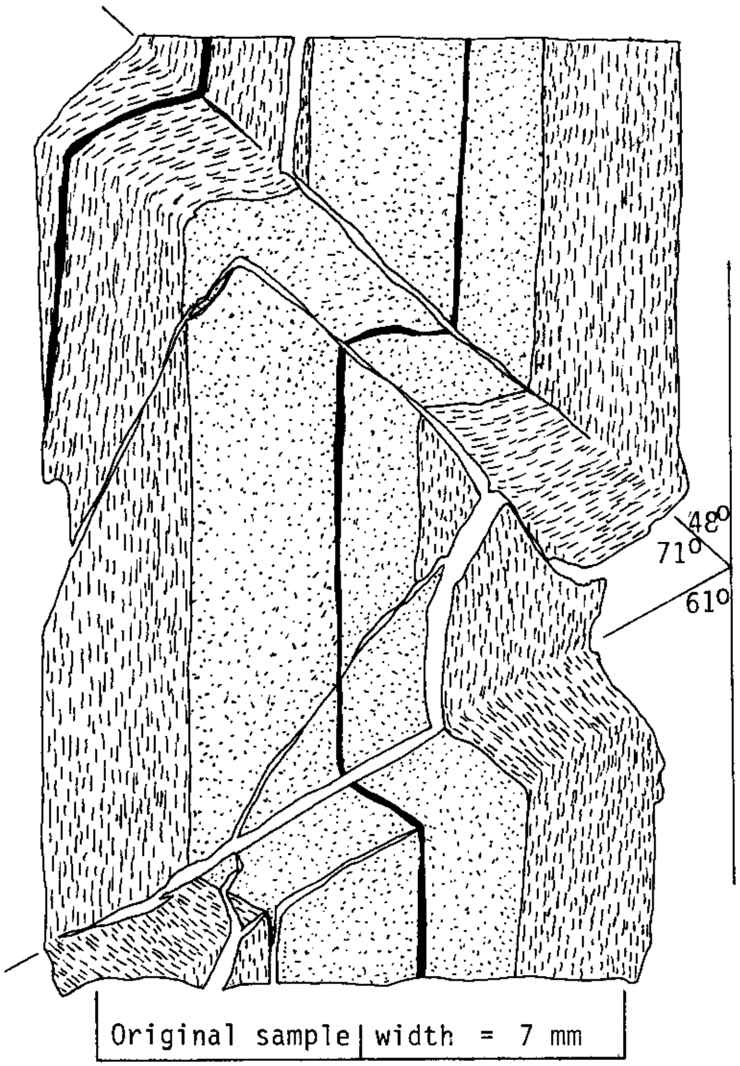


Figure 9A: Line drawing of Plate 2A of Paterson and Weiss (1966). Experimentally deformed phyllite compressed parallel to the foliation.

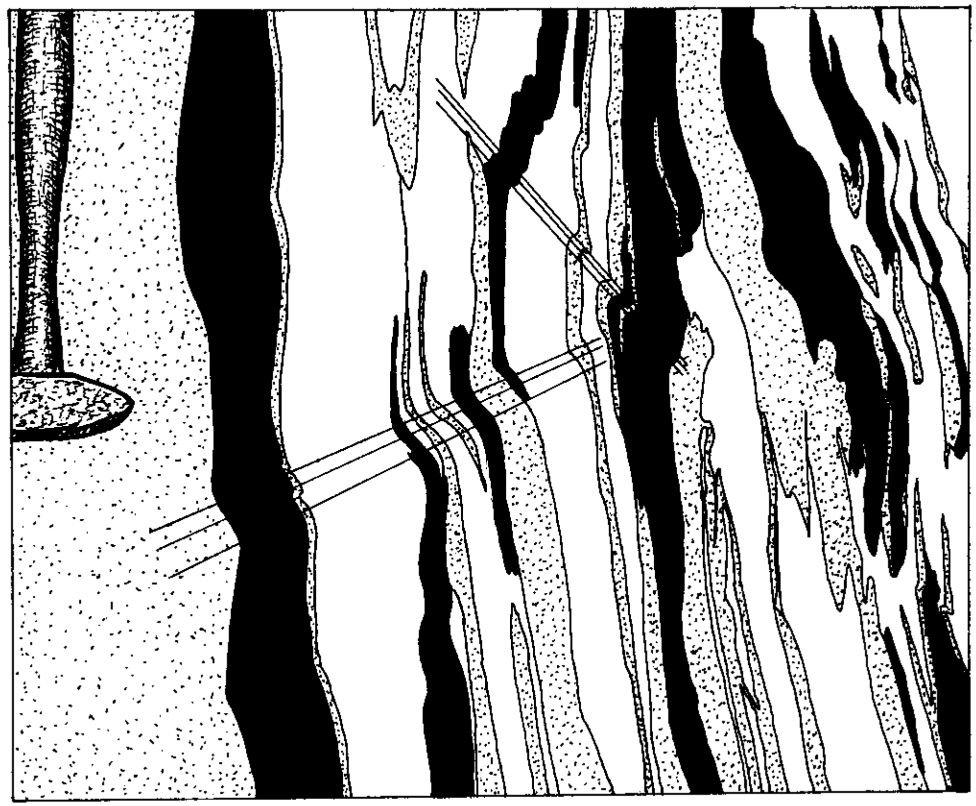


Figure 9B: Line drawing of a photographed pavement of Unit 5 located 1 mile south of Davis Hill in the Dover-Foxcroft quadrangle. Sketched straight lines show the orientations of axial planes of intersecting kink folds.

tween the axial planes of the folds is seen here to be 73°, essentially identical to the angle of 71° for the sample shown in Figure 9A. In addition, the angles between the kinks and the foliation in both figures are strikingly similar. The experimental data of Paterson and Weiss (1966) have been compared with the geometry of intersecting fracture cleavages and foliation at other outcrops, and the pattern of correlation is consistent throughout the study area. The results of these comparisons strongly suggests that the small-scale folds and their associated fracture cleavages are best explained as the result of regional compression with a direction of maximum stress parallel to the bearing N55-60E.

Joints:

High angle joints (dips greater than 75°) can be observed in most outcrops in the study area, and the variation in orientation of these fractures is illustrated in Figure 10. Only those joints whose surfaces were sharp and planar were included in the measurements used to construct that figure. Many of the joint surfaces were observed to be coated with quartz. For comparative purposes, the orientation of joints in the region south of the study area are presented in Figure 11. With only two exceptions, these fractures are the youngest observed in the study area.

Post-Pleistocene faults:

Two locations which exhibit what appear to be post-Pleistocene faults were observed in the study area. The most conclusive example is located in the Boyd Lake quadrangle at the town dump south of Boyd Lake. This outcrop is a glacially smoothed surface with an exposed area of approximately 600 m^2. Well-preserved glacial striations can be seen on much of this surface. The rocks consist of thickly bedded metasandstones, metasiltstones and metapelites of Unit 4 (in the Sangervelle Formation of Griffin, 1973c) which trend N55E, V with tops facing to the south. The observed fault is parallel to bedding (N55E,V) with the south side down 7mm., vertically offsetting glacial striations continuously along strike for a distance of 20 m across the outcrop with no lateral motion. No evidence was observed to suggest the possibility of frost heave of this pavement surface.

In the northwest corner of the study area, several outcrops of the Solon (Carrabassett) Formation are exposed in roadcuts along Route 15. One outcrop located 0.4 miles south of Moosehorn exhibits offset glacial striations on five cleavage surfaces oriented N45E, V, cutting across the bedding which is oriented N60E, V. The sense of offset is south side down with no lateral movement. These "faults" may be the result of blasting and/or frost heave.

MODEL RELATING SMALL-SCALE FOLDS AND CURRENT SEISMICITY

An effort to understand the geologic conditions which produced the abundant small-scale folds and associated fracture cleavage may yield an explanation of current seismic activity in the region of the study area. It has been pointed out by Barosh (1976) that the wedge-shaped region of seismic activity (Figure 1) is bounded on the eastern side by the N-S trending Penobscot lineament which was first identified by Hobbs (1904). The western boundary of the active region is less well defined and has been named the Dover-Foxcroft line by Lee and others (1977). This line marks the axis of a regional scale flexure of major

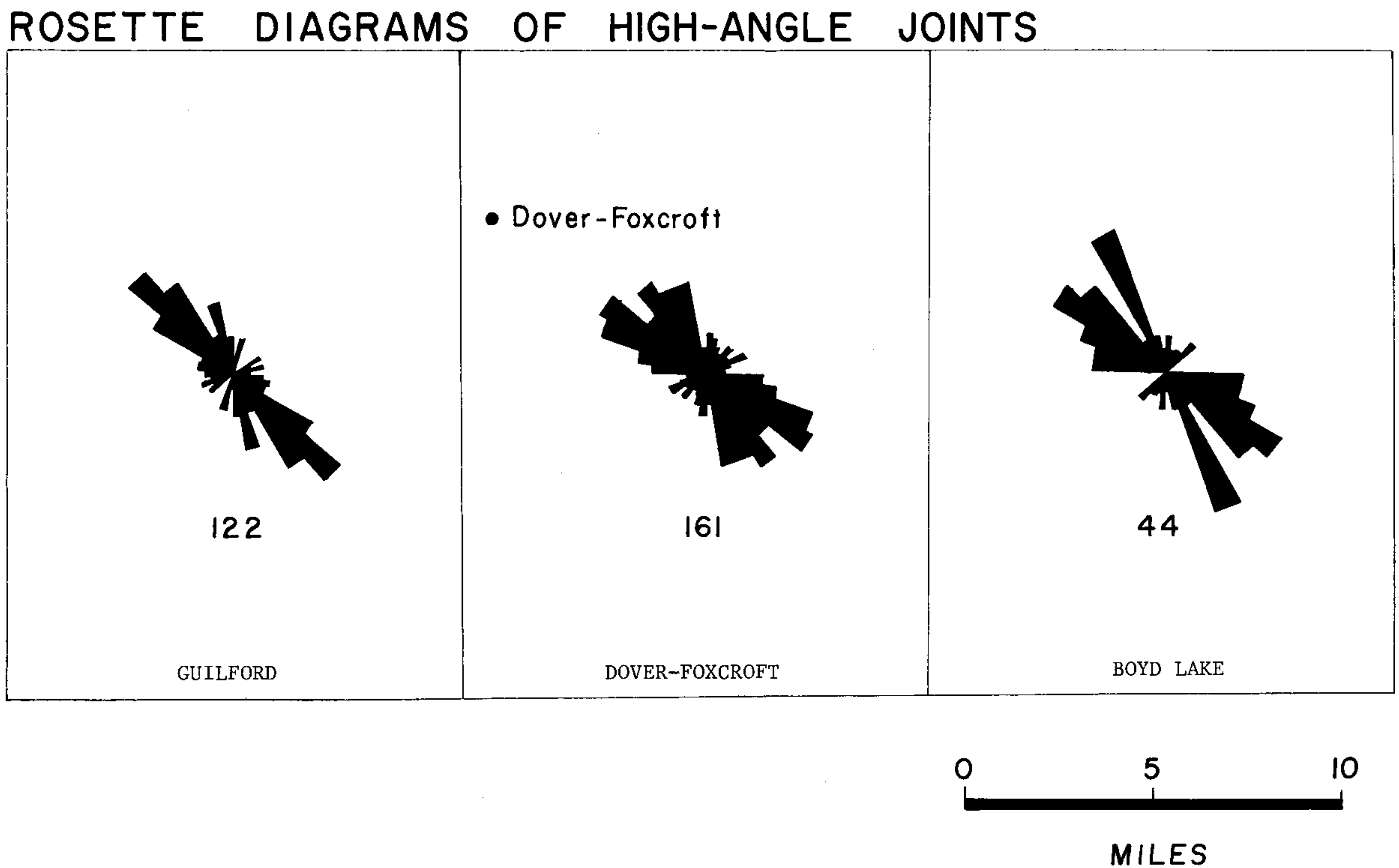


Figure 10

Orientation of joints in the 1981 study area.

ROSETTE DIAGRAMS OF HIGH-ANGLE JOINTS

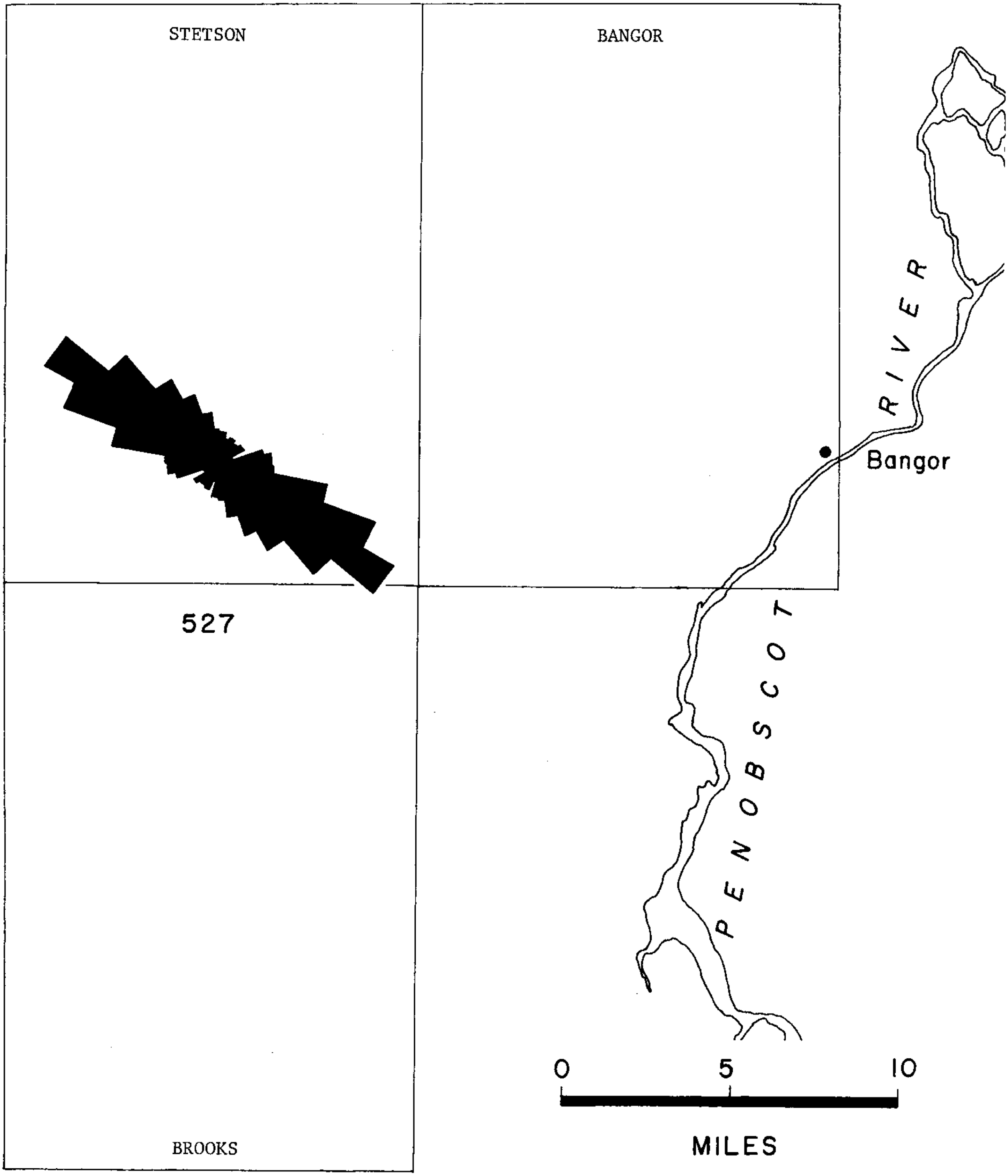


Figure 11

Orientation of joints in the 1980 study area.

lithologic units which appears as a large drag fold truncated at its eastern margin by the Penobscot lineament (Barosh, 1976). The southern boundary of the active zone corresponds approximately to the intersection of the Penobscot lineament and the northeasterly trending Norumbega fault zone. The Norumbega fault zone extends across the state of Maine roughly parallel to the coast (Williams, 1978) and exhibits considerable evidence of right-lateral movement (Stewart and Wones, 1974; Wones and Stewart, 1976; Wones and Thompson, 1979; Westerman, 1981a). Wones (1980) shows that the Norumbega fault zone east of the Penobscot lineament has at least four distinct traces, and west of the lineament the zone also has at least four traces (Westerman, 1981b).

The basic model presented here for the development of small-scale folds and associated brittle fractures in the study area calls for global-scale stress in the basement beneath all the exposed rocks, with two principal planes of dislocation in the basement. These planes correspond to the Norumbega fault zone and the Penobscot lineament (refer to Figure 1 for locations of these features). This model calls for movement along the full length of the Norumbega fault zone being interrupted by movement parallel to the Penobscot lineament. This movement could have created a condition in which the eastern portion of the Norumbega became locked (due to offset) until a new trace developed both in the basement (where driving forces persisted) and in the exposed rocks above. During this period continuing movement on the western portion of the Norumbega would have created a zone of local compression in the region north of the active section of the Norumbega and west of the Penobscot lineament. The resulting release of strain in the compressed region would have occurred by the development of kink folds such as those illustrated in Figure 9 with the direction of maximum compression parallel to the Norumbega fault zone and the regional foliation, that is approximately N55-60E. Once the eastern portion of the Norumbega fault zone developed a new trace, the local compression in the study area would be greatly reduced.

Obviously, the observed kink folds in the study area and their associated fracture cleavage were formed far in the geologic past when the rocks now exposed at the surface were at considerable depth. The closing step in the model is to invoke recent movement on the Penobscot lineament, once again locking the eastern portion of the Norumbega fault zone and reproducing a stress field at depth which existed at an earlier time. The distribution of recent seismic epicenters suggests that the eastern segment of the Norumbega fault zone is much less active than the western segment where more frequent and intense activity has occurred. The suggestion is, therefore, that seismic activity in the wedge-shaped region north and west of Penobscot Bay is due to local compression in the rocks on the northwest side of the Norumbega fault zone and west of the Penobscot lineament.

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