Geology of the Precambrian Igneous-Metamorphic Complex of the Blue Ridge in the Snowden Quadrangle, Virginia

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CONTENTS

ABSTRACT

The Snowden 7.5 minute quadrangle is located entirely within the Blue Ridge physiographic province of Virginia. Early Cambrian sediments of the Chilhowee Group occur in the northern half of the quadrangle, while the southern half consists of Precambrian igneous and metamorphic rocks of the Blue Ridge Basement Complex. The basement rocks to the south have been thrust up and over the younger Chilhowee sediments. The fault contact can be traced across the quadrangle. Since the division of the Chilhowee Group north of this fault into the Unicoi, Hampton, and Erwin Formations is widely accepted, this paper will focus on relationships within the basement complex south of the fault. A number of different rock units within the basement can be recognized on the basis of field occurrence and gross lithology. The Pedlar Formation of Bloomer and Werner (1955) occurs as a dark green, garnet-bearing charnockite which appears to grade eastward into a more massive charnockite containing large porphyryoblasts of perthitic feldspar. A third, leucocratic charnockite can be recognized in the vicinity of the thrust fault, but its areal distribution is restricted by the fault itself. Well-foliated granulites occur as large-scale lensoid masses within the younger charnockites. A wide cataclastic

zone of protomylonites, mylonites, and mylonite gneisses cuts across the southeastern portion of the map and obscures any original lithologies in that area. Greenstone dikes and isolated granitic intrusions occur locally within the cataclastic zone and, in many cases, have been highly sheared and/or recrystallized.

INTRODUCTION

The Snowden 7.5 minute quadrangle comprises parts of Rockbridge, Amherst, Bedford, and Botetourt counties in west-central Virginia (fig. 1). It is situated entirely within the Blue Ridge physiographic province of the Appalachians. Elevations range from 640 feet along the James River south of Snowden to 3960 feet on the crest of Thunder Ridge at the western edge of the quadrangle. The James River cuts through the Blue Ridge at the James River Gap in the northeastern part of the area. Numerous streams run off the flanks of the Blue Ridge to the north and south, but all drain directly into the James River. The James River Face Wilderness Area occupies the north-central portion of the quadrangle and access to this area is restricted to the Appalachian Trail and various National Forest trails. The Blue Ridge Parkway runs for 11 miles through the area and provides easy access to higher elevations along the crest of the Blue Ridge. Road cuts along the Parkway, while only rarely continuous, do yield fresh outcrops. State Roads 122, 600, 602, and 637 provide access to flat-lying areas in the southern sections of the quadrangle, but outcrops there are isolated and highly weathered, thus making relationships between units difficult, if not impossible, to determine.

The most detailed work in this area was done by Bloomer and Werner in their study of the geology of the Blue Ridge in central Virginia (1955). Their division of the basement into the Pedlar (hypersthene granodiorite), Marshall (quartz-feldspar-biotite gneiss), and Lovington ("augen gneiss") Formations has only recently come into disfavor. Work by Bartholomew (1977) and Herz (1979) in the Blue Ridge basement further to the north indicates that Bloomer and Werner's basement stratigraphy was probably greatly oversimplified.

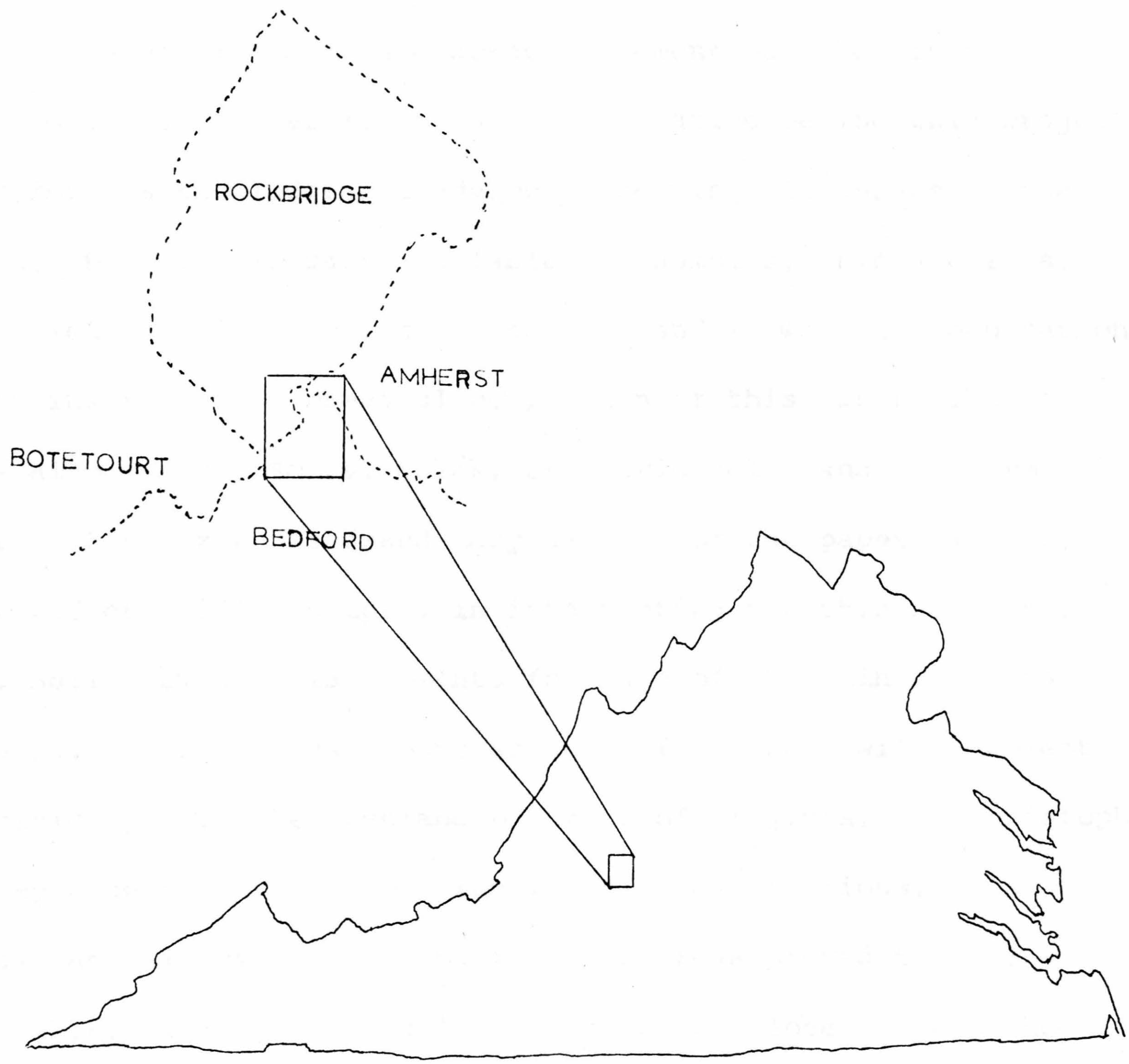

FIGURE 1 - Location of Snowden Quadrangle in Virginia.

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STRATIGRAPHY

I. Precambrian Rocks

Igneous and metamorphic rocks of Grenville age (1.1 billion years old) make up the basement complex in the Snowden quadrangle. They are, for the most part, products of the high pressures and high temperatures characteristic of the granulite facies of regional metamorphism. In addition to granulites, charnockites are also very prevalent in the area. Charnockites are a special type of granultie having hypersthene as a major constituent and in which quartz makes up more than 20% of the felsic components. The name charnockite is derived from that of Job Charnock (d. 1693), the founder of Calcutta, India, from whose tombstone the rock was first described (Gary, et al 1974). In the southeastern portion of the quadrangle dynamic metamorphism has produced a wide zone of cataclastic rocks.

Layered Granulite - This rock type is exposed along the Blue Ridge Parkway near the 72-mile post. Other outcrops occur along the Parkway, but their isolated nature makes accurate correlation difficult at best. The rocks are light colored, distinctly crystalline, and have a prominent alignment of the dark mafic minerals. Herz's layered granulites in the Roseland district of Virginia are characterized by deep blue quartz, perthitic or antiperthitic feldspar, orthopyroxene, and garnet (Herz, 1979). Herz claims (personal communication) that his granulites are the product of high-grade metamorphism of a sedimentary protolith. It seems that this would be a difficult generalization to prove, and I have found no evidence of a sedimentary nature to the granulites in the Snowden area. While the mineralogy of the granulites in the Snowden area is not identical to those of Herz (blue quartz is missing and perthitic feldspar is not the most common fledspar), there is evidence that these rocks were metamorphosed under very high pressures and temperatures. The coexistence of two feldspars as separate phases and the absence of hydrous phases such as biotite, which only occurs as a secondary alteration product, suggest dry conditions (water pressure approaching zero) typical of high pressure and high temperature metamorphism (Winkler, 1976).

In thin section these granulites exhibit a distinctly granoblastic texture--that is, the crystals are mostly equidimensional and are characterized by highly sutured grain boundaries, especially in the quartz. The quartz is often finely crystalline and show undulatory extinction, further evidence of recrystallization. Plagioclase(oligoclase) and microcline are the prominent feldspars.

In the vicinity of the 68-mile post along the Parkway, these light-colored granulites are in contact with dark "popcorn" charnockites. The contact is very sharp and is at an angle to the foliation within the granulites. This would seem to indicate that the charnockites were younger rocks which were intruded after the quartz-rich granulites. On the basis of this evidence and on the basis of Herz's discovery of granulitic xenoliths within charnockites to the northeast, the granulites will here be considered the oldest rocks in the area. A paucity of critical outcrops makes these age relationships difficult to confirm and, without radiometric age dates, the absolute ages of the units cannot be determined. Whatever their relationship, the areal distribution of the granulite seems to be restricted by the surrounding charnockites.

Pedlar Charnockites - This rock type is widely distributed in the southwestern portion of the quadrangle and is particularly well-exposed on the Blue Ridge Parkway along the crest of Thunder Ridge. I am retaining the name "Pedlar" as proposed by Bloomer and Werner since this is one of the few rock types in the area which actually seems to fit their description of the Pedlar Formation as ". . . a hypersthene granodiorite" (Bloomer and Werner, 1955). High pressures and high temperatures are thought to be essential to formation of these charnockites. The lack of any major hydrous phases such as biotite seems to be indicative of a deep crustal origin (Herz, personal communication).

In the vicinity of Thunder Ridge the Pedlar occurs as a medium-grained, dark greenish gray, garnet-bearing charnockite. It is usually massive, but often shows a rough foliation with garnet concentrations oriented parallel to the foliation. Quartz is abundant, as is plagioclase (plage 2A), while hypersthene is the main mafic constituent. In thin section the rock exhibits a distinctive texture with abundant inclusions and intergrowths of quartz. Myrmekite intergrowths of quartz in the feldspars are very common (plate 13A) and indicate that portions of the rock were still molten when it was emplaced.

The Pedlar charnockites seem to grade eastward into lighter, more massive charnockites characterized by abundant porphyryoblasts. No sharp contact between the two units was ever observed and rocks intermediate between the two extremes were found along the Parkway near the 69-mile post (near James River Valley Overlook). This would seem to suggest a gradational contact, the nature and cause of which will be discussed in the next section.

<u>Porphyryoblastic Charnockite</u> - This is an easily recognizable rock unit which occurs in a wide (up to 3 km) belt trending southwest-northeast through the area. It underlies most of Terrapin Mountain and is exposed in very fresh outcrops along the Blue Ridge Parkway between the 67 and 68-mile posts. The

unit is bordered to the southeast by a zone of cataclastic rocks and appears to grade westward into the previously mentioned Pedlar charnockites. The rocks are medium to dark gray "popcorn" charnockites with large (up to 5 cm) porphyryoblasts of perthitic feldspar. The term "popcorn", while not an accepted textural name, accurately describes the very characteristic texture of these rocks. The porphyryoblasts are highly variable in size and their lack of any preferred orientation contributes to the "massive" appearance of the outcrops.

Essential minerals of these rocks are quartz, perthitic feldspars, hypersthene, apatite, and ilmenite. The abundant garnet present in those charnockites to the west on Thunder Ridge is largely missing from these "popcorn" charnockites, whereas opaques such as ilmenite are now far more abundant. Biotite is present only as a secondary alteration product on the rims of other minerals. It can thus be seen that the mineralogy of the unit is typical of a charnockite and yet different from the Pedlar charnockites.

In thin section it can be seen that the porphyryoblasts are actually large crystals of perthitic feldspar surrounded by a quartz and hypersthene-rich matrix (plate 20B). The quartz shows undulatory extinction and sutured grain boundaries and often occurs as myrmekitic intergrowths in the feldspars (plates 12A & 12B). The opaque grains of ilmenite show no leucoxene rims, but are closely associated with abundant prisms of apatite.

As has been previously mentioned, the "popcorn" charnockites appear to grade westward into the Pedlar charnockites. This is evidenced by a decrease in size and abundance of the characteristic porphyryoblasts from east to west within the charnockites. At the same time, garnet seems to increase in abundance from east to west. This phenomenon can best be explained with reference to the geologic map of the Snowden quadrangle (Appendix). A wide zone of cataclastic rocks borders the charnockites to the southeast. The dynamic metamorphism which affected these cataclastic rocks could easily have caused partial recrystallization of the immediately adjacent charnockites. Effects of this partial recrystallization would be myrmekite intergrowths, perthitic and antiperthitic feldspars, quartz showing embayed and sutured grain boundaries, and a porphyryoblastic texture. Those charnockites which border the cataclastic zone exhibit all these features, and yet these characteristic indicators of metamorphic recrystallization die out westward away from the cataclastic zone. This would simply be a reflection of the decreasing metamorphic intensity as one moves away from the cataclastic zone. Thus it seems that the Pedlar and "popcorn" charnockites may originally have been identical. The porphyryoblasts which are so diagnostic of the "popcorn" unit are merely a product of recrystallization due to proximity to a zone of intense cataclasis.

<u>Leucocratic Granulites</u> - These rocks are very limited in their areal distribution. To the north they ride on the leading edge of the major thrust fault which separates the basement rocks from the younger sediments of the Chilhowee Group. To the south they are restricted by a second thrust fault and are involved in the wide cataclastic zone which has already been mentioned. The thrust faults obliterate any indication of the original extent of the unit.

These leucocratic rocks are massive, fine to medium-grained and have a paucity of dark mineral constituents such as hypersthene. Plagioclase (oligoclase) and microcline are the primary feldspars. Quartz is abundant and ilmenite is also present and closely associated with apatite. Small euhedral crystals of zircon and apatite suggest an igneous origin, but field relationships and mineral associations suggest that the rock is a product of subsequent granulite-facies metamorphism. In thin section, the rock exhibits a distinctly granoblastic texture with no preferred orientation of the minerals. Sutured, embayed, and recrystallized grain boundaries, perthitic intergrowths of feldspars, and undulatory extinction in quartz grains all suggest partial recrystallization due to regional metamorphism.

Cataclastic Rocks - A wide (at least 4 kilometer) zone of cataclastic rocks occupies the entire southeastern portion of the map area. These rocks are best exposed along the James River in the adjoining Big Island Quadrangle. Varying intensities of dynamic metamorphism, along with varying degrees of response by the original rock units, have produced a complete series of protomylonite, mylonite, ultramylonite, and mylonite gneiss. As defined by Higgins (1971), these rocks all exhibit some sort of fluxion structure (i.e. cataclastic foliation), but in most the cataclasis has been so intense as to obliterate any indication of the original nature of the rock. Higgins classifies cataclastic rocks with fluxion structure on the basis of whether or not cataclasis was dominant over recrystallization and neomineralization. Those in which cataclasis was dominant he assigns to the series protomylonite-mylonite-ultramylonite. He distinguishes between these three on the basis of size and percentage of prophryoclasts. Protomylonites have more than 50% porphyryoclasts (plate 16B) while ultramylonites have less than 10% porphyryoclasts (plage 18A)--mylonites (plate 15B) are intermediate between the two. Porphyryoclasts in protomylonites and mylonites tend to be larger than .2 mm, while those in ultramylonites are smaller than .2 mm. When neomineralization and recrystallization are dominant over cataclasis, Higgins assigns them to either mylonite gneiss (augen less than 30% of rock) or blastomylonite (augen less than 30% and smaller than .5 mm) (plate 17A). These criteria of Higgins can be used to distinguish between the many types of cataclastic rocks which are found in the Snowden area. Most of the rocks appear to be either mylonite gneisses or protomylonites, with mylonites and even some ultramylonites occurring locally in the vicinity of the faults just north of the parkway along the James River. In general, the number and size of the augen seem to diminish as one moves northeast through the cataclastic zone. This is to be expected since the increased shearing stresses associated with dynamic metamorphism along the fault zone would result in a greater degree of granulation and recrystallization. Such conditions would not be favorable to the production of augen. In addition to the thrust faults which bring basement rocks into contact with younger sediments, it is possible that there might be a larger strike-slip fault trending through the cataclastic zone from southwest to northeast. This is suggested by the regional trend of the cataclastic zone, its wide areal extent, and the marked southwest-northeast alignment of fluxion structures within the cataclastic rocks.

While it is obvious that several types of cataclastic rocks can be recognized in the field, it is also apparent that any attempt at mapping should be done primarily on the basis of textural attributes. Mineralogy within the cataclastic rocks is more a function of the dynamic metamorphism and thus tends to be fairly uniform throughout the area. Quartz is very abundant and always shows the greatest effects of the metamorphism. In hand specimen it is typically deep blue, reflecting the high pressure of the cataclasis. The blue color of the quartz can be a result of rutile inclusions, but these are not evident in thin section analysis. The quartz is easily granulated and recrystallized and usually shows wavy extinction, sutured grain boundaries, and pronounced internal strain patterns (plate 13B). Most of the quartz is elongated in lenticular aggregates oriented parallel to the cataclastic foliation (plate 11B). In contrast to quartz, feldspars respond much less readily to the shearing and recrystallizing effects of dynamic metamorphism. The "augen" so characteristic of Higgins' protomylonites and mylonite gneisses are usually porphyryoclasts of feldspar (plate 14B). The feldspars of cataclastic rocks often show deformation twinning (plate 2A) and exsolution perthitic and antiperthitic lamellae. Micaceous minerals, especially biotite and chlorite, are very common and usually the primary source of the gneissic or schistose foliation. They are products of secondary crystallization and occur as platy fibrous needles, often wrapping any porphyryoclasts in a "cataclastic envelope" (plate 18A). Garnet is common in cataclastic rocks as euhedral to subhedral crystals whose equant dimensions cause them to be rolled and wrapped by the foliation rather than elongated parallel to the foliation (plate 6B). Larger garnet crystals often show prominent fractures and alteration to biotite or chlorite (plate 6A). Opaque minerals, in particular ilmenite, are very abundant and typically show very characteristic whitish leucoxene (a titanium oxide) alteration rims (plate 4A). These leucoxene rims seem to be much more common in rocks of the cataclastic zone than in rocks outside this zone.

II. Precambrian (?) Rocks

These igneous and sedimentary rocks seem to fall somewhere between the Grenville-age basement and the Cambrian sediments of the Chilhowee group. They were not affected by the granulite facies metamorphism which characterizes the other basement rocks. Bloomer and Werner (1955) placed these rocks in the "late Precambrian" and this seems to be a very safe conclusion.

Greenstone Dikes - The best exposure of this rock type is along Highway 501 about 4 kilometers south of Snowden. It is exposed as a fine-grained light to medium green igneous rock and shows a crude layering or schistosity which is probably a result of a later paleozoic metamorphic event. In thin section the primary minerals are mafics which have been chloritized and foliated (Bell, personal communication). Muscovite, quartz, and feldspar are present only in limited amounts (plate 19A). Opaque oxides (ileminte or magnetite) are common and typically show leucoxene alteration.

The characteristic schistose texture, limited occurrences, and green color of these igneous rocks makes them easily recognizable in the field. On the basis of mineralogy and similar ages, Herz (1979, personal communication) has suggested that these may be feeder dikes for the late Precambrian greenstones of the Catoctin Formation. However, without more direct evidence, this seems like a very tenuous association.

Granitic Dikes - These leucocratic rocks are scattered throughout the cataclastic zone, but the limited exposures there prohibit correlation from one outcrop to another. The anomalous occurrence of these rocks in the middle of the cataclastic zone suggests that they are younger than the metamorphic event which formed the mylonite gneisses common in the area. A distinct granoblastic texture, undulatory quartz with sutured grain boundaries (plate 3A), perthitic intergrowths in feldspars, and intergranular fracture and strain patterns (plate 1A) all are evidence of partial recrystallization. This is probably best explained by a Paleozoic regional metamorphic event which occurred after the granites were emplaced. Such evidence of polymetamorphism is common throughout the Blue Ridge region.

In hand specimen the rocks show no foliation or cleavage and this gives the rocks a very massive appearance in outcrop. Quartz (often deep blue) is very abundant, as is feldspar (both plagioclase and microcline). In two cases the rocks closely resemble anorthosites from the Roseland district. Apatite is often present and closely associated with opaque ilmenite.

Swift Run Formation - The Swift Run Formation was first described by Stose and Stose in 1946 from exposures near Swift Run Gap in Rockingham County in northern Virginia (Bloomer & Werner, 1955). Bloomer and Werner first mapped this unit in the Snowden and Big Island quadrangles and it is partially on the basis of their identification of Swift Run outcrops that some of the sediments in the area are mapped as Swift Run in this paper. The Swift Run is characterized by conglomerates, volcanics, and graywackes, some of which are locally metamorphosed to phyllites (plate 15A). The Swift Run sediments unconformably overlie the basement rocks. This description, however, describes the lower units of the Chilhowee Group as well. The best way to tell them apart is on the basis of their relative stratigraphic position with respect to the Catoctin greenstones--Swift Run lies below the Catoctin and Chilhowee lies above. In the Snowden area, the Catoctin is absent and there is thus no failsafe way of distinguishing the Siwft Run and lower Chilhowee units. Both are in fault contact with the basement and accurate identification would require correlation with similar units in other areas.

III. Cambrian Rocks

The Cambrian sediments exposed in the area of study are all members of the Chilhowee Group. They include the Unicoi, Hampton, and Erwin Formations. The Unicoi is a coarse conglomeratic unit with some interbedded siltstones. The Hampton is a mixture of dark sandstones, shales, and graywackes while the Erwin is a massive white orthoquartzite. The nature of these sediments is beyond the scope of this paper and they will only be considered with respect to their fault contact relationship to the basement rocks.

METAMORPHISM

I. Regional Metamorphism

Most of the rocks of the Precambrian Basement in the Snowden quadrangle are products of a Grenville-age (1.1 billion years ago) metamorphic event. The textures and mineralogies of the granulites and charnockites in the area are very indicative of the high pressures and high temperatures (granulite facies of regional metamorphism) under which these rocks were formed.

In hand specimen the rocks have a coarsely crystalline, granular texture. Preferred orientations, such as alignment of dark minerals and vague compositional banding can be observed in many of the rocks. The characteristic granoblastic texture visible in thin sections is very typical of high-grade regional metamorphism. The component mineral grains are all roughly equidimensional and show embayed and sutured grain boundaries. Myrmekitic intergrowths of quartz in feldspar, perthitic and antiperthitic exsolution lamellae, and undulatory finely crystalline quartz are all characteristics of metamorphic recrystallization under high pressures and temperatures.

Mineral assemblages within the basement rocks are also typical of high-grade regional metamorphic terranes. Quartz is often deep blue in hand specimen. Euhedral to subhedral garnet crystals are locally very abundant, as are myrmekitic and perthitic feldspars. Hydrous phases such as biotite and muscovite are absent except as secondary alternation products. This indicates high pressures and temperature under very dry (i.e. water pressure approaching zero) conditions. Apatite and zircon occur as small, euhedral crystals. Opaque minerals (ilmenite or magnetite) are often associated with the apatite prisms, but only rarely show any signs of leucoxene alteration.

II. Dynamic Metamorphism

Cataclastic rocks produced by dynamic metamorphism are very abundant in the Snowden quadrangle. They occur in a wide belt cutting diagonally across the southeastern corner of the area. While some of these cataclastic rocks are obviously genetically related to movement along thrust faults which bring the basement in contact with younger sediments, many cannot be directly attributed to such movement. The regional SW-NE orientation of fluxion structures and the widespread nature of this cataclastic zone both suggest a second, more deeply seated fault zone in the area which is not directly observable in outcrops. Herz (1979, personal communication) states that a major cataclastic zone in his Roseland district is the site of intense shearing along a fault and can be traced as far south as Roanoke. Whether this zone passes close enough to the Snowden quadrangle to account for the cataclasis in this area cannot be determined without more detailed mapping in the intervening areas between Snowden and Roseland.

According to Spry (1969), the character of the cataclastic products of dynamic metamorphism is a function of the interrelations of temperature, pressure, strain rate, presence of solvents, and the mechanical properties of the rocks concerned.

Crystalline basement rocks are very brittle and therefore respond to shearing by granulation and recrystallization of the constituent minerals. Mineralogy of crystalline rocks is by no means uniform, and each mineral behaves differently under stress as a function of its chemical and physical properties. Quartz is easily recrystallized at high pressures or temperatures and may undergo flowage as it is elongated parallel to the cataclastic foliation. Brittle minerals such as feldspar and garnet respond much less readily to cataclastic shearing stresses. Feldspars may be fractured or show granulated margins, but they still tend to persist as porphyryoclasts. Garnets may be fractured, but they often have euhedral outlines which show evidence of rotation or rolling. More ductile minerals such as micas, pyroxenes, and amphiboles have glide properties within the crystal lattice which tend to promote the development of the cataclastic foliation (Spry, 1969).

STRUCTURE

I. Megascopic Features

The major structural feature in the area of study is the large thrust fault which separates the crystalline rocks of the basement from the younger sedimentary rocks to the north. The thrust sheet moved northward as a unit, carrying basement rocks up and over the sediments. The fault trends east-west across the quadrangle and bifurcates near Falling Rock Creek, leaving an exposed wedge of Swift Run sediments. It is possible to locate the fault precisely in a number of outcrops across the area (see map). The fault zone itself is narrow and marked by intense cataclasis of the basement rocks, which are locally metamorphosed to mylonites and ultramylonites. Sediments in the vicinity of the fault are strongly fractured and sheared, but show no signs of recrystallization.

II. Mesoscopic Features

The most prominent mesoscopic structures in the basement rocks are the commonly occurring foliations which were produced by metamorphism. The foliations can be divided into two groups on the basis of their genesis. Cataclastic foliation, or fluxion structure, is the result of dynamic metamorphism and is most common in rocks in the large cataclastic zone and in the vicinity of the thrust faults. A second type of foliation, which is evidenced by a dimensional preferred orientation of only some of the mineral grains, is a product of the regional metamorphism which affected the area and is especially common in the charnockites and granulites found along the Blue Ridge Parkway on Thunder Ridge.

In the granulites along the Parkway, the dark mineral constituents show a definite preferred orientation in the massive, coarsely crystalline background. In the charnockites, the foliation is often a rough compositional banding which is most likely a result of minor metamorphic differentiation. The fluxion structures in the cataclastic rocks are more easily recognized than other types of foliation. The shearing associated with the cataclasis in these rocks has produced a foliation evidenced by a strong alignment of platy or fibrous minerals such as micas, pyroxenes, and amphiboles. This usually gives the rock a prominent gneissic or schistose textural layering which is very characteristic and only interrupted by porphyryoclasts of feldspar. These porphyroclasts are usually oriented parallel to, and are wrapped by, the foliation.

Fractures are another mesoscopic structural feature common in the basement rocks. Within the massive crystalline rocks they often occur in sets oriented at right angles, thus giving the outcrops a distinctive blocky appearance. Within the cataclastic rocks, cleavage planes and fractures are usually parallel to the cataclastic foliation and often give the rock a layered or bedded appearance.

III. Microscopic Features

Microscopic structural features are common within the metamorphic rocks of the basement. They reflect the responses of individual grains to the stresses associated with regional and/or dynamic metamorphism. Microscopic structures often show strong evidence of polymetamorphism as well.

Within individual mineral grains slippage or translation gliding can occur along zones of weakness in the crystal lattice or along microscopic fractures. These are microscopic strain features resulting from directed pressures and can be recognized by such things as offset twin lamellae, kinking, and banding (plates 1A, 1B, 2B). Kinking and banding occur particularly within the micaceous minerals so common in cataclastic rocks. Deformation twinning is common in plagioclase crystals (plate 2A) but cannot really be distinguished from growth twinning occurring during crystallization (Spencer, 1977).

Dimensional and/or lattice preferred orientations of mineral grains are a common response of individual crystals to directed pressures. The grains tend to be oriented, either by rotation, recrystallization, or fracture, into a position where the principal stresses are least. While this is a response of single grains on a microscopic scale, it can result in a foliation on a mesoscopic scale.

Grain boundaries often show distinct evidence of strain. In brittle minerals the margins are granulated (plate 1B), whereas, in minerals such as quartz, embayed and sutured grain boundaries are evidence of recrystallization (plate 3A). Euhedral minerals such as garnet are often wrapped by micaceous folia and show evidence of having been rolled or rotated as a result of shearing stresses (plate 6B).

CONCLUSION

Geologic mapping of igneous-metamorphic terranes within the Blue Ridge is a very complex procedure which can be done on any number of different scales. Ubiquitous mineralogical variations within the basement rocks necessitate that, as the size of the map area increases, so must the mineralogical parameters of individual units to be identified. These abundant textural and mineralogical variations are a function of both the original composition of the rock and the regional metamorphism which affected the entire basement in the Precambrian. Textural variations within the cataclastic zone are easily recognizable and primarily a function of the intensity of dynamic metamorphism. It is possible that a very detailed analysis of the cataclastic rocks across this zone (its extent in the adjoining quadrangles is unknown) could yield valuable information about deep-seated faults in the area.

In this project I have attempted to discern mappable units in the rocks of the basement complex. While detailed chemical and petrological analysis might be useful in identifying rock types, it is certainly not practical for field usage. The units proposed here have characteristic textures and mineralogies which can be recognized in the field. The rocks mapped as layered granulite, while showing some similarities to Herz's rocks of the same name in the Roseland district, are different enough to make any correlation between the two units tenuous. The charnockites in this area show remarkable likeness to the major characteristics of the charnockites mapped by Bartholomew in the Greenfield and Sherando quadrangles. This is true even for the porphryoblastic textures observed in many of the charnockites. Both Herz and Bartholomew recognize a wide zone of cataclastic rocks trending southwest-northeast, but effective correlation would require detailed mapping in the intervening areas.

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