BEDROCK GEOLOGY
OF THE
KEZAR FALLS QUADRANGLE, MAINE

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SUMMARY OF GENERAL GEOLOGY

The Kezar Falls Quadrangle is underlain by igneous and metamorphic rocks of Paleozoic and Mesozoic age. Rocks of the Rindgemere Formation of Devonian age have been metamorphosed under sillimanite zone conditions producing mica schists and migmatites, sulfide ("rusty") schists and limesilicate granofels. The metasedimentary rocks have been intruded by granitic rocks of the New Hampshire Magma Series of Devonian age, and by syenite and quartz-syenite with associated volcanic breccias belonging to the White Mountain Plutonic-Volcanic series of Mesozoic age. The latter are best displayed in the Burnt Meadow Mountains in the northern part of the area. The metasedimentary rocks are extensively engulfed by granitic rocks in the central part of the quadrangle. Bedding plane schistosity probably accompanied regional isoclinal folding of the sediments. Subsequent deformation produced a complexly folded schistosity. Bedrock exposures are best on steep slopes and on tops of ridges: Valley floors are generally filled with glacial drift and stratified sand and gravel deposits of Pleistocene age.

ROCK UNITS

The bedrock of the Kezar Falls quadrangle consists of metasedimentary rocks of the Rindgemere Formation of Early Devonian (?) age that have been intruded by numerous bodies of igneous rocks. The igneous rocks consist predominantly of granitic types with the exception of volcanic rocks found in the Burnt Meadow Mountains. They are correlated with the New Hampshire and White Mountain series rocks of Devonian and Triassic - Cretaceous ages of New Hampshire.

RINDGEMERE FORMATION

General Statement

The name Rindgemere Formation was proposed by Katz (1917) for a sequence of schists, gneisses, and quartzites exposed in southeastern New Hampshire and southwestern Maine. The name has been used by Hussey (1962) in southern York County in the Berwick quadrangle. I have continued the usage of the name for all of the metasedimentary rocks in the Kezar Falls quadrangle inasmuch as they are apparently lithologically continuous through the Newfield and Berwick quadrangles to the south.
Several lithologies are represented within the formation, some of which are mapable over one or two quadrangles. It is, therefore, evident that the stratigraphic nomenclature will eventually require revision.

However, until more detailed stratigraphic work is completed, it seems best to use lithic names for the various rock units for purposes of mapping and discussion, but not attempt as yet a formal stratigraphic revision of the Ringgemere Formation.

The major lithic categories used in this report are as follows: mica schists and migmatite, lime-silicate granofels and rusty-weathering, micaceous, sulfide bearing schists.

These lithologies are in part similar to those included within the Littleton Formation as mapped in New Hampshire in the Wolfeboro quadrangle (Quinn, 1953) and in the Ossipee Lake Quadrangle (Wilson, 1969).

Mica Schists and Migmatites

Within this unit are included all of the metasediments of the quadrangle exclusive of the lime-silicate granofels and the rusty schists. There are several lithologies within this unit, none of which can be mapped separately, and all of which are usually intermixed within the quadrangle. The most abundant varieties are 1) red-brown to grey, coarse-grained schists and migmatite, 2) fine-to medium-grained, brown, well bedded mica-sillimanite schist, and 3) fine-grained, grey, well bedded biotite schist.

Migmatites: In addition to the general red-brown or grey color and the coarse-grained texture, the migmatitic schist is characterized by abundant quartz-feldspar pods and lenses. The rocks usually display compositional layering on a scale of a fraction of an inch to several inches. The layering is due either to migmatitic stringers of coarse quartz and feldspar or to alternating pelitic and psammitic layers that probably reflect original bedding. In most exposures muscovite porphyroblasts (5 mm diam.) are abundant and characteristically have grown across the dominant schistosity. The rock is always highly contorted, and clearly demonstrates that the schistosity has been folded. Garnet and sillimanite are commonly present. The migmatite is exposed in all parts of the quadrangle that are mapped as mica schist and migmatite, but is particularly abundant in the western part of the area. It is also abundant within parts of the area shown on the map as foliated granodiorite where it is intimately mixed with granodiorite and pegmatite.

Well bedded, brown schists: The brownish grey, fine-to medium-grained mica schist is more uniform in appearance than the migmatites. The schistosity is more nearly planar and all platy minerals lie parallel to the schistosity. Wisps of muscovite
porphyroblasts and sillimanite bundles produce a laminated appearance when viewed parallel to the schistosity. Bedding commonly shows up better on a weathered surface than on a fresh fracture and is on the scale of laminations up to layers a few inches in thickness.

This lithology is best exposed in the eastern and southern parts of the quadrangle, particularly in the Saddleback Hills area. It is, however, also mixed with migmatitic rocks and at the present time it seems unlikely that the two types can be mapped separately. In the Newfield quadrangle to the south, the same general occurrence is common.

Fine-grained biotite schist: This rock type is characterized by fine-grained, grey, and contains approximately 80% quartz and intermediate plagioclase, 20% biotite and no muscovite.

The foliation is, however, well developed and concentrations of biotite flakes give the rock a laminated appearance. In exposures such as at Great Falls (Hiram Falls) the rock is rhythmically layered on the scale of one to three inches. The rocks look similar to those of the Berwick Formation exposed in the Sebago Lake and Buxton quadrangles to the east.

Within the Kezar Falls quadrangle the rock does not occur as a mapable unit. It occurs in considerable abundance between the towns of Porter and Kezar Falls, but cannot be traced much beyond these limits. Occasionally the rock is found interbedded with mica schist and migmatite (e.g. Hiram Falls). More commonly, however, the presence of the fine-grained biotite schists indicates the proximity of the lime-silicate granofels. In the Newfield quadrangle the lime-silicate rock and the fine-grained biotite schist are usually closely associated.

Lime Silicate Granofels

The well bedded lime-silicate granofels of the Kezar Falls quadrangle are restricted to the southernmost areas. They are well exposed on the west side of Pease Mountain, at a road outcrop on the east side of Day Hill (known locally as Berry's Ledge) and on Bickford Hill. Other exposures are scattered throughout this region but none are of large areal extent. They are widely exposed in the Newfield quadrangle to the south.

The rock is always light grey-green, fine to medium-grained, granoblastic, and bedded on the scale of thin laminations up to two inches in thickness. Some exposures are "punky" due to weathering of calcite. The common major mineral assemblage is quartz-plagioclase-diopside. The rock is frequently highly contorted and small scale folds are abundant. The granofels is commonly interbedded with thin beds of biotite schist and easily splits into tabular pieces parallel to bedding. Vesuvianite is abundant in large aggregates of crystals in many localities but is completely absent in others. Under the hand lens green crystals of diopside and brown-salmon colored garnets can usually be seen.
Rusty Schists

These units are fairly distinctive due to their rusty, yellow-brown weathering surface. However, there appear to be several minor units within the mica schists and migmatites that weather in a similar manner and, therefore, may lead to errors in map interpretation. Usually, however, the two may be distinguished on the basis that the rusty migmatites tend to have a reddish brown color whereas the true "rusty schists" have a yellow-brown weathered surface and may at times weather black. Fresh surfaces of the rock are usually nearly white with quartz, feldspar and muscovite being the major mineral constituents. The rock tends to appear rather massive from a distance, but actually is quite finely schistose. Outcrop surfaces tend to be crumbly due to the ease with which the rock weathers. Pyrite and/or pyrrhotite are the common sulfide minerals.

The rusty-weathering mica schists occur in two belts within the Kezar Falls quadrangle. The larger of these extends from Sawyer Mountain (just off the southeast corner of the map in the Newfield quadrangle) to the southern flanks of Mt. Cutler in Hiram, a distance of about eight miles. The outcrop band is about two miles wide at the north, narrows to less than a mile at the southeastern border of the quadrangle, and is not traceable at all south of Sawyer Mountain. Neither can it be traced north of Mt. Cutler where it is cut out by the foliated granodiorite that becomes abundant to the northwest.

The second belt of rusty schists is by comparison quite poorly defined and appears to be considerably thinner than that just now described. The belt lies just northwest of Rattlesnake Pond (now called Pequawket Lake) and is apparently part of the nose of a southwesterly plunging synform. Scattered outcrops suggest this zone may extend east of Stanley Pond, terminating in the vicinity of South Hiram.

Stratigraphy and Regional Correlation

The interpretation of the stratigraphy of the metasediments is intimately related to the interpretation of the structural pattern and vice versa. In the Kezar Falls quadrangle neither the structure nor the stratigraphy is clearly evident. Therefore, in order to develop a probably stratigraphic succession the simplest possible structural pattern that is consistent with known data has been used.

The basic pattern of the stratiform foliation is that of generally westerly dips at low to moderate angles. This suggests that the northwest trending belts of metasedimentary rocks get progressively younger to the west. Complications arise in the central part of the area south of the Ossipee River where gentle dips with frequent reversals of directions suggest rather broad
folds involving the lime-silicate granofels and associated schists. The relationship of the lime-silicate granofels to the schists north of the Ossipee River is quivocal, for nowhere is the lime-silicate found north of the river.

The resulting interpretation of the stratigraphic column is shown in figure 1. The lowest units would be those east of the Saco River; these are grey mica-sillimanite schists and migmatites with well bedded schists within the migmatites. These rocks have not been mapped separate from the other migmatites because of the difficulty in distinguishing rock types in the field. This section of rock extends eastward into the Sebago Lake quadrangle where it is truncated by the Sebago Pluton, or in other instances comes in conformable contact with the underlying Berwick Formation.

Overlying these migmatites and bedded schists are the rusty weathering quartz-muscovite schists forming the belt extending from Hosac Mountain to Mt. Cutler. At the northern end of this belt the width of outcrop, assuming an average westerly dip of twenty degrees, indicates an estimated thickness of about four thousand feet. This does not, however, take into consideration possible complications due to isoclinal folding. At the south end of the belt the apparent thickness is much less, but structural complexities make it difficult to estimate. The rusty belt is lost entirely a few miles to the southeast in the Newfield and Buxton quadrangles.

Overlying the rusty schists are the predominantly coarse-grained mica-sillimanite schists and migmatites. The map suggests these to be several thousands of feet thick, possibly containing thin interbeds of rusty schists. This unit continues westward to the New Hampshire state line.

The lime-silicate granofels is interpreted as being interbedded within the migmatite but the detailed stratigraphy is not known. Thickness estimates on the basis of very limited exposures are on the order of a few hundred feet.

The metasedimentary rocks along the southwestern margin of the quadrangle can be followed westward into the Ossipee Lake quadrangle in New Hampshire where they have been mapped as the Littleton Formation by Wilson (1969). He found only grey and red-brown migmatitic schists believed to be younging westward toward the axis of the Merrimack Synclinorium (Billings, 1956).

To the southwest, the metasedimentary rocks can be followed through the Newfield quadrangle, where lime-silicate granofels and micasillimanite schists are abundant, into the Wolfeboro quadrangle in New Hampshire. There Quinn (1952) mapped them as Littleton Formation distinguishing only the schists and the lime-silicate granofels. There also the predominant dips are to the west.
SCHEMATIC STRATIGRAPHIC COLUMN OF THE RINDGEMERE FORMATION. TOTAL STRATIGRAPHIC THICKNESS IS UNKNOWN BUT ESTIMATED TO BE SEVERAL THOUSAND FEET. RELATIVE THICKNESS BASED ON FIELD DATA.
To the south, the metasedimentary rocks are equivalent to the Lower Rindgemere Formation of the Shapleigh Group (Hussey, 1968).

Correlation to the north and northeast is made difficult by the large mass of granitic rock of the Sebago Pluton. On the basis of lithic similarities the metasedimentary rocks of the Kezar Falls Quadrangle would appear to correlate with the mica-sillimanite gneisses and rusty gneisses of the lower Littleton Formation in the Bethel quadrangle (Fisher, 1962). Farther east in the Bryant Pond quadrangle Guidotti (165) subdivided the metasedimentary rocks into a northern and a southern sequence, each sequence having several formations or members. Lithologic similarities and stratigraphic succession would suggest that the Kezar Falls metasedimentary rocks correlate with parts of the Thompson Mountain, Shaff Pond and Billings Hill Formations and the Concord Pond, Wilbur Mountain, and Howard Pond members of the Littleton Formation, all part of the northern sequence.

IGNEOUS ROCKS

Igneous rocks in the Kezar Falls quadrangle belong to one of two general categories: 1) Pink to brown granite, syenite and volcanics of the White Mountain Plutonic-Volcanic Series that occur as small stocks at Whales Back Ridge, Burnt Meadow Mountain, and the Boston Hills, and 2) granitic rocks believed to be correlative with the New Hampshire Plutonic Series of Billings (1956). The rocks of the New Hampshire series are of two types: 1) light grey binary granite found in several areas but particularly in the northern part of the quadrangle where it is known to be continuous with the large Sebago Pluton to the north and east; and 2) foliated, fine-grained biotite granodiorite or quartz diorite found abundantly throughout the quadrangle but particularly in the central and northwest portions.

NEW HAMPSHIRE PLUTONIC SERIES

Binary Granite

Binary granite is restricted primarily to the north and northeastern margins of the map area. From the regional picture it is evident that this is part of the large mass of granitic rocks making up the Sebago Pluton to the east. Smaller areas of binary granite are found surrounding Colcord Pond and around Mine Pond, both in the southwestern part of the quadrangle. Precise contacts for this unit have not been observed anywhere in the quadrangle.

Microscopically the rock is a light grey, medium-grained binary granite consisting of approximately 35% quartz, 45% microcline, 15% plagioclase, 5% mica and accessories. Muscovite and biotite are both obvious under the hand lens. The rock is not usually
foliated, but a weak foliation has been observed in some exposures. The texture of the rock is in places uniform over large outcrops, but in other cases the granite coarsens in texture over a few feet and become the pegmatite that is ubiquitous throughout most of the quadrangle. For this reason I consider the pegmatite to be genetically related to the binary granite. The predominant minerals of the pegmatite are K-feldspar and quartz with minor amounts of biotite, garnet, muscovite, tourmaline, and occasionally beryl. Though pegmatite is found abundantly throughout the quadrangle, the binary granite is restricted to the areas mentioned.

Field relations indicate that the binary granite is younger than the foliated granodiorite but neither the granite nor the pegmatite is found cutting the rocks believed correlative with the White Mountain series of New Hampshire. The binary granite appears similar to the Concord granite and is, therefore, considered as part of the New Hampshire Plutonic Series of Lower or Middle Devonian age. (Billings, 1956).

The granite stock around Colcord Pond displays a distinctive porphyritic texture. Mineralogically it is similar to the binary granite except that the potash feldspar is orthoclase microperthite instead of microcline.

Fine-grained, gray granodiorite to quartz diorite is abundantly exposed in the northwestern through central sections of the quadrangle. The rock is almost never found as the single rock type at an outcrop, rather it is normally complexly intermixed with migmatites and with pegmatite. The granodiorite is relatively free of metasedimentary material in the north, but toward the south exposures show more and more of the metasedimentary inclusions. Pegmatite cuts the granodiorite and is particularly abundant in the northern two thirds of the quadrangle. Since the contact between the granodiorite and the metasediments is poorly defined it has been drawn on the map where the granodiorite is no longer the dominant rock type. There is, however, much granodiorite exposed in the area mapped as metasediments. Structural symbols for metasediments within the areas mapped as granodiorite indicate inclusions or isolated patches (of undetermined size) of the metasediments in the granodiorite terrain.

The major contact between the granodiorite and the binary granite has not been observed, but it is known that the binary granite is the younger, as evidenced by dikes and inclusions. The granodiorite is traceable into the Ossipee Lake quadrangle to the west where Wilson (1969) mapped it as trondhjemitie. Several smaller areas of granodiorite are found in the southern part of the Kezar Falls quadrangle and to the south in the Newfield quadrangle.

In hand specimen the granodiorite is characterized by its uniform grain size (about 1.0 mm), its light grey color, and the presence of biotite as the only mafic mineral. The average rock composition is 35% quartz, 40% plagioclase (An20), 20% orthoclase,
and 5% biotite. The biotite is usually oriented subparallel providing a weak to moderate foliation that is discernible at most exposures. Frequently only the strike of the foliation can be determined from the flat surfaces of bald outcrops. The rock is quite homogeneous in texture and foliation, but it is not uncommon to find biotite segregations as schlieren, producing a pronounced banded appearance locally. The strike of the foliation in the granodiorite generally parallels that of the schistosity of the neighboring metasedimentary rocks. At a few exposures, however, the foliation in the granodiorite is oblique to the foliation of enclosed blocks of schist.

Field relations indicate that the rock is intrusive into the metasedimentary rocks and that it was probably intruded in a late tectonic stage as evidenced by its foliation. It is in turn intruded by the predominantly nonfoliated binary granite and related pegmatite. Comparisons with similar rocks in New Hampshire support the conclusion that the granodiorite belongs to the New Hampshire Plutonic Series of Middle Devonian (?) age.

WHITE MOUNTAIN PLUTONIC-VOLCANIC SERIES

Whales Back Ridge and the Boston Hills

Whales Back Ridge in the western-central part of the quadrangle is the only area of outcrop of a pink to grey biotite granite. On a single outcrop the texture is seen to be variable from aplitic to medium-to coarse-grained and subporphyritic. Phenocrysts of K-feldspar are usually present. The color is mostly pinkish, but in a few exposures the rock is a grey-lavender. Mafic minerals are present in only minor amounts.

Wilson (1969) has mapped the western margin of this body in the Ossipee Lake quadrangle and has correlated the rock with the Conway Granite of the White Mountain series.

The Boston Hills stock appears to be a simple one composed solely of medium-grained brown syenite carrying small amounts of quartz and clinopyroxene.

Burnt Meadow Mountains

General Statement: The Burnt Meadow Mountains cover about six square miles immediately south of the town of Brownfield in the northern part of the Kezar Falls quadrangle. They are a pronounced physiographic feature rising a few hundred feet above the highest hills of the surrounding area. The range is approximately two miles wide and three miles long, the long axis trending nearly north-south.
Three major rock types constitute the complex; 1) coarse-grained brown syenite, 2) medium-grained, porphyritic, tan to pink quartz syenite, and 3) dark grey volcanic rocks that are commonly porphyritic and/or fragmental. Rocks of minor occurrence include aplitic and basic dikes, and fine-grained syenitic rocks of uncertain relationships.

Syenite: This is predominantly a brown-to grey, medium-to coarse-grained rock consisting of more than 95 percent k-feldspar grains up to 10-15 mm and only minor amounts of mafic minerals. The texture is slightly variable, usually being equigranular with minor porphyritic varieties. Locally the rock has a pronounced pinkish cast on the weathered surface. This type is abundant on the slopes of the twin summits on the north end of the range. It is also found on the west side of the range but because of limited exposures it is not known if the syenite is actually continuous along this side.

Along the contact between the syenite and the quartz syenite on the south side of the twin summits there are several exposures of a fine-grained brown syenite. The relationships of this rock to the others is not clearly displayed, but on the basis of composition the rock appears to be related to the brown syenite, perhaps as younger dikes.

Quartz syenite: Pinkish tan, prophyritic quartz syenite forms the largest exposed body in the range. The most common variety consists of euhedral phenocrysts of light brown to grey feldspars up to 15 mm long embedded in a finer-grained (1-2 mm) groundmass of feldspar and dark minerals. Minor amounts of interstitial quartz can be seen in most specimens. Average mineral proportions are 70% orthoclase, 20% plagioclase, 5% quartz, and 5% accessories. The rock is distinguished from the syenite on the basis of its color, porphyritic texture, presence of quartz, and greater amounts of mafic minerals. This rock commonly contains two-to five-inch rounded inclusions of darker grey rock that frequently contain feldspar megacrysts.

Along the south and southeast sides of the range this rock appears to grade into a pink, fine-grained, porphyritic phase.

A phase of the quartz syenite of minor extent is found southwest of Stone Mountain where a large xenolith of volcanic rock is enclosed in the quartz syenite. For several hundred feet around the xenolith the quartz syenite is fine-grained and displays euhedral phenocrysts of tan orthoclase up to 40 mm long. This phase appears to pass into the normal quartz syenite with no pronounced contact. A similar rock was found cropping out on the ridge south of Stone Mountain but outcrops were insufficient to delineate the extent of the body.

Volcanic rocks: As used here, the term volcanic rocks will include rocks that may have been shallow intrusives as well as those that were extrusive. At the present time it is not clear how many of these aphanitic, prophyritic, and commonly fragmental
rocks were intruded and how many surface flows and pyroclastics. Two general rock types will be described here, but these were impossible to map separately. The distinction made is between (1) predominantly fragmental and (2) non-fragmental porphyries. The two are found together, and exposures of non-fragmental porphyry appear to grade into fragmental rocks. No sharp contacts between the two types were found. The fragmental types constitute about 80 percent of the volcanic materials.

The most extensive exposures of volcanics are on the summit and sides of Stone Mountain, and on the northernmost of the twin summits to the north.

Within the fragmental rocks fragments range in size from a few millimeters to several feet, but most are on the order of a few inches in diameter. All fragments are of rock materials, the most abundant being grey porphyries, with minor basalts, schist and granite. The fragments may be either angular or rounded and are poorly sorted. The matrix is generally medium to dark grey, and aphanitic. Only on two occasions were either the syenite or the quartz syenite found as possible included fragments in the volcanics. Generally these two rocks are conspicuous by their absence from the volcanics. This is interpreted as meaning that for the most part the volcanic rocks predate the intrusion of the syenite and quartz syenite. Field evidence suggests, however, that the volcanic activity and syenite intrusion may have been closely related in time as discussed below.

The non-fragmental volcanics are predominantly medium gray trachyte to andesite porphyries. In rare cases euhedral feldspar laths show a weak preferred orientation, but in general flow structures were not observed. Some of the best exposures of these non-fragmental rocks are found on the north slope of the twin summits.

Dikes: Aplitic dikes are numerous in the range and may be seen cutting the syenite, the quartz syenite, and the volcanic rocks.

Dikes of recognizable Burnt Meadow complex rocks are rarely found in the surrounding country rocks.

Structural Features: Structural features discussed below include the nature of contacts, joint patterns, and flow structures.

The contact with the country rock is not well exposed in the range, the only two good exposures being southwest of Burnt Meadow Pond and along the extreme southwest corner of the range. As indicated on the map, the contacts here are nearly vertical. The map contacts suggest a steep inward dip, but control is not adequate to evaluate their exact attitude. Other places on the map show only inferred contacts concealed by glacial deposits or rock and soil rubble.

Within the interior of the range contacts are variable but tend to be steeply dipping, in many cases nearly vertical. This is demonstrated (1) along the syenite-fragmental volcanic contact
at the north end of the range, and (2) in several places along the contact between the quartz syenite and the volcanics—especially on the south slopes of summit 1592' at the south end of the range. These contacts indicate that the volcanics, which are generally limited to the highest parts of the range, are not thin cappings, but rather are thick blocks, at least 300 to 500 feet thick.

The bodies of volcanic rocks are presently interpreted as large xenoliths enclosed in the surrounding syenitic rocks. Volcanic rocks are not found outside the Burnt Meadow Range even on hills that are higher than many outcrops of volcanics. This suggests that the only volcanics that have been preserved from erosion are those blocks that sank into the underlying magma, and that higher level volcanics within the range, and possibly in the surrounding area, have been totally removed by subsequent erosion.

Evidence suggests that the northernmost block of volcanics was engulfed by syenite magma while still hot. Along its northern contact the volcanic breccia and syenite are exposed in a complex zone a few tens of feet wide in which the two rocks are mixed in a "swirled" pattern with no clear indication as to which of the two rocks is the younger. Since it has been concluded on the basis of other evidence that the volcanics are older than the coarse-grained rocks, this exposure is interpreted to mean that the xenolith of volcanic rock was hot enough at the time it sank into the surrounding melt that the outer rind was still plastic and thus became intimately mixed with the magma. Thin section study also suggests that the intruding syenite melt was essentially a crystal mush at the time the xenolith was emplaced. Thus it may be that volcanic breccia is the near surface or surface ejecta of the deeper-seated syenite.

Two bodies of foliated granodiorite are found in the interior of the complex on the south and east flanks of summit 1952'. Evidence suggests that the contact between this rock and the volcanic rocks is an intrusive one. A poorly exposed dike of fragmental volcanics apparently cuts the foliated granodiorite and the granodiorite is shattered in other exposures. This contact may have been the original boundary between country rock and volcanics, which subsequently became engulfed by the intrusion of the younger quartz syenite.

Joints are abundant in all the rocks of the range and many of the more prominent cliffs faces are joint controlled. The topographic map (Brownfield quadrangle; 7 1/2 min. series, 1964 ed.) shows gullies and streams with joint control in N 60 E, N 75 E, E-W and N 60 W directions. From data collected within the range there seems to be no preferred directions unique to any particular part of the complex. A comparison of joints in the country rock and those in the Burnt Meadow Range shows that joint directions in the country rock are generally similar to those of the range. A study of diabase dikes shows a similar distribution of trends as do the joints with the exception of a lack of dikes in the N 40-60 W direction.
Flow structures in the volcanics, primarily in the form of oriented crystals or oriented fragments were observed in only a few cases. Strikes tend to be generally north-south with steep to moderate dips. On the north slope of the twin summits near the pronounced topographic bench along the ridge, a two-foot layer of spherulitic volcanic rock shows a near vertical contact with surrounding volcanics. The layer could be traced for only a few feet. Faint igneous lamination was also observed in the syenite in a few exposures.

Summary of relative ages: Field evidence suggest the relative age relationship of the Burnt Meadow rocks are as follows, from oldest to youngest:

1. formation of various porphyries as flows and/or shallow intrusions
2. formation of the fragmental volcanic rocks, perhaps as the result of explosive eruptions
3. intrusions of the brown syenite
4. intrusion of the pink to tan quartz syenite
5. intrusion of late stage dikes.

STRUCTURE

General Statement

Bedding-plane schistosity and repeated reversals of dip involving overturned beds (as evidenced by graded bedding) suggests that the basic structural style in the Kezar Falls quadrangle is that of overturned isoclinal folding. These folds may have been nearly recumbent with the development of an axial plane schistosity which has subsequently been folded producing the major structures seen in the area, namely, the Pequawket synform, the Hiram antiform, and folds in the vicinity of Long Pond (south-central part of the quadrangle).

Major Folds

The Pequawket synform is found in the north-central part of the quadrangle in the vicinity of Pequawket Pond (named Rattlesnake Pond on the 1910 map). Evidence for the structure comes from scattered and disconnected exposures of the schist and migmatite, and a more-or-less traceable group of exposures of the rusty schist. The metasediments in this area are impregnated by pegmatite and the foliated granodiorite. Even so, the attitudes of the schistosity from these exposures is consistent enough to broadly outline the structure. The axial trace of the synform appears to lie northeast
of Pequawket Pond. Structural attitudes of the schistosity on both limbs indicate that the fold axis plunges S 50° W at approximately 10 degrees. The structure is largely cut out by igneous rocks farther west.

The Hiram Antiform is a large open fold occupying most of the east-central part of the quadrangle. The fold axis as determined on a pie diagram of the schistosity plunges at about 20 degrees to the west. The numerous "abnormal" attitudes found on the map in this area indicate that there are several smaller scale folds causing variations in local attitudes. The structure produces a general westerly dip over much of the central part of the quadrangle.

Along the southern margin of the Kezar Falls quadrangle there are numerous exposures of the lime-silicate granofels. The attitude of bedding and schistosity in this region suggests a series of open folds with gently dipping limbs (usually less than 30 degrees) and gently plunges to the northwest. From the structural data it would appear that these folds plunge beneath the schist north of the Ossipee River, but this presents problems in explaining the observed outcrop patterns. Wilson (1969) reports minor calc-silicate lenses within the schists in the Ossipee Lake quadrangle, but there is no extensive exposure of calc-silicate known north of the Ossipee River. However, if the calc-silicate lies stratigraphically below the migmatites north of the river, but above the rusty schist, then calc-silicate should be found north of the Ossipee River in a belt west of the rusty schist. Numerous solutions to the problem are possible, but none can be demonstrated to be unequivocal. A solution involving faulting along the Ossipee River valley seems invalid because the belt of rusty schist apparently crosses the Ossipee valley with no major offset. A second possibility involves facies changes in which the lateral equivalents of the calc-silicate in the south are pelites to the northwest, and, therefore, are lost in the general pelitic section that extends into New Hampshire. Proof of such a facies change would require much more stratigraphic control than is presently available. Solutions involving multiple folding are also possible and perhaps the most attractive at this point. From regional considerations it is possible that the calc-silicate in the Kezar Falls quadrangle lies near the hinge of a southerly plunging synform that continues through the Newfield and Berwick quadrangles to the south. The northwest trending folds shown on the map might be younger superposed folds obliquely crossing the hinge of the older synform. These folds are nearly perpendicular to the regional northeast structural grain found in nearby areas. (Wilson, 1969, Hussey, 1971).

Small Scale Folds

The character of the small scale (outcrop size) structures varies with the different lithologies. In the fine-grained biotite schist and the bedded, brown, mica schist the attitude of the schistosity over a single outcrop is usually quite planar and uniform. The lime-silicate granofels on the other hand is
frequently highly contorted showing tight, disharmonic folding within a few square feet of exposure. In areas where the overall bedding of the lime-silicate is nearly horizontal, it is common to find one to three-inch isoclinal folds with horizontal axial planes. Structures in the migmatite and other mica schists are generally complex, there being little or no consistency in trends in an outcrop of several square yards. In all cases the schistosity has been deformed and most of the linear measurements recorded in the quadrangle are axes of minor folds of the schistosity.

**Joints and Dikes**

No attempt has been made to make a systematic study of joint and dike orientations. Dikes and prominent joints are recorded at each outcrop, but determination of joint density and types of joints was not attempted. Data from the Kezar Falls and Newfield quadrangles show preferred strikes are E-W, N 15-30 E and N 40-60 W (114 measurements). Preferred strikes for post metamorphic dikes are N 20-30 E and N 80-90 E (61 measurements). East-west and N 15-30 E directions are reflected in both joints and dikes whereas the N 40-60 W joint trend is not represented by abundant dikes.

**ECONOMIC GEOLOGY**

While there have been no discoveries of major economic mineral deposits during this investigation, several aspects deserve brief comments.

In several locations throughout the quadrangle small prospect pits have been opened in the pegmatites. In my opinion, however, these are not likely to prove productive for two reasons: (1) the pegmatites are largely lacking in rare minerals although beryl is occasionally present in small crystals. However, no mineralogical or geochemical studies of the pegmatite has been done; (2) the grain size and texture of the pegmatite would seemingly make it unsuitable for mining the feldspar or mica. Grains are seldom over a few inches in diameter and the texture is apt to vary markedly from place to place within a small outcrop (a few hundred square feet).

A large quartz vein of unknown extent was found about 1.3 miles west of Denmark near the old Colby School (15' series topographic map, 1910). This is massive, slightly rose colored quartz and might be of economic value.

The valley floors are generally covered with glacial deposits. In many cases this glacial material is well sorted and stratified sand and gravel. Several pits have been opened in this material but additional resources are abundant.
REFERENCES


Quinn, A., 1953, Geology of the Wolfeboro Quadrangle, New Hampshire; New Hampshire State Planning and Development Commission, Concord, N.H.
