STRATIGRAPHY AND PETROGRAPHY OF THE IRON MOUNTAIN FORMATION (BASAL PART OF THE UNICOI GROUP) IN SOUTHWESTERN VIRGINIA

By

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INTRODUCTION

Purpose of the Investigation

The object of this study was to determine the environment, source, and history of the coarse clastic portion of the basal part of the Unicoi Group in southwestern Virginia. Most previous work in the area of study has been of a general nature. Local reconnaissance suggested that several misconceptions as well as disagreements concerning the basal part of the Unicoi Group and the subjacent Mount Rogers Group are now in the literature. This study was made in order to collect data which might shed further light on the geologic history of the area and surrounding region, and might serve to clarify at least some of the apparent misconceptions.

Preliminary studies indicated the possibility, at least locally, of a gradational contact between the Mount Rogers Group and the Unicoi Group (see Dietrich, 1956, and King and Ferguson, 1960). The nature of the contact, therefore, was to be of primary concern during the course of the investigation. Further, shale beds which were tentatively classified as tuffaceous were noted in the basal part of the Unicoi Group. Attempts were to be made to prove or disprove the time correlative value of the sedimentary interval containing the tuffaceous(?) beds.

Dates and Procedure of the Investigation

This report is based on fieldwork carried on during the spring, summer, and fall of 1960, and the winter, spring, and summer of 1961. Laboratory work and the preparation of the manuscript were done between the spring of 1962 and the fall of 1964.

Field mapping was done on the following, 1:24,000, 7½-minute, topographic quadrangle sheets of the United States Geological Survey and/or Tennessee Valley Authority (Index map, Plate 1): Laurel Bloomery, Virginia-Tennessee; Grayson, Virginia-Tennessee-North Carolina; and Konnarock, Whitetop Mountain, Troutdale, Middle Fox Creek, and Cedar Springs, Virginia. The Speedwell and Independence, 1:62,500, 15-minute, topographic quadrangle sheets were used for areas for which 7½-minute sheets are unavailable.

Field mapping was supplemented in the laboratory by aerial photograph interpretation, macroscopic and microscopic study of rock samples, studies of heavy (or persistent) minerals from saprolites and soils derived from the lower part of the Unicoi Group, and x-ray diffraction, differential thermal, and emission spectrographic analyses of several rock and mineral specimens.

Acknowledgments

My sincere appreciation is extended to Professor Richard V. Dietrich, whose suggestions and constructive criticism directed the course of this study. Special thanks are extended to Professors Byron N. Cooper, Wallace D. Lowry, Chauncey G. Tillman and Jack A. Redden for counsel and encouragement during the course of the field work and thesis writing. Many fellow students, professors, and co-workers not named herein took part in several discussions relating to concepts and conclusions later accepted or rejected.

A Grant-in-Aid of Research was extended the writer by the Society of Sigma Xi to defray expenses incurred in the field during the summer of 1961. A Faculty Research Grant was given by Birmingham-Southern College to aid in completion of the thesis. The society and college are extended my gratitude.

Previous Investigations

Reconnaissance mapping of the area was directed by Stose (1928) in preparation of the "Geologic Map of Virginia". Butts (1933, 1940), who mapped and briefly discussed the stratigraphy and structure of the Appalachian Valley in Virginia, also included part of the area.

Jonas and Stose (1939) discussed the age relationships of the Precambrian rocks in the Mount Rogers anticlinorium in Virginia. Stose and Stose (1944) discussed the Chilhowee Group and Ocoee Series of the southern Appalachians, and introduced the term "Mount Rogers Volcanic Series".

More recently, Rodgers (1953) mapped and described the areal geology, stratigraphy, and structure of eastern Tennessee, which is directly south of the area of this study, and he later (1956) discussed the stratigraphy and problems of the basal clastic portion of the Cambrian System of the central and southern Appalachians. Dietrich (1956) has discussed the possible significance of the mineralogy of amygdules in the different basalt units contained in the middle to upper part of the Unicoi Group of the area and has presented (1961) a preliminary statement relating to the possible age(s) of the Mount Rogers - Unicoi - Hampton - Erwin sequence in southwestern Virginia.

Stose and Stose (1957) mapped and described the geology of the Gossan Lead District, which includes about fifteen square miles of the northeastern part of the area of this study. King and Ferguson (1960) discussed the rocks lying within the area of the Mountain City window to the southeast and used the term "Mount

Rogers Group". Carrington (1961) described some rhythmically bedded, graded, tuffaceous sediments within the upper part of the Mount Rogers Group in the vicinity of Konnarock, Virginia. Derby (1961) mapped the Damascus, Virginia, area, which lies directly west of the southwestern portion of the area of this study.

GEOGRAPHY

Location

The area of study lies in the Unaka Mountain Group of southwestern Virginia. Field mapping was confined to those sedimentary strata below the base of the lowest of three basalt units within the middle to upper part of the Unicoi Group, and included various lithologic units of the Mount Rogers Group which locally underlie the Unicoi Group.

Whereas no formal boundaries of study were defined areally, the area of concentration was a roughly 35 mile-long, northeasterly-trending strip (Plate 3) which locally encompasses three outcrop belts of the Unicoi-Mount Rogers sequences and includes portions of southeastern Washington, southern Smyth and Wythe, and northern Grayson counties, Virginia. Thus, the reported field mapping is bounded on the southwest at or near the Virginia-Tennessee State Line between McQueen Gap to the east and Tennessee Highway 91 to the west. To the northeast, the reported mapping extends to U. S. Highway 21 (Dry Run Gap vicinity) in north-central Grayson County, Virginia. The strip is about 1.5 miles wide from the vicinity of Dry Run Gap to the vicinity of Konnarock, Virginia, from which it is about 3.5 miles wide.

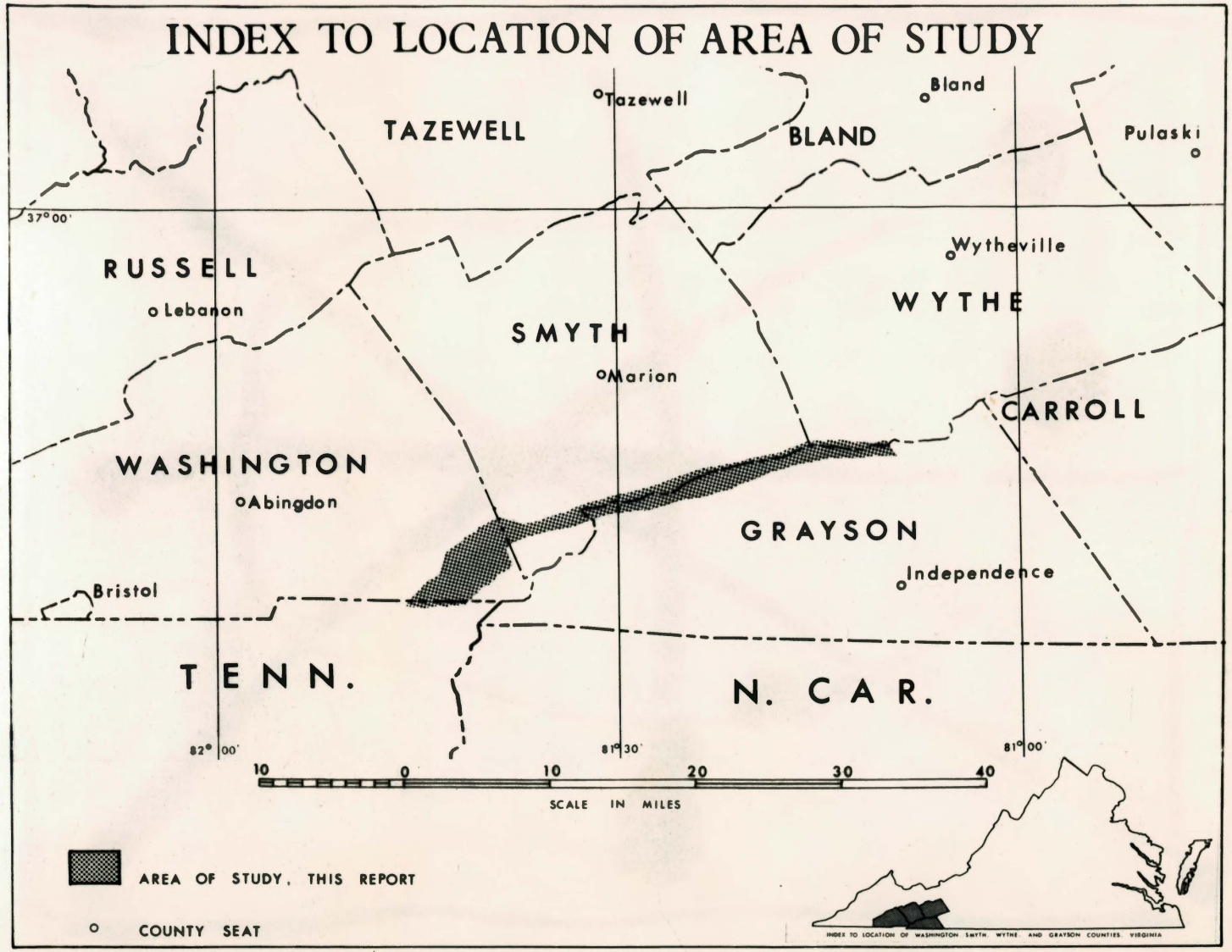

INDEX TO LOCATION OF AREA OF STUDY
TAZEWELL
Tazewell
BLAND
Bland
Pulaski
37° 00'
RUSSELL
Lebanon
Wytheville
WYTHE
SMYTH
Marion
CARROLL
WASHINGTON
Abingdon
GRAYSON
Independence
Bristol
TENN.
N. CAR.
82° 00'
81° 30'
81° 00'
10 0 10 20 30 40
SCALE IN MILES
AREA OF STUDY, THIS REPORT
COUNTY SEAT
INDEX TO LOCATION OF WASHINGTON, SMYTH, WYTHE, AND GRAYSON COUNTIES, VIRGINIA

PLATE 3

Accessibility

The area has limited accessibility. The Norfolk and Western Railway, U. S. Highways 58 and 21, Virginia Highways 16 and 78 (Tennessee Highway 91), County Roads 600 and 603, and unnumbered secondary and private roads form a network across ridges at widely separated points and within the valleys parallel to the ridges. Logging roads and fire trails also provide access to portions of the ridge slopes and tops. In the major portion of the area of study, however, there is a dearth of roads or trails and an abundant forest cover and slope wash on the ridge flanks.

Principal Geographic Features

General Statement

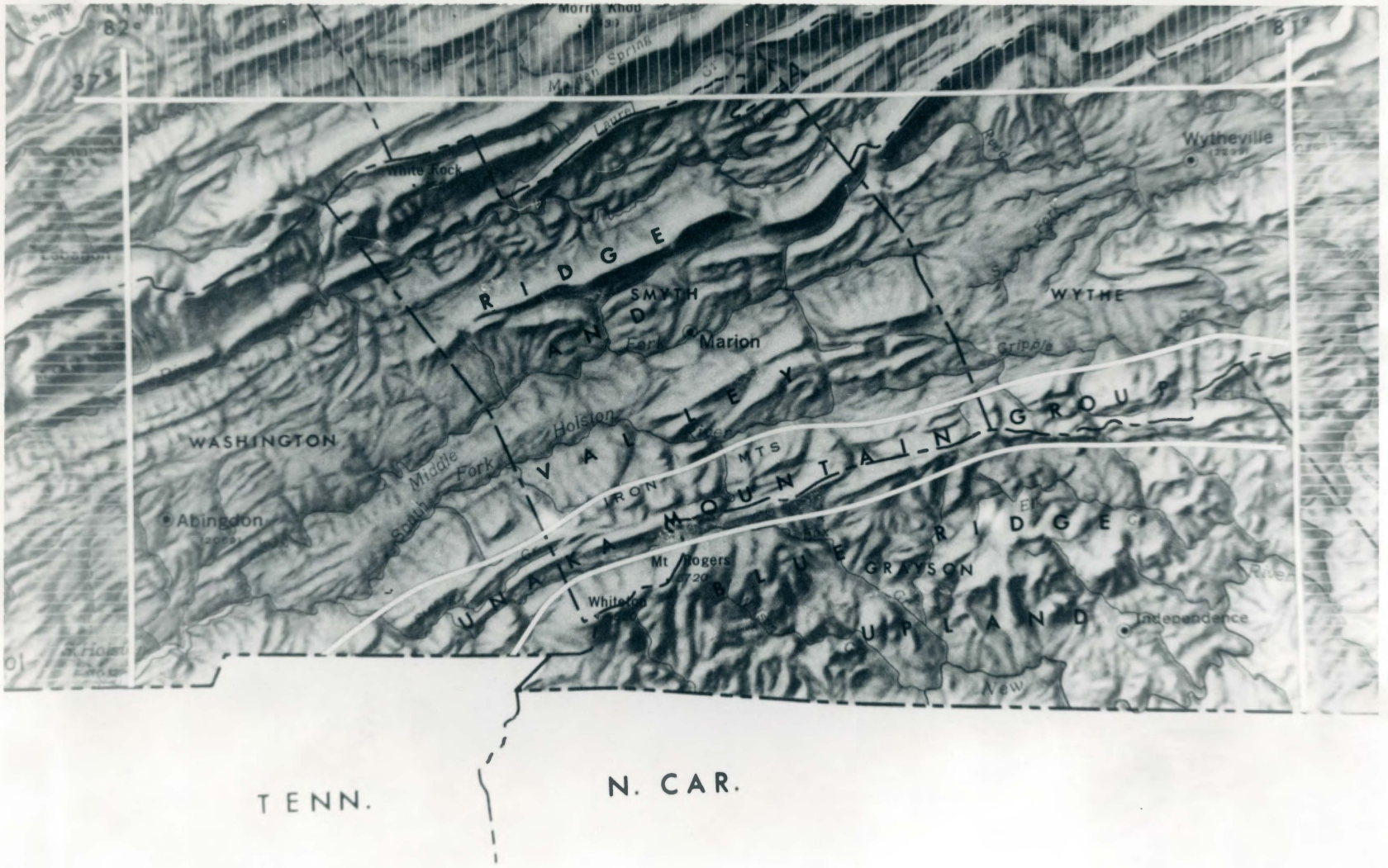
The Blue Ridge Province (Plate 4) in southwestern Virginia is about 30 miles wide. The region including and surrounding the area of this study may be divided into subsidiary provinces: the Blue Ridge Upland (Dietrich, 1959) or Plateau (Stose and Stose, 1957), and the Unaka Mountain Group (Safford, 1869, and Fenneman, 1938).

Blue Ridge Upland

The Blue Ridge Upland consists of a dissected, gently

Landform map with physiographic provinces in parts of Washington, Smyth, Wythe, and Grayson counties, Virginia, outlined.

PLATE 4


Morris Knob
Marden Spring
White Rock
Laurel
Wytheville
RIDGE
AND
VALLEY
SMYTH
Marion
WYTHE
Cripple
WASHINGTON
Holston
Middle
Fork
South
Abingdon
IRON
MTS
UNAKA MOUNTAIN GROUP
BLUE RIDGE
GRAYSON
Mt Rogers
Whiteton
UPLAND
Independence
New
TENN.
N. CAR.

rolling upland underlain by metamorphic and igneous rocks the overall resistances of which play an important role in the control of stream pattern and topography. The topography is typified by unaligned hills and knobs with local reliefs of a few hundreds of feet. The general summit level of the hills and knobs lies between 2700 and 3100 feet elevation. Isolated ridges, with up to a thousand feet of relief, reflect occurrences of more resistant strata and typically trend parallel to the strike of the underlying rocks. Two of the highest peaks in Virginia, Mount Rogers (5720') and Whitetop Mountain (5520'), are located in the southwestern part of the Blue Ridge Upland in the State, and define in part a major drainage divide which separates the drainage basin of New River and its tributaries from that of South Holston River and its tributaries.

All drainage of the region to the southeast and east of the major drainage divide flows into the Gulf of Mexico via the New, Kanawha, Ohio, and Mississippi rivers, whereas all drainage to the northwest and west of the divide flows into the Gulf of Mexico via the South Holston, Holston, Tennessee, Ohio, and Mississippi Rivers.

Streams tributary to New River are incised from 400 to 500 feet below the general surface of the Blue Ridge Upland. Below the slopes of the mountains on the Blue

Ridge Upland the stream pattern is dendritic and the streams are typically winding, with low-gradient courses. On the mountain slopes where the stream erosion is more marked, the stream courses are more nearly straight and have relatively high gradients.

Unaka Mountain Group

The Unaka Mountain Group in this region is principally represented by the Iron Mountains, with which the area of chief study is for the most part coincident. The Unaka Mountain Group extends along the northwestern periphery of the Blue Ridge Province in this region. The mountains are structurally and physiographically separated from the Valley and Ridge Province as a result of erosion subsequent to large-scale thrusting along the Holston Mountain fault of resistant strata northwestward onto younger, less resistant strata. Thus the northwestern border of the Unaka Mountain Group, and the Blue Ridge Province, is nearly coincident in part with the trace of the Holston Mountain thrust fault. The border is less distinct where this is not the case.

The Unaka Mountain Group is comprised by a series of en echelon ridges (Plates 4, 5B) which bear various local names, and which in general are parallel to the strike of the underlying rocks. The belt of structurally related

mountains trends generally N.72°E. and averages about 4.5 miles wide in this region. The width of the belt along the border between Smyth and Washington counties, however, is only about one mile because of closer folding of the relatively resistant strata and the irregularity of the trend of the trace of the Holston Mountain fault.

Elevations of ridge summits in the Unaka Mountain Group are about 1000 feet more than those characteristic of the Blue Ridge Upland, and about 1000 feet less than the summits of Mount Rigers and Whitetop Mountain (Plate 5A). The highest ridges and peaks are in the northeastern portion of the area of study, where summit elevations are a few tens of feet above 4400 feet. In the southwestern part of the area, only a few summits reach 3800 feet in elevation.

The more continuous series of ridges of the locally double- or triple-ridged Iron Mountains in southwestern Virginia consist of, from southwest to northeast, Butt Mountain (Washington County); Straight Mountain (Smyth and Washington counties); Grave Mountain (Smyth County); Hurricane and Straight Mountains (Smyth and Washington counties); and such knobs as Buzzard Rock (Smyth, Grayson, and Wythe counties), Comers Rock, High Knob, and Perkins Knob (Wythe and Grayson counties). Numerous erosional gaps separate and isolate the ridges and knobs. Many of

them, such as Laurel Creek Gap, Beartree Gap, Comers Creek Gap, and Dry Run Gap, have been utilized for the construction of highways and railways that cross the mountains.

Grosses Mountain is a short ridge northwest of and parallel to the trend of the Iron Mountains; it extends from about 2.5 miles east of Damascus to the vicinity of the Smyth-Washington County Line. Isolated knobs extend for a short distance along the general trend at both ends of Grosses Mountain, but the trend is terminated by faulting within a few miles.

Another irregular ridge, also essentially parallel to the trend of the Iron Mountains is comprised by Chestnut and Lost mountains in Washington County, Virginia, and peaks such as Catface, Rogers, and Grindstone ridges, and Bald Knob in adjacent Tennessee.

The northwestern flanks of the Unaka Mountain Group west of Longtitude 81°22'30"W. are drained by streams tributary to the South Holston River and the waters so drained eventually reach the Gulf of Mexico as mentioned. In the southwestern part of the area of study one tributary to the South Holston River, Laurel Creek, has breached the Iron Mountains near Damascus, Virginia, and with its tributaries, Beaverdam, Straight, and Whitetop creeks, drains the southeastern slopes of the Iron Mountains and the northwestern slopes of Whitetop Mountain and Mount

Rogers.

Tributaries of the South Holston River are to a great degree controlled by structure. The larger creeks closely follow the trend of the underlying rocks; whereas their tributaries typically flow more nearly perpendicularly to that trend. A rudimentary dendritic pattern is exhibited by Laurel Creek and the lower mile or two of its larger tributaries in the vicinity of Damascus.

A. Whitetop Mountain (right) and Mount Rogers (left) as they appear from Feathercamp Lookout Tower. The valley on this (northwest) side of the mountains is underlain by rocks of the Mount Rogers Group, the two near ridges are underlain by resistant rocks within the Unicoi Group; the trace of the Iron Mountain fault is on the near flank of the middle ridge.

B. Iron Mountains, looking along the trend east of Comers Rock, Grayson-Wythe Counties, Virginia. Low bench on the flank of the mountains right of center expresses the position of the uppermost of three basalt flows which occur within the Unicoi Group.

PLATE 5



A



B

GEOLOGY

General Statement

The Unaka Mountain Group and the Blue Ridge Upland directly southeast of the Unakas contain two major fault blocks, each bounded on the northwest by a thrust fault, and each consisting in part of an overturned syncline (Plates 1 and 32). The most northwesterly block, the Holston Mountain fault block, is bounded on the northwest by the Holston Mountain thrust fault and consists chiefly of the southeastern limb and locally the northwestern limb of a northeastwardly trending syncline. The second major block, the Iron Mountain fault block, occurs in the southwestern part of the mapped area where it is bounded on the northwest by the Iron Mountain fault. The rocks comprising the block are present in the locally overturned southeastern limb of a northeastwardly trending syncline which has been thrust northwestward onto the Holston Mountain block.

Within the actual, mapped area are sedimentary, metamorphic, and igneous rocks which range in age from Precambrian to Cambrian. All rocks have been deformed and thrust-faulted. Metamorphism is slight to absent in the younger rocks.

No attempt was made to unravel the stratigraphy of

the Mount Rogers Group. Nonetheless, where possible the lithologic identity of the rocks of the volcanic group that directly underlie the basal part of the Unicoi Group was determined. Descriptions and discussions of lithologic types and possible succession within the Mount Rogers Group is based on impressions gained while mapping relatively widely spaced outcrops.

The Precambrian Mount Rogers Group overlies older Precambrian igneous and metamorphic rocks in an exposure along U. S. Highway 21 about 2.5 miles northeast of Elk Creek community, Grayson County, Virginia, and in an exposure at Azen Church, Washington County, Virginia. The lower contact of the Mount Rogers Group has not been observed elsewhere in the area.

The Mount Rogers Group is composed of tuffaceous and arkosic sediments, porphyritic rhyolite flows, and purplish-red and gray-green rhythmites. The volcanic group appears locally to grade upward into the overlying Precambrian or Cambrian Unicoi Group, but at other exposures it appears to be overlain unconformably by the Unicoi Group.

In the basal part the Unicoi Group is comprised chiefly by medium- to coarse-grained, feldspathic and arkosic, pebbly and non-pebbly sandstones with intercalated orthoquartzites, conglomerates, siltstones, and clay

and tuffaceous shales. The basal part is overlain by a sequence of three basalt flows which are interlayered with graywacke, arkosic or feldspathic sandstones, and tuffaceous shales. Above the basalt interval are vitreous orthoquartzites, feldspathic quartzites, siltstones, and clay and tuffaceous shales. No fossils have been found in the Unicoi Group.

The Hampton Formation of Precambrian or Cambrian age, which overlies the Unicoi Group with intervening gradational contact, consists predominantly of silt and clay shales, siltstones, feldspathic fine-grained sandstones, and locally vitreous quartzites. According to King and Ferguson (1960), the supposed worm tube, Scolithus, occurs locally in the upper quartzites and lower arkosic sandstones of the Hampton Formation on the Nolichucky and Watauga rivers in Tennessee.

The Erwin Formation of Cambrian age which overlies the Hampton Formation with intervening gradational contact, is comprised by massive, vitreous quartzites with intercalated shales and sandstones. Fossils such as Olenellus, Hyolithus, and inarticulate brachiopods have been found in the upper part of the Erwin Formation and/or its equivalents in other areas, and according to Dietrich (personal communication, 1964) Lower Cambrian fossils have recently been found in the lower or middle part of the

Erwin Formation. Scolithus is common in the upper part of the formation within the mapped area.

Injection Complex (Precambrian)

Precambrian igneous and metamorphic rocks constituting the Injection Complex are exposed nonconformably beneath the Mount Rogers Group in a small area surrounding Azen Church in Washington County, Virginia (Plate 6).

This area is underlain by adamellite and its alteration facies, altered porphyritic trachyte, ilmenite-bearing andesite, and metasedimentary sericite schist. The areal interrelationships among these rocks have not been mapped.

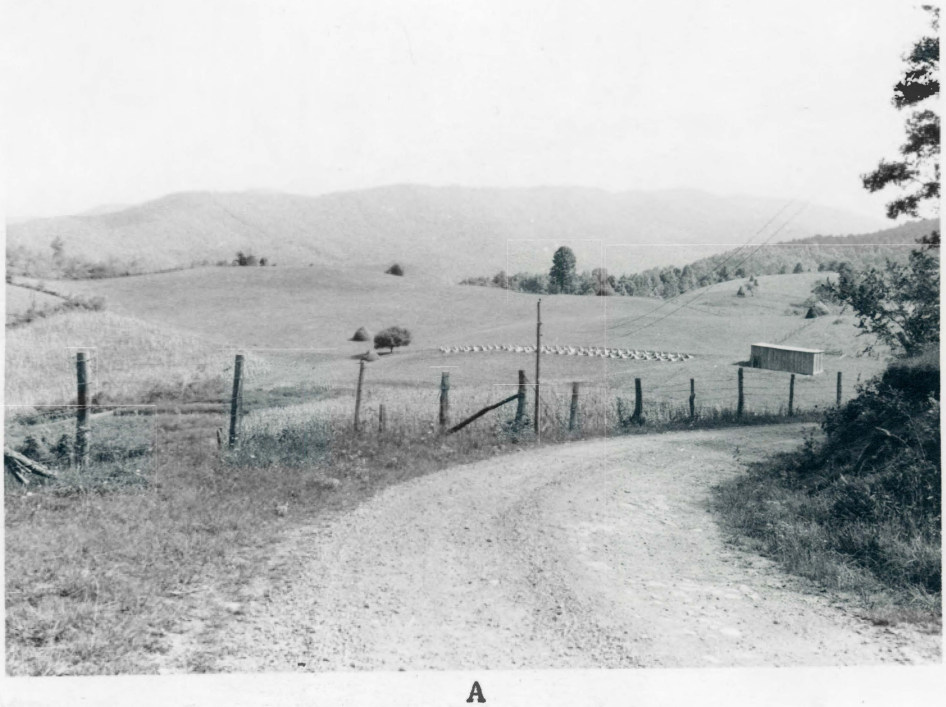
The suite comprised by the adamellite and its alteration facies is similar to the hypersthene granodiorite-to-unakite suite which occurs at various places, e.g., near Vesuvius, Virginia, in the province.

The area underlain by the exposures is about 750 feet from north to south and is in excess of 2700 feet from east to west. The southern border of the exposures is marked by a thrust fault (Iron Mountain fault) which trends northeastward and dips to the southeast, and which cuts across the strike of the strata of the younger Unicoi Group to the southeast. Northwestward movement along the fault plane probably accounts for the vertical to locally

A. Iron Mountains (Grave Mountain) as seen from near Azen Church, Washington County, Virginia. Terrain in foreground is underlain by Precambrian Injection Complex rocks. Low ridge in middle distance is underlain by rocks of the Mount Rogers Group.

B. Isolated outcrops of Precambrian Injection Complex rocks north of Azen Church, Washington County, Virginia. Erosion along the small creek has exposed scattered masses of andesine adamellite.

PLATE 6



A



B

overturned attitudes (Plate 1) of the rocks northwest of the fault in the vicinity of Azen Church.

Sediments of the Mount Rogers Group unconformably overlie the Injection Complex rocks to the west, north, and east; the trace of the mapped contact suggests that the rocks of the Injection Complex formed a topographic "high" during part of Mount Rogers time. A white, kaolinitic, quartz-bearing saprolite which evidently represents a deeply weathered and leached decomposition product of the igneous rocks occurs in the north cut-bank of a dirt road west of Azen Church. The exposure is about 10 feet high so the saprolite is more than 10 feet thick. A few yards to the west in the same cut-bank, a deep brick-red to purplish, shaly, locally rhythmic, tuffaceous sediment of the Mount Rogers Group (Plate 7A) is exposed. These sediments appear possibly to overlie the saprolite.

Saddle Gneiss (Stose and Stose, 1957) of the Injection Complex is exposed along U. S. Highway 21, about 2.5 miles northeast of Elk Creek community, Virginia. This sequence consists of intercalated layers, 6 or 8 feet thick, of white to light gray quartzite, locally garnetiferous and sillimanite-bearing biotite gneiss and schist, and augen gneiss. All lithologies have been veined by granite pegmatite, aplite, and quartz. The veins are locally as much as 3 to 4 feet thick. The general attitude of the

rocks is difficult to ascertain, and probably most of the measurable attitudes are of only local significance. Within the Saddle Gneiss, however, the strike of the layering appears to be about N.45°W., and the dip about 45° to the northeast.

Less than 100 feet of Mount Rogers Group is exposed between the Saddle Gneiss and the Unicoi Group at this exposure. Strike and dip measurements indicate an angular unconformity between the Saddle Gneiss and Mount Rogers. The contact is not exposed. Part of the Saddle Gneiss is probably repeated by faulting, because about 350 feet below the top of the Saddle Gneiss there is a 2-foot layer of red tuffaceous sediment of the Mount Rogers Group. The degree of metamorphism of the tuffaceous sediment is markedly less than that of the adjacent rocks, which suggests that these sediments are not a part of the Injection Complex.

Stratified Rocks

Mount Rogers Group (Precambrian)

Name

Stose and Stose (1944) named the Mount Rogers Volcanic Series for extensive exposures near Mount Rogers in southwestern Virginia. Following the usage suggested by King

and Ferguson (1960, p.31) and the Code of Stratigraphic Nomenclature (Article 8, f), "Mount Rogers Group" is used herein.

Distribution and Thickness

Rocks of the Mount Rogers Group underlie a large part of southern Washington, southern Smyth, and northern Grayson counties, Virginia, and extend into northwestern Ashe County, North Carolina, and northeastern Johnson County, Tennessee. In the area of this study, the Mount Rogers Group is extensively exposed on the Holston Mountain and Iron Mountain fault blocks.

On the Holston Mountain fault block, the volcanic sequence is exposed beneath the Unicoi Group on the southeastern flanks of the Iron Mountains. Rocks of the Mount Rogers Group are probably absent on the northwestern flanks of the Iron Mountains because of faulting.

In the southwestern part of the mapped area, exposures of the volcanic sequence on the Holston Mountain fault block are bounded on the southeast by the trace of the Iron Mountain fault. Farther northeast in the mapped area, the trace of the Iron Mountain fault becomes less distinct apparently because rocks of the Mount Rogers Group occupy adjacent positions on both the hanging wall and footwall. In this part of the area of this study, exposures of the

volcanic sequence extend southward at least as far as the southeastern flanks of Whitetop Mountain and Mount Rogers on the Iron Mountain thrust block. In the northeasternmost exposure in the mapped area, south of Dry Run Gap, Grayson County, Virginia, less than 100 feet of sediments of the Mount Rogers Group are present between the overlying Unicoi Group and the underlying Injection Complex.

On the Iron Mountain thrust block the Mount Rogers Group is exposed beneath the Unicoi Group in the southeastern flanks of Chestnut and Lost mountains, and Big Hill, all of which are located in Washington County, Virginia. The southeastern flanks of these mountains coincide with the southeastern limb of the syncline previously mentioned. Near Azen Church, which is located on the nose of the southwestwardly-plunging syncline, the Mount Rogers Group is exposed on the southeastern side of the Iron Mountain fault. The Injection Complex is exposed to the north of the fault (Plate 1). The area underlain by the volcanic sequence extends southeastward and eastward to constitute the bedrock of Whitetop Mountain, Mount Rogers, Elk Ridge, and other topographic features comprising the "high massif" referred to by King and Ferguson (1960, p.29).

Any discussion of the total thickness of the Mount Rogers Group in the area of this report is largely conjectural. The effects of folding and/or faulting on the

thickness are not known because no detailed stratigraphic work has been done on the volcanic sequence in the region.

If the Iron Mountain fault persists northeastward from Azen Church as is believed, the area of exposure of the Mount Rogers Group consists of an outcrop belt on each of the two structural blocks and the sequence is not so thick as indicated by the area of exposure. The two belts, and the fault, are more distinct southwest of Azen Church (Plate 1) where younger sediments of the Unicoi Group and the Hampton and Erwin formations are present on the south side of the fault and separate the two belts of the volcanic sequence.

The apparent thinning of the Mount Rogers Group to the southwest on the Holston Mountain fault block is the result of discordance between the strikes of the Iron Mountain fault and the sediments of the volcanic sequence.

The total thickness of the Mount Rogers Group has been estimated by Stose and Stose (1944) as "a thousand feet or more". King and Ferguson (1960) think field relations suggest a much greater thickness. In exposures along the Norfolk and Western Railway tracks at and directly north of the junction of Green Cove and Whitetop-Laurel creeks in Washington County, Virginia (Plate 1), about 1300 feet of rhythmites within the Mount Rogers Group were measured by Carrington (1961). The rhythmites comprise

only a part of the total thickness of the volcanic sequence there.

According to Rodgers (1953) and to King and Ferguson (1960), the feather edge of the volcanic sequence occurs on Stack Ridge about a mile north of Laurel Bloomery, Tennessee. Stose and Stose (1957) think the volcanic sequence is also thinned (because of erosion) about a mile southeast of Dry Run Gap, northern Grayson County, Virginia. The thickness of the volcanic sequence as measured by the author at this exposure is about 87 feet. The thickness at this exposure is considered questionable, however, because the lower contact with the Injection Complex is concealed by slope wash and the upper contact with the Unicoi Group is indistinct. The Unicoi Group at this locality contains several red tuffaceous shale beds similar to sediments in the underlying Mount Rogers Group.

About 4 miles west of the vicinity of Dry Run Gap, north of Comers Rock community, Stose and Stose (ibid.) measured about 800 feet of Mount Rogers Group; about 2.5 miles farther west, on Cinnamon Ridge, the volcanic sequence is about 290 feet thick (Stose and Stose, op. cit.).

Lithologic Description

In the western edge of the Gossan Lead District, Stose and Stose (ibid.) distinguish, in ascending order,

the Flat Ridge Formation and rhyolite porphyry as component parts of the Mount Rogers Group.

The Flat Ridge Formation was described as "composed of volcanic agglomerate and conglomerate, arkose, tuffaceous slate, and basalt" (op. cit., p.49). Two members of the formation were distinguished: the Cornett Basalt Member, which consists principally of green amygdaloidal basalt flows, but which locally contains purple and green tuffaceous slates and a basal green quartzite; and the Cinnamon Ridge Member, which consists of dense blue basalt underlain by agglomerate and flow breccia. The Cornett Basalt Member generally occurs at the base of the Flat Ridge Formation, but is locally absent. The Cinnamon Ridge Member occurs above the base, and where the Cornett Basalt Member is absent, may be underlain by as much as 100 feet of tuffaceous sediments. The Flat Ridge Formation, according to Stose and Stose (p. 52, op. cit.), is replaced for the most part by quartzose sediments where the Mount Rogers Group is thin, such as in that part of the area of this report east of Blue Spring Gap (Plate 1 and Stose and Stose, Plate 60). The quartzose sediments consist of green to gray arkose, quartzite, and white conglomerate containing rounded quartz pebbles up to 1 inch across.

It may be noted that upon comparison of the area mapped in this study (Plate 1) with the western edge of

the area mapped by the Stoses (ibid., Plate 60), that the outcrop belt of the lower part of the Unicoi Group coincides with that mapped by the Stoses as quartzose sediments of the Flat Ridge Formation. It is believed that the sediments are more appropriately mapped as Unicoi Group because they may be traced into exposures where stratigraphic sections of the group were measured (Appendix, Geologic Sections E, F, and G), and the sedimentary sequence is overlain by the basalt flows which characteristically overlie the Unicoi Group. Complex faulting (Plate 1) probably accounts in part for the divergence of viewpoints.

The rhyolite porphyry, which contains coarse red feldspar and clear white quartz phenocrysts in a purplish gray matrix, is said by Stose and Stose (ibid., p.53) to underlie large areas west of the Gossan Lead District but is present only in the northwestern part of the district, i.e., that part overlapped by the mapped area of this report.

North of Comers Rock community the rhyolite porphyry is overlain unconformably by the Unicoi Group. In the vicinity of Dry Run Gap to the northeast, the Mount Rogers Group consists of tuffaceous shales and conglomeratic tuffs; the rhyolite porphyry is not present. Southwestward on the Holston Mountain fault block, increasingly thick sequences of volcanic sediments overlie the rhyolite

porphyry. Near Houndshell Gap the rhyolite is overlain by rhythmites; near Trout Dale it is overlain by rhythmites and tuffaceous matrixed conglomerates; northwest of Fairwood community, and north of Konnarock Girls' School the rhyolite is overlain by rhythmites, tuffaceous matrixed conglomerates, and interbedded siltstones and tuffaceous shales. As has been mentioned, about 1300 feet of rhythmites, which constitute a relatively minor part of the volcanic sequence in the southwestern part of the Holston Mountain fault block, were measured along the Norfolk and Western Railway tracks near Creek Junction, Washington County. Although stratigraphic interrelationships are imperfectly known, it is believed that the rhythmites are overlain here in ascending order by boulder conglomerates (Plate 7B) with the tuffaceous matrix, and interbedded siltstones and tuffaceous shales. The sequence of interbedded siltstones and tuffaceous shales are apparently conformable with and gradational upward into the Unicoi Group in the area between Konnarock Girls' School and Fairwood community.

Stose and Stose (ibid., p.56) report the occurrence of granitic boulders which reach a maximum of 10 inches across in tuffaceous conglomerates of the Mount Rogers Group west of Cinnamon Ridge. To the southwest the boulders contained in the tuffaceous conglomerates increase in size. In exposures of the conglomerate about 1.5 miles

A. Rhythmically bedded tuffaceous rocks of the Mount Rogers Group, west of Azen Church, Virginia. The strike is east-west and the dip to the north.

B. Polymictic conglomerate with tuffaceous matrix within the Mount Rogers Group. Exposure is in roadcut on U. S. Highway 58 about two miles west of Konnarock, Washington County, Virginia. Many boulders within the conglomerate resemble rocks of the Injection Complex exposed near Azen Church, Virginia.

PLATE 7



A



B

west of Konnarock, Virginia, granitic boulders up to 3 feet across (King and Ferguson, ibid., Plate 8B, and p. 30; Plate 7B, this report) occur.

There is a similar increase in the size of granitic and metamorphic rock fragments contained in the rhythmites in exposures southwestward from Houndshell Gap. At Houndshell Gap the igneous and metamorphic rock fragments rarely attain a half inch across; north of Konnarock Girls' School, they are as much as 3 inches across; and on the north flank of Big Hill they are as much as 3.5 feet across. Two boulders, each about 3 feet across, occur in rhythmites along the Norfolk and Western Railway tracks north of Creek Junction. No rhythmite exposures have been seen southwest of Creek Junction on the Holston Mountain fault block. Many of the granitic rock fragments in the conglomerates and rhythmites are similar to rocks exposed near Azen Church.

No rocks of the Mount Rogers Group on the Holston Mountain fault block have been examined and identified as being older than the rhyolite porphyry.

The stratigraphy of the Mount Rogers Group in the Iron Mountain fault block is even less well known. Certain similarities in stratigraphy exist between post-rhyolite sediments on the Iron Mountain and Holston Mountain fault block which have unknown stratigraphic relationships, and

may be prerhyolite in age (Flat Ridge Formation?).

Occupying the stratigraphic interval between the rhyolite porphyry and the Unicoi Group in the vicinity of Big Hill are boulder-bearing tuffs and rhythmites. Beneath the Unicoi Group in exposures along Green Cove Creek are boulder-bearing tuffs; the rhyolite porphyry was not found to occur. Farther southwest in the vicinity of McQueen Gap, the Unicoi Group is underlain by tuffaceous shales which in turn overlie boulder-bearing tuffs.

Epidotized pillow lavas (believed to be older than the rhyolite porphyry) are exposed in the Norfolk and Western Railway cut about 1.25 miles west of Green Cove. Underlying the pillow lavas and associated red tuffaceous shales are silvery gray tuffaceous(?) sediments interbedded with greenish gray siltstones and red-brown slates which contain irregularly ovoid, greenish gray spots.

Dark green, locally amygdaloidal, basic flows are exposed at Elk Garden, on the eastern flank of Whitetop Mountain; their relationship to the other units of the Mount Rogers Group is unknown.

The conglomeratic, quartzose sediments on the north flank of Big Hill, thought by King and Ferguson to be part of the Mount Rogers Group, should be more appropriately mapped as the Iron Mountain Formation (Appendix, Geologic Section I). The formation is underlain here by

tuffaceous sediments of the volcanic sequence and overlain by two of the three basalt flows of the medial part of the Unicoi Group which characteristically overlie the Iron Mountain Formation. The formation may be traced southwestward into exposures along the Norfolk and Western Railway tracks in the valley of Green Cove Creek.

No metamorphic and/or igneous rock fragments have been found to occur in the rhythmites exposed on the Iron Mountain fault block.

Origin.-- The rocks of the Mount Rogers Group are principally the result of deposition in a volcanic environment (Jonas and Stose, 1939; Rodgers, 1953; Stose and Stose, 1957; Dietrich, 1961; Carrington, 1961). The rhythmically bedded tuffaceous slates pictured by Stose and Stose (op. cit., Plates 28B and 29A), and pictured and discussed by Carrington (op. cit., Figures 1, 2, and 3) exhibit many features characteristic of water-deposited materials. The boulder conglomerates may be of mudflow origin, or as Jonas and Stose (ibid.) inferred, of nueé ardentes origin. These rocks and the associated igneous extrusives support the suggestion that this was a region of volcanic activity adjacent to a topographically mature area with sporadic, relatively shallow lakes.

The rhythmic deposition and the occurrence of rounded

igneous and metamorphic rocks up to three feet across in predominantly thinly bedded rhythmite sequences (Plate 8A) suggest volcanism possibly similar to that described by Perret at Mount Vesuvius (1924) and Mont Pelee (1937). Perret's concept of "progressive descent of explosion level" (1924, p. 84) may even explain the origin of many of the metamorphic and igneous erratics within the sediments. Furthermore, the progressive decrease in size of the erratics northeast and southwest of the north flank of Big Hill suggests that area as a site of volcanism during deposition of the sediments.

Unicoi Group (Precambrian or Cambrian)

Name

Campbell (1899, p. 3) introduced the name, "Unicoi sandstone" for exposures of a "heavy bed of sandstone or quartzite at the base of Holston Mountain", southeast of Bristol, Tennessee. Keith (1903, p. 4) referred the "Unicoi formation" to a thick series of sandstones and quartzites with interbedded shales, slates, and conglomerates exposed in Iron, Forge, and Stone mountains in North Carolina and Tennessee. He stated that the name was derived from Unicoi County, Tennessee, where the formation is prominently displayed. King and Ferguson

(1960, p. 36) designated exposures on the "Nolichucky River southeast of Unaka Springs" as the type section for the Unicoi Formation.

It is herein proposed that the Unicoi Formation be raised to the rank of group and that the type section remain as suggested by King and Ferguson (ibid.). The Unicoi Group as redefined consists of at least three lithologically distinct rock sequences which are, in ascending order: arkosic sandstone and conglomerate sequence, basalt-bearing sequence, and orthoquartzite sequence.

The arkosic sandstone and conglomerate sequence (=lower member of the Unicoi Formation of Ordway, 1948, and Stose and Stose, 1957) in the mapped area includes the sedimentary rocks above the contact with the subjacent Mount Rogers Group, and below the base of the lowest of the three basalt flows which occur in the middle unit of the Unicoi Group. The basalt sequence (=middle member of the Unicoi Formation of Stose and Stose, ibid.) consists of three basalt flows interlayered with graywacke, conglomerates, sandstones, and shales. The upper sequence of orthoquartzites (=upper member of the Unicoi Formation of Stose and Stose, ibid.) consists of the sedimentary rocks above the top of the uppermost basalt flow, and below the contact with the suprajacent Hampton

Formation. Ordway (ibid.) included all the rocks above the base of the lowest basalt flow and below the contact with the overlying Hampton Formation in his upper member of the Unicoi Formation.

Distribution and Thickness

The contact between the Unicoi Group and the overlying Hampton Formation is generally placed at the top of a sequence of vitreous and arkosic sandstone beds which occur from 2500 to 3000 feet below the top of the Erwin Formation (King and Ferguson, 1960, p. 37). According to Derby (1961, p. 20) this horizon may be traced over a wide area and occurs about 3100 feet below the base of the Shady Dolomite in the Damascus area, Virginia.

The contact between the Unicoi Group and the underlying Mount Rogers Group, as mentioned, is locally gradational. In exposures where conglomerates or sandstones typical of the Unicoi Group (poorly sorted, highly cross-bedded, gray to gray-green where fresh, and tan to buff where weathered) occur above rocks typical of the Mount Rogers Group (maroon shales, argillites, or conglomerates, or rhyolite porphyry), the contact is easily defined.

In places where the contact must be placed rather arbitrarily the sediments of the Unicoi Group overlie sandstones or siltstones of the Mount Rogers Group which

are, in individual beds, well sorted, and cross-bedding is comparatively delicate. The rocks of the volcanic group where fresh are gray to gray-green, but upon weathering attain a tan to buff color with a maroon to purple tint.

The main belt of exposures of the Unicoi Group in the mapped area is located on the southeastern flanks of the parallel ridges comprising the Iron Mountains on the Holston Mountain fault block (Plate 1). A second short belt of outcrop is on the northwestern flank of the Iron Mountains directly southeast of the Holston Mountain fault, and northeast of Konnarock, Washington County, Virginia. A third belt of exposures occurs on the southeastern flanks of Chestnut and Lost mountains, on the Iron Mountain fault block. A fourth belt of exposures constitute part of a fault sliver within the Iron Mountain fault zone at and southwest of Creek Junction, Washington County, Virginia. The latter exposures represent the arkosic sandstone and conglomerate sequence but as far as could be determined neither the top or bottom of the formation occurs within the sliver.

Thus, in the part of the mapped area generally northeast of Konnarock, the Unicoi Group crops out as one belt on the southeast flank of the Iron Mountains whereas in the vicinity of Konnarock and to the southwest, it occurs as four generally parallel outcrop belts.

Only two measured sections have been made by the author of the Unicoi Group in the mapped area. One which is south of Dry Run Gap in northern Grayson County, Virginia, and which was measured by B. N. Cooper, J. A. Redden and the author (Cooper, 1961), is about 2200 feet thick. The other, about 1.5 miles northeast of Konnarock, Virginia, along Smyth County Road 600, was measured by Butts (1940). The thickness obtained by the author for the Unicoi Group at the latter exposures is about 3100 feet.

Other thicknesses for the Unicoi Group were obtained by calculations based on average dip of the strata and width of the outcrop belt where both basal and upper contacts of the group have been examined. At Blue Spring Gap, northern Grayson County, Virginia, the thickness is, on this basis, about 2400 feet. In exposures along Green Cove Creek, Washington County, Virginia, the thickness is about 1700 feet. Farther northeast on the north flank of Big Hill, where faulting has removed all of the upper orthoquartzite sequence and part of the underlying basalt sequence, the thickness is about 1400 feet.

Lithologic Description

General.-- The Unicoi Group may be divided into at least three formations based on the predominant rock type included in each. The basal arkosic sandstone and conglomerate

formation overlies the Mount Rogers Group with a contact which is locally conformable and gradational, and underlies the formation containing basalt flows. This arkosic sandstone and conglomerate formation, to be described in more detail below, consists principally of poorly sorted coarse grained arkosic or feldspathic sandstones which range from pebble-free to conglomeratic. The sandstones are interbedded with conglomerates, siltstones, silty clay and tuffaceous shales, and tuffaceous argillites.

The basalt-bearing formation, which overlies the arkosic sandstone and conglomerate-bearing formation, is composed of three (locally only two on the Iron Mountain fault block) basalt flows which are separated by interbedded graywackes, feldspathic and arkosic sandstones, conglomeratic sandstones and conglomerates, siltstones, clay shales, and tuffaceous shales or argillites. The base of the lowest flow marks the base of the formation and ranges from 500 to 1300 feet above the base of the Unicoi Group. The contact with the overlying orthoquartzite formation is at the top of the upper flow and occurs from 45 to as much as 700 feet below the top of the group. The thickness of this formation also ranges considerably--from about 450 feet to more than 1600 feet; the differences in quantities of interbedded sedimentary material from one locality to another account for the major part of the

range in thickness. In exposures along Green Cove Creek, Washington County, Virginia, where only two flows have been identified the upper flow is separated from the underlying flow by three feet of arkosic sandstone; about two miles northeast of Konnarock in exposures along Smyth County Road 600, where three flows are present and the upper flow is separated from the underlying flow by six feet of arkosic sandstone and micaceous, silty clay shale. In the vicinity of Dry Run Gap the upper basalt is separated from the middle basalt by 1148 feet of interbedded quartzite, conglomerate, siltstone, and graywacke.

The lowest basalt of the formation ranges from about 100 to 300 feet thick, with an average thickness of about 200 feet. It is a dark green, fine grained rock which is locally amygdaloidal, especially in the upper part. Where dense and even-textured, the basalt commonly weathers spheroidally, but where finely laminated (flow banding?) it typically weathers to platy masses. Pillow structures in the lowest basalt are exposed northeast of Konnarock and along an unnumbered road between Taylors Valley and McQueens Gap. The base of the lowest basalt at exposures such as south of Dry Run Gap not uncommonly contains flow structures which are made more distinct by distorted lenticular bodies of sandy material, tuffaceous shale fragments, and other material derived from the sediments

over which the basalt flowed. The lowest basalt north of Trout Dale is highly epidotized and faint textural differences suggest pillow structures. The upper contact is typically distinct, but locally is indistinct so that the basalt appears to grade into the overlying sediments.

The middle basalt is also dark green and fine grained and is locally amygdaloidal. Its thickness ranges from about 30 to 80 feet in the exposures examined. Adjacent to its basal and upper contacts the basalt characteristically weathers to platy masses that may be confused with sedimentary strata.

The upper basalt is dark green, fine grained, and locally amygduloidal in its upper part. Its thickness ranges from 45 to 100 feet in exposures examined. Both the basal and upper contacts are typically distinct.

The sediments interbedded with the basalts resemble those of the underlying arkosic sandstone and conglomerate formation more than those typical of the overlying orthoquartzite formation. They are, for example, more poorly sorted in individual beds, more arkosic, and more heavily cross-bedded than the strata typical of the orthoquartzite formation.

The orthoquartzite formation consists of feldspathic and arkosic sandstones interbedded with siltstones and tuffaceous shales or argillites in the lower part, pebbly

and non-pebbly orthoquartzites in the middle part, and thin-bedded orthoquartzite interbedded with increasing amounts of Hampton-like silty clay shales in the upper part. Medium to coarse grained sandstones which are heavily cross-bedded are common to the transition zone between the lower arkosic sandstones and the overlying orthoquartzites within the formation. Along the cross-bedding planes the rock is commonly maroon to purple, in contrast to the white to light gray color of the major part of the rock. Finely speckled maroon and white, medium grained sandstones occupy a similar stratigraphic position in other exposures. It is believed that the maroon color is the result of tuffaceous material which settled concurrently with the deposition of the sediments, or which was deposited as reworked material.

The contact of the orthoquartzite formation with the underlying basalt formation is commonly distinct, but where the basalt weathers to platy masses, may be relatively indistinct. The upper contact with the overlying Hampton Formation is a gradational zone and is placed rather arbitrarily at the top of a sequence of vitreous quartzite strata which occur about 3100 feet below the base of the Shady Dolomite in the Damascus, Virginia, area. The thickness of the orthoquartzite formation ranges from about 50 feet in exposures south of Dry Run

Gap to more than 600 feet in exposures northeast of Konnarock and along Green Cove Creek.

Iron Mountain Formation.-- The basal part of the Unicoi Group, which includes the sedimentary strata between the contact with the underlying Mount Rogers Group and the base of the lowest basalt flow within the Unicoi Group is herein designated the Iron Mountain Formation (Table 1). Complete exposures of the formation crop out on the southeastern flanks of the component ridges of the Iron Mountains in Smyth and Grayson counties, Virginia. Three such exposures are as follows: along roadcuts of Smyth County Road 600 on the western end of Grave Mountain, about 1.75 miles northeast of Konnarock, Virginia (Appendix, Geologic Section B, and Butts, 1940, p. 30); along an unnumbered Grayson County road crossing the western end of Locust Ridge about a mile west of Fairwood (Appendix, Geologic Section C); and along roadcuts at Houndshell Gap, Grayson County, about 5.5 miles northeast of Trout Dale, Virginia (Appendix, Geologic Section E).

Three gradational sequences, each of which contains conglomerates at or near its base and which grades upward through arkosic sandstones and siltstones to clay shales (or as in the upper gradational sequence, is overlain by basalt) at its top, may be distinguished as members within

TABLE 1

IRON MOUNTAIN FORMATION	Upper Member	250-900	Medium gray to gray-green, medium- to coarse-grained, locally pebbly to conglomeratic arkosic sandstones with interbedded siltstones and conglomerates. Locally the arkosic sandstones are light gray to white and contain little silt- and clay-sized material in the matrix. Red-brown tuffaceous shales* are characteristically interbedded with other rock types within the member. Largest phenoclasts contained at or near the base may be as much as four inches across, but typically range up to one inch across.
	Middle Member	0-550	Medium gray to gray-green, medium- to coarse-grained, locally pebbly to conglomeratic, arkosic sandstones and polymictic conglomerates with some interbedded siltstones. Becomes grossly finer grained upward, where silstones and silty clay shales predominate. Red-brown tuffaceous shales are locally interbedded in upper half of the member. Phenoclasts range up to five inches across.
	Lower Member	0-550	Medium gray to gray-green, coarse-grained locally pebbly to conglomeratic, arkosic sandstones and polymictic conglomerates, which grade to siltstones and silty clay shales at the top. Largest phenoclasts at or near the base are as much as six inches across; three-inch phenoclasts predominate.

*These shales are similar to those common to the Mount Rogers Group.

Schematic geologic section of the Iron Mountain Formation.

the formation. The conglomeratic sandstones and conglomerates in the basal part of the lower member contain well rounded rock particles which commonly range up to four inches across, but which locally are up to eight inches across. Maximum sizes, as well as the number of pebbles or cobbles, diminish upward in the member where the lithology is comprised by sandstones or pebbly sandstones, thence to siltstones, and near the top to silty clay shales. The middle and upper members of the Iron Mountain Formation are similar to the lower member in that they grade from conglomerates or conglomeratic sandstones at or near their bases through sandstones and siltstones to silty clay shales at their tops. The largest fragments within the basal strata of the middle member are typically about three inches across, but locally may be as large as five inches across. The largest fragments within the basal part of the upper member are rarely as large as two inches across. Red tuffaceous shales and/or argillites are sporadically interbedded with the strata of the upper member, and locally with those of the middle member.

The thickness of the Iron Mountain Formation ranges from about 650 to 1320 feet on the Holston Mountain fault block and from about 520 to 900 feet on the Iron Mountain fault block. More than 2500 feet of Iron Mountain Formation are exposed north of Trout Dale, Virginia (Plate 2, D), but

as much as 1300 feet of strata here are repeated by faulting. On the Holston Mountain fault block the formation thins markedly to the northeast (Plate 9), and to a lesser extent to the southwest and north, from a maximum thickness in exposures along Little Laurel Creek (Plate 2, B) about 1.75 miles northeast of Konnarock, Virginia. On the Iron Mountain fault block the formation thins markedly to the southwest from a maximum thickness as exposed on Big Hill (Plate 2, I) about one mile south of Konnarock. The decrease in thickness of the formation chiefly is the reflection of the progressive disappearance of the lower and middle members of the Iron Mountain Formation.

The lower member of the Iron Mountain Formation is exposed only at Little Laurel Creek, Locust Ridge, Trout Dale, and Houndshell Gap; it is absent from exposures of the Iron Mountain Formation southwest and northwest, respectively, from Little Laurel Creek and Houndshell Gap in the main outcrop belt and from exposures on the Iron Mountain fault block (Plates 2, 9). The member is also absent from exposures at Horseshoe Bend, on the northwestern flanks of the Iron Mountains; its absence may be the result of either non-deposition or faulting, or a combination of the two. The thickness of the member ranges errat ically from a maximum of 525 feet at Trout Dale to a feather edge between Blue Spring Gap and Houndshell Gap

to the northeast and between Little Laurel Creek and Beartree Gap to the southwest (Plate 29). The distribution and thicknesses are probably the result of restricted deposition on an unevenly subsiding surface.

As mentioned the member consists chiefly of a sequence which grades irregularly from arkosic conglomerates or conglomeratic, arkosic sandstones at or near its base to silty clay shales at its top. The lowest conglomeratic interval may, as at Houndshell Gap and Locust Ridge, rest directly on rocks of the Mount Rogers Group, or, as at Little Laurel Creek and Trout Dale, overlie sequences of fine- to medium-grained arkosic sandstones which contain sporadic pebbles. The sandstone sequences, which may be as much as 120 feet thick, are suprajacent to rocks of the volcanic group and are apparently gradational into them.

Medium- to coarse-grained feldspathic and/or arkosic sandstones are interbedded with the conglomeratic beds (Plate 8B) and overlie the conglomeratic horizon; similar material forms the matrix of the conglomeratic beds. Well rounded phenoclasts which locally range up to six inches across occur within the lowest conglomeratic beds although one- to three-inch phenoclasts predominate. Each younger conglomeratic bed or sequence of beds contains smaller phenoclasts in its base than similar beds or sequences of

A. Granitic boulder within Mount Rogers Group rhythmites southwest of the intersection of U. S. Highway 58 and Washington County Road 600. The thinly laminated rhythmites display supratenous folding above the boulder.

B. Irregularly interbedded arkosic sandstones and conglomeratic arkosic sandstones. Exposure is located on the southeast flank of Locust Ridge and represents interbedding which is common within the lower member of the Iron Mountain Formation.

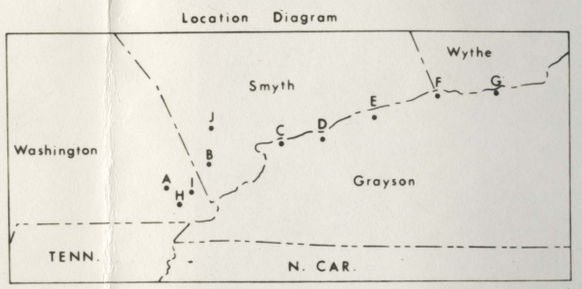
PLATE 8



A



B



PANEL DIAGRAM OF MEMBER RELATIONSHIPS IN THE IRON MOUNTAIN FORMATION

A. Irregularly interbedded arkosic sandstones and pebbly arkosic sandstones. Torrential cross-bedding is evident in beds near the center of the photograph. Exposure is in roadcut along U. S. Highway 16 north of Trout Dale, Virginia, and represents bedding typical of the lower member of the Iron Mountain Formation.

B. Imbrication of phenoclasts within the lower member of the Iron Mountain Formation. Exposure is in roadcut of dirt road which crosses the west end of Locust Ridge, northwestern Grayson County, Virginia.

PLATE 10



A



B

beds below, and most beds or sequences of beds contain larger phenoclasts near their bases than near their tops. Phenoclasts contained in the highest conglomeratic beds rarely are as much as 0.75 inch across.

The rocks are medium to dark gray or gray-green where fresh and tan to buff where weathered. White, tan, gray, and pink phenoclasts give the pebbly and conglomeratic rocks a mottled appearance on freshly broken surfaces. Where fresh the rocks break along conchoidal fractures which are vitreous in appearance; where weathered they are extremely friable and commonly exhibit spheroidal weathering. Many beds where traced laterally thicken and thin irregularly because of cut-and-fill structures along their contacts. Sole markings (current and rill types, Twenhofel, 1932, pp. 668-671) occur on the bottoms of many beds. Torrential cross-bedding (Plate 10A) is common in the rocks; some of the beds are wedge-shaped and thin greatly over short distances. Most of the beds which contain torrential cross-bedding, however, retain a uniform thickness where traced laterally. In the conglomeratic beds, discoid and rod-shaped phenoclasts are markedly imbricated (Plate 10B).

Conglomerate beds are fewer and thinner toward the top of the member. The rather ill-defined conglomeratic horizon, which ranges from about 75 to 200 feet thick,

grades upward into an overlying sequence of sandstones.

The sandstones are medium- to coarse-grained, feldspathic and/or arkosic, and either pebbly or non-pebbly. They are interbedded toward the bottom with thin conglomeratic beds which locally are only one pebble thick (lag gravels?), and toward the top with siltstones and silty shales. The sandstones and siltstones are medium to dark gray or gray-green where fresh, and break along conchoidal fractures. Where fresh the rocks are vitreous. Where weathered the sandstones are tan to buff and the siltstones are tan to brown; both are friable and exhibit speroidal weathering. Bedding ranges up to four feet thick. Torrential cross-bedding is common in the sandstone beds whereas foreset cross-bedding is characteristically present in the siltstones. Thin lamination resulting from alternating laminae of different grain sizes are not uncommon in the siltstones and in many places mark ripple marks and very delicate cross-lamination. Phenoclasts to 0.25 inch across occur sporadically in the siltstone beds.

The upper 10 to 30 feet of the lower member of the Iron Mountain Formation is a shale horizon which only locally is free from silt. Muscovite commonly occurs along bedding planes. The silty clay shales are thinly bedded (0.25 to 1 inch thick) and are tan to light gray where fresh. The clay shales are fissile (less than 0.1

inch thick) and white to light apple-green where fresh. Where weathered the shales are tan to brown with bedding planes and fracture surfaces commonly stained with iron oxide. Fine lamination is evident where clay shale, silty clay shale, and thin beds of siltstone are interbedded. Delicate cross-bedding and ripple marks are relatively common. The top of the shale horizon, which coincides with the top of the lower member, is most commonly overlain by coarse conglomerates of the basal part of the middle member of the Iron Mountain Formation. In some exposures, however, the shale horizon grades, although rather abruptly, into siltstones and/or sandstones of the overlying member.

The lower member of the Iron Mountain Formation rests on different rocks within the Mount Rogers Series. In at least two exposures (Little Laurel Creek and Trout Dale) the rocks of the lower member of the formation are believed to grade into the rocks of the underlying volcanic group.

From southwest to northeast along the main outcrop belt, sporadically pebbly, arkosic sandstones of the lower member overlie fine- to medium-grained sandstones, tuffaceous shales, and thick bedded tuffaceous argillites of the Mount Rogers Group. The sandstones of the lower member are characteristically poorly sorted, medium- to

coarse grained, gray to gray-green where fresh, tan to buff where weathered, and cross bedded. In contrast, the sandstones of the volcanic group are fine- to medium-grained, moderately to well sorted, white to tan or gray where fresh, pinkish tan to pinkish buff where weathered, and contain little, if any cross bedded strata. Stratigraphically below the sandstones, shales, and argillites of the volcanic group are exposures of tuffaceous bouldery argillites, rhythmites, and rhyolite porphyry. At Locust Ridge, coarse conglomerates and coarse-grained sandstones of the lower member overlie fine grained, even textured, white to tan sandstones of the Mount Rogers Group. Stratigraphically below the latter sandstones are exposures of tuffaceous bouldery argillites and rhyolite porphyry. At Trout Dale, medium grained arkosic sandstones of the lower member overlie tuffaceous shales, sandstones, and tuffaceous bouldery argillites of the volcanic group with relationships similar to those at Little Laurel Creek. The position of the rhyolite porphyry, if present, is unknown, but rhythmites are exposed below the shales, argillites and sandstones. At Houndshell Gap, conglomeratic sandstones of the lower member rest on tuffaceous shales and tuffaceous bouldery argillites. Rhythmites are exposed stratigraphically below, but no rhyolite porphyry was seen.

The middle member of the Iron Mountain Formation, which appears to be more widely distributed than the lower member, is present in all exposures on both fault blocks, with the exception of the Green Cove Creek section on the Iron Mountain fault block (Plates 2, 9). At Green Cove Creek both the lower and middle members are absent. Where it is underlain by the lower member the thickness of the middle member ranges rather consistently between 375 and 450 feet on both fault blocks (Plate 30); where the middle member rests directly on rocks of the Mount Rogers Group, such as at Blue Spring Gap and Dry Run Gap, the thickness ranges from about 40 to 125 feet. Exceptions occur, however, at Houndshell Gap, where the thickness of the middle member is only about 225 feet (although a somewhat greater thickness of the lower member is present below) and at Beartree Gap, where the thickness is about 400 feet (although the middle member rests on rocks of the volcanic group). Thus the thickness of the middle member generally decreases to the northeast of Trout Dale on the Holston Mountain fault block, and to the southwest of Big Hill on the Iron Mountain fault block.

The member consists chiefly of a sequence which grades irregularly from conglomeratic arkosic sandstones at or near its base to silty clay shales, and locally, tuffaceous shales, near its top. The conglomeratic

horizon, the lowest bed of which may rest directly on the shale horizon of the lower member or which may overlie a sequence of sandstones and interbedded siltstones which in turn rest on the shale horizon, is not well defined. Pebble beds and granule conglomerate beds persist sporadically throughout the stratigraphic range of the middle member. Siltstones also are interbedded with other rock types at several horizons within the member, although they are typically, nearly confined to the upper part.

Gradational conglomeratic sequences similar to those which occur within the lower member are characteristic of the middle member. The lowest conglomeratic sequence within the member locally contains well rounded phenoclasts up to five inches across, but one- to three-inch phenoclasts predominate. In general, the largest phenoclasts within the conglomerates in the middle member on the Holston Mountain fault block occur at Little Laurel Creek (four inches) and their sizes diminish irregularly to the northeast (Dry Run Gap, one-half inch) and southwest (Beartree Gap, three inches). A possible exception occurs at exposures about two miles southwest of Taylors Valley, in northern Johnson County, Tennessee (Plate 1), where coarse conglomerates which contain well rounded phenoclasts up to eight inches across directly overlie tuffaceous shales of the Mount Rogers Group. The members

of the Iron Mountain Formation were not differentiated southwest of Taylors Valley because of the lack of good exposures. The conglomerates there are tentatively placed in the middle member because of the disappearance of the lower member southwest of Little Laurel Creek. The conglomerates may, however, belong to either the lower or middle member.

North of Little Laurel Creek at exposures at Horseshoe Bend, the lowest conglomeratic sequence contains phenoclasts to as much as 3.5 inches across (Plate 10B). In exposures at Big Hill, on the Iron Mountain fault block and south of Little Laurel Creek, phenoclasts as large as five inches across are common in the lowest conglomerate sequence. Thus the largest phenoclasts (3.5 to five inches) appear to occur along a generally north-south line which passes through exposures at Horseshoe Bend, Little Laurel Creek, and Big Hill. The size of the phenoclasts diminish from south to north along the line, and excepting the exposures southwest of Taylors Valley, to the southwest and northeast from the line. Imbrication of the phenoclasts is common (Plates 11, 12A).

As in the lower member, fine- to coarse-grained feldspathic and/or arkosic sandstones are interbedded with and form the matrix of the conglomerate beds (Plates 11B, 12A); more siltstones are interbedded with the coarse-

grained rocks throughout the middle member than in the lower member. At Big Hill (Plate 2), two, two-feet-thick red-brown tuffaceous shale beds occur about 225 feet above the base of the section and about 50 feet below the base of the shale horizon.

The shale horizon, the top of which coincides with the top of the middle member, ranges from about 25 to 120 feet thick. In general the horizon is well defined and consists of a sequence of irregularly interbedded silty clay shales and clay shales (Plate 12B, 13A) which generally grade into the underlying siltstones and arkosic sandstones, but which may overlie older rocks with a sharp contact (Plate 12B). At two localities (Beartree Gap and Dry Run Gap, Plate 2) medium- to coarse-grained arkosic sandstones, siltstones, and red-brown tuffaceous shales are interbedded with the shales. At these localities the stratigraphic limits of the horizon are indistinct and shale beds locally occur throughout a stratigraphic thickness of up to 275 feet. In such places the top of the shale horizon is placed rather arbitrarily at the top of the highest shale bed which is separated from younger shale beds by significant thicknesses (50 feet or more) of sandstone, siltstone, and/or conglomeratic beds. This is considered to reflect the termination of a "cycle" of deposition.

The physical characteristics of the clay shale, siltstone, sandstone, and conglomeratic beds are similar to those which occur in the lower member. The tuffaceous shales are similar to those which characterize a large part of the Mount Rogers Group. They are red-brown, composed of clay to silt sized material where shaly, and clay sized material where argillitic and brittle. Where interlaminated with non-tuffaceous clays and/or siltstones, delicate ripple marks, cross-bedding, and graded bedding are relatively common. Individual tuffaceous shale or argillite beds range from a fraction of an inch to as much as ten feet thick; beds from three to twelve inches thick predominate. Tuffaceous beds are locally interbedded with lithologic types which range from coarse-grained pebbly arkosic sandstones, as at Horseshoe Bend, to clay shales, as at Beartree Gap and Dry Run Gap.

The middle member of the Iron Mountain Formation overlies rocks of the Mount Rogers Group on the northeastern and southwestern extremities of the main outcrop belt and at Big Hill on the northeastern extremity of the southeastern outcrop belt (Plates 2, 9, and 13B). The base of the member is not exposed at Horseshoe Bend on the northwestern outcrop belt. At Dry Run Gap, the northeasternmost exposures of the member in the main outcrop belt, the middle member overlies about 50 feet of Mount

A. Well-rounded phenoclasts within arkosic sandstone matrix. Rock is within the middle member of the Iron Mountain Formation in exposures along Smyth County Road 600 near Horseshoe Bend.

B. Imbrication of phenoclasts within exposure of irregularly interbedded conglomeratic arkosic sandstones and arkosic sandstones. Exposures in roadcuts along U. S. Highway 58 on the north flank of Big Hill, Smyth County, Virginia. Rocks are within the middle member of the Iron Mountain Formation.

PLATE 11



A



B

A. Imbrication of quartz and quartzite phenoclasts within the middle member of the Iron Mountain Formation at Horseshoe Bend, Smyth County, Virginia.

B. Spheroidal weathering of arkosic sandstone subjacent to shale horizon within upper part of the middle member of the Iron Mountain Formation. Exposures are in roadcuts along U. S. Highway 58 about 3.5 miles west of Konnarock, Virginia.

PLATE 12



A



B

A. Shale horizon at the top of the middle member of the Iron Mountain Formation. Exposure in roadcuts along Smyth County Road 600 just south of Horseshoe Bend.

B. Contact between rocks of the Unicoi (right of hammer point) and Mount Rogers (left of hammer point) groups on north flank of Big Hill, Smyth County, Virginia. The Unicoi Group here is represented by rocks within the middle member of the Iron Mountain Formation. Note the displacement of the contact by faults about a foot above the hammer head and at the butt of the handle.

PLATE 13



A



B

Rogers Group rocks which in turn overlie rocks of the Injection Complex. The volcanic group rocks are composed of pebbly tuffaceous argillites and tuffaceous shales. About five miles to the west, at Blue Spring Gap, the member is separated from the underlying rhyolite porphyry of the volcanic group by a six-inch saprolite zone suprajacent to about three feet of tuffaceous polymictic conglomerate. At Beartree Gap, on the southwestern end of the main outcrop belt, the middle member rests on a sequence of interbedded fine-grained sandstones and tuffaceous shales which, in turn, overlie an unknown thickness of conglomerates with tuffaceous matrices and a more than 1300-feet-thick sequence of rhythmites.

On the north flank of Big Hill the member overlies a sequence of interbedded rhythmites, tuffaceous shales, and siltstones which, in turn, overlie an undetermined thickness of conglomerates with tuffaceous matrices of the volcanic group.

The upper member is more widely distributed than either the lower or the middle member and is underlain by the middle member in all exposures within the mapped area except at Green Cove Creek, where it directly overlies rocks of the Mount Rogers Group (Plate 9). The thickness ranges from about 250 to 900 feet (Plates 2, 31). The minimum thickness is exposed at Trout Dale from whence

it increases along the main outcrop belt to the northeast at Blue Spring Gap, beyond which it decreases toward Dry Run Gap. The thickness also increases to exposures at Little Laurel Creek, beyond which it decreases along the main outcrop belt toward Beartree Gap. On the Iron Mountain fault block the thickness increases southwestward from Big Hill to Green Cove Creek. Along a generally north-south line through Horseshoe Bend, Little Laurel Creek, and Big Hill the thickness decreases to the north and south of Little Laurel Creek.

The member consists predominantly of a sequence which grades irregularly from arkosic conglomeratic beds at or near its base to arkosic sandstones or siltstones at or near its top. Conglomeratic and/or pebbly sandstone beds (Plate 14A) are not confined to a definite horizon but occur sporadically throughout the stratigraphic range of the member. The lowest conglomeratic and/or pebbly bed may rest on the shale horizon of the middle member (or, as at Green Cove Creek directly on the Mount Rogers Group) or it may overlie a sequence of interbedded siltstones and pebbly and non-pebbly sandstones. Siltstones and tuffaceous shales are locally interbedded with other rock types at several horizons within the member.

Gradational conglomeratic and/or pebbly sandstone sequences similar to those which occur in the other members

are common within, but not typical of, the member. The largest phenoclasts within the lower beds of the upper member generally range up to one inch across and are well rounded. Those within the lowest beds of the member in exposures at Green Cove Creek (Plate 14B), however, range up to four inches across.

Fine- to coarse-grained arkosic sandstones, irregularly interbedded with conglomeratic beds, siltstones, and tuffaceous shales, characterize the upper member. Cross-bedding (Plate 15A) and spheroidal weathering (Plate 15B) are common in the sandstones. The physical characteristics of the sandstones generally resemble those of the sandstones within the lower and middle members. At Dry Run Gap, Blue Spring Gap, Little Laurel Creek, Beartree Gap, and Green Cove Creek, however, some sandstones and conglomeratic sandstones within the upper member are white to light gray where fresh or weathered and commonly constitute beds up to 20 feet thick.

The tuffaceous shale and/or argillite beds are numerous and occur throughout the stratigraphic range of the upper member on the southwestern end of the main outcrop belt (Plate 2, 16, and 17A). In more centrally located exposures in the outcrop belt (Trout Dale and Houndshell Gap) they are less numerous and are restricted to the upper 100 to 150 feet of the member. On the northeastern

A. Irregularly interbedded arkosic sandstones and conglomeratic arkosic sandstones in exposures along U. S. Highway 58 on north flank of Big Hill, Smyth County, Virginia. Rocks belong to the middle member of the Iron Mountain Formation.

B. Contact between rocks of the Unicoi (center and left) and Mount Rogers (right) groups in exposures along Green Cove Creek, Washington County, Virginia. Basal conglomerates of the upper member of the Iron Mountain Formation are overturned to the northwest and dipping to the southeast. The contact is between the dark saprolite at right and the base of the conglomerate bed at left.

PLATE 14



A



B

A. Bedding characteristics of the arkosic sandstones within the upper member of the Iron Mountain Formation in exposures along U. S. Highway 58 about 2.5 miles west of Konnarock, Virginia. Note lensing-out of beds and torrential cross-bedding.

B. Spheroidal weathering of arkosic sandstones within upper member of the Iron Mountain Formation along U. S. Highway 58 about 2.5 miles west of Konnarock, Virginia.

PLATE 15



A



B

A. Exposure of a three-feet thick zone of interbedded tuffaceous shale, clay shale, and siltstone. The zone is overlain and underlain by arkosic sandstones. Within the zone are three, three-inches thick beds of tuffaceous shale. Upper member of Iron Mountain Formation, Horseshoe Bend.

B. Three tuffaceous shale beds (dark beds near end of hammer handle in ditch) interbedded with arkosic sandstones within upper member of Iron Mountain Formation, Horseshoe Bend.

PLATE 16



A



B

end of the belt they are still fewer in number, but locally occur at several horizons within the member. In exposures in the northwestern and southeastern outcrop belts the tuffaceous shales are numerous and occur sporadically from the top to within fifty feet of the base of the member. The physical characteristics are similar to those of the tuffaceous shales and/or argillites which occur in the middle member.

The contact between the upper member of the Iron Mountain Formation and the lowest basalt flow of the overlying basalt formation is generally distinct. The highest strata of the upper member typically consist of interbedded siltstones and arkosic sandstones in beds which are typically less than one foot thick. Where fresh the overlying basalt is massive and dark green; where weathered to thin plates it can be distinguished from weathered siltstones, which it resembles, by the absence of quartz grains. Where the rocks on both sides of the contact are covered by soil the sediments of the upper member weather to a pebbly yellowish red-brown sandy soil, whereas the basalt weathers to a deep brownish red clay soil. At one locality, Dry Run Gap, the lower part of the lowest basalt weathers to slabby rubble and contains irregular lenses and masses of clastic material which was apparently derived from the sedimentary rocks (or sediments) over which the basalt

flowed.

Petrography

Sandstones.-- Petrographic studies of the sandstones which constitute a major part of the Iron Mountain Formation and the matrix of the conglomerate beds within the formation indicate that they are compositionally similar throughout the mapped area with the exception of the white to gray sandstones within the upper member at Dry Run Gap, Blue Spring Gap, Little Laurel Creek, Beartree Gap, and Green Cove Creek.

The sandstones of the Iron Mountain Formation are typically feldspathic to arkosic, poorly sorted, and range from pebble-free to conglomerates (Plate 8B) in which the sand grains comprise less than 40 per cent of the rock. Mineralogically the sandstones are composed of from 40 to 65 per cent quartz, 10 to 40 per cent microcline, as much as 25 per cent plagioclase, 5 to 25 per cent "cementing material", and trace amounts of biotite, ilmenite, tourmaline, hypersthene, zircon, garnet, and silicified rock fragments which resemble chert.

Quartz is present as angular (in the fine-grained sand and silt sizes between larger grains) to well-rounded (in the medium- to coarse-grained sand sizes), clear white to milky bluish white grains which commonly exhibit Boehm

lamellae so orientated as to suggest post-diagenetic strain resulting from pressures at grain contacts. Irregular masses and streaks of very fine-grained black opaque material are common within grains. Identifiable inclusions include rounded to well rounded green to black tourmaline, euhedral to rounded light green to light gray apatite, flakes of tan to black biotite, rounded blebs of light gray microcline, angular to rounded brown sphene, sub- to well-rounded black ilmenite (with and without rims of leucoxene), and rounded deep red rutile. Some quartz grains are rutilated. One distinctive type of quartz which occurs in nearly all samples examined contains sub- to well-rounded grains of clear white zircon. Of particular note are occurrences of vermiform growths of epidote and/or chlorite within some quartz grains (Plate 17B) near fractures, microfaults, or other possible zones of solution percolation.

Microcline is present as angular to well-rounded grains of two types. One type is non-perthitic and unaltered whereas the other is perthitic and very slightly to almost completely altered to sericite, chlorite, and/or epidote. The alteration is most evident in the relatively large rounded grains. Both types exhibit "grid" twinning. The perthites (Plate 18A) are of the "string" and "patch" types, the former the more common. The lamellae or "strings"

of plagioclase within the host microcline are typically altered to epidote and/or chlorite and some are stained with iron oxide. Some grains are twinned according to the Carlsbad Law. Common inclusions are zircon, quartz, and ilmenite (with and without rims of leucoxene).

Plagioclase (An_{3-12}) is commonly fractured and/or bent and ranges from fresh to almost completely altered to sericite and/or epidote. Where epidotization is advanced the grains may have a higher calcium content than An_{12}. The presence of relict albite twinning identifies such grains as altered plagioclase. Albite twinning in fresh grains is irregular in both width and continuity of lamellae.

The matrix of the sandstones (Plate 18), which was apparently formed in part as a result of decomposition or alteration of larger sand grains, is composed of granulated fragments of the listed minerals plus magnetite and/or ilmenite, clay material, sericite, epidote, and chlorite. Iron oxide staining is common. The clay material is probably of detrital origin. The sericite is probably an alteration product of feldspars and clay material. Locally, muscovite in bent laths is present. Some of the epidote is apparently an alteration product of plagioclase feldspar; some of it, as mentioned, may have been introduced.

The white to light gray sandstones which occur within the upper member of the Iron Mountain Formation at the localities mentioned are mineralogically similar to the sandstones described except for the composition of the cementing material and the more advanced stage of alteration of the feldspars. The differences in the color of these sandstones apparently reflect a difference in sorting because they contain little or no clay material or sericite, and chlorite and/or epidote, where present, is restricted to extremely thin zones bordering the grains. Instead, the cementing material is secondary quartz and locally feldspar (Plate 19). The quartz generally exhibits undulatory extinction and is commonly oriented with the long dimension of its crystallites perpendicular to grain borders (Plate 19A). In many of the rocks, grains of quartz or feldspar do not have distinct boundaries but appear to grade into adjacent cementing material through a zone of secondary crystallites. This "gradation" exists because the crystallites are very small nearest the identifiable portions of the original grains but larger away from the grains. Veins of quartz intersect all types of detrital grains. In one thinsection, authigenic feldspar was seen to be projecting from the bounding feldspar into a quartz vein (Plate 19B).

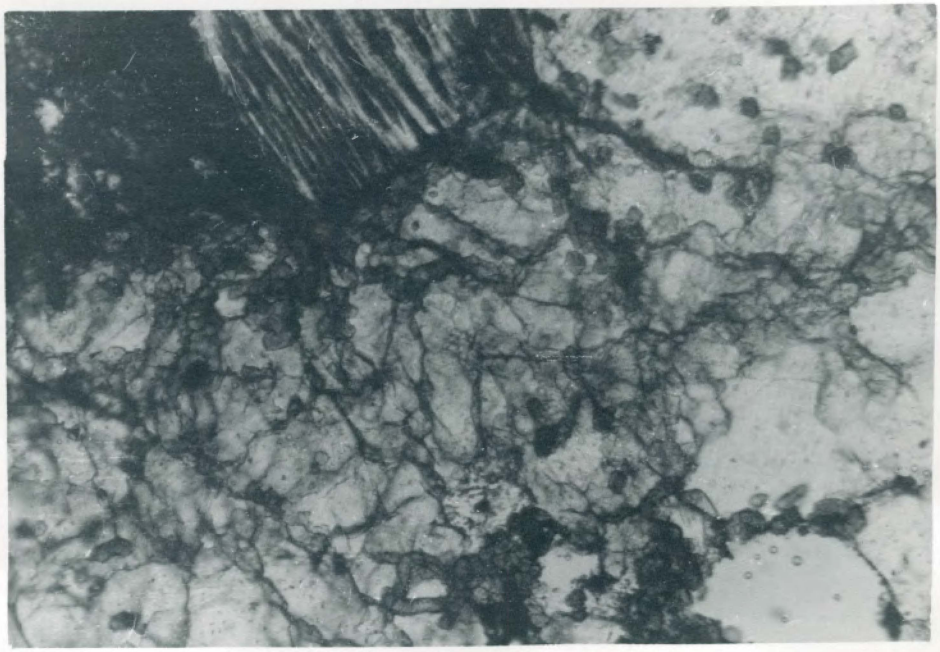
A. Thick-bedded, locally pebbly arkosic sandstones within the upper member of the Iron Mountain Formation. Two thin tuffaceous shale beds occur to the right of center. Exposure along Smyth County Road 600 on southeast flank of Grave Mountain.

B. Vermiform epidote (lower center and left center) replacing quartz in arkosic sandstone within the lower member of the Iron Mountain Formation. Such epidotization is especially common near micro-shear areas with the rocks. Sample obtained from exposures along dirt road crossing the west end of Locust Ridge, northwestern Grayson County, Virginia.

PLATE 17



A



B

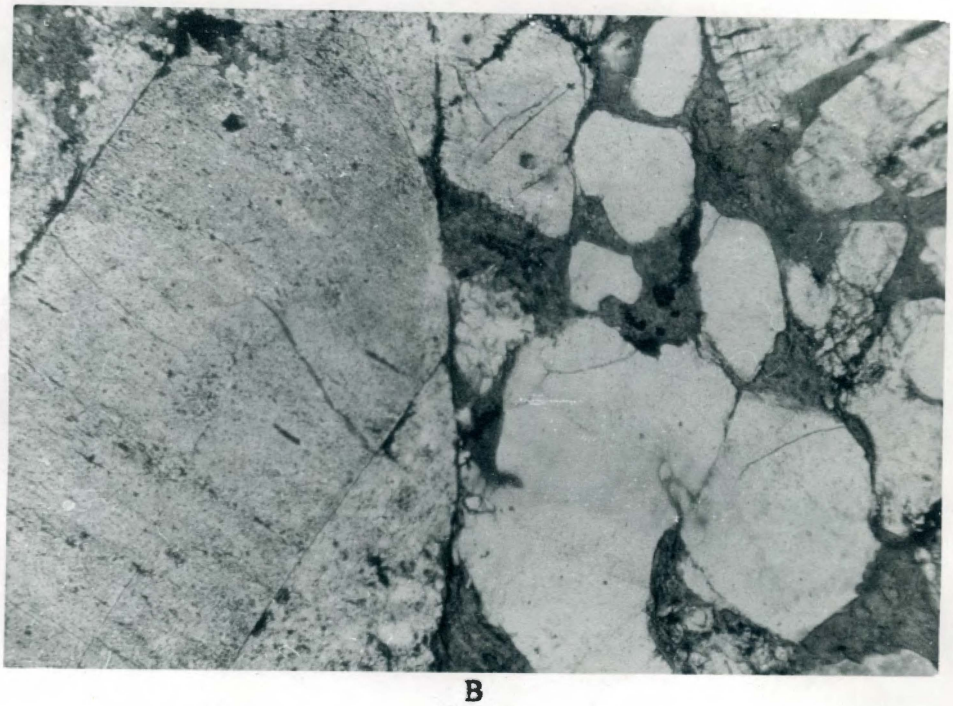
A. Patch perthite (right) and rod perthite (left) in a matrix of granulated quartz and feldspar, clay material, and secondary sericite. Epidote (dark blebs in upper right) appears to have replaced quartz grains. Sample obtained from exposures of rocks within the upper member of the Iron Mountain Formation along U. S. Highway 21 south of Dry Run Gap, northern Grayson County, Virginia. Crossed nicols, 50X.

B. Quartz and feldspar grains in a matrix of chloritic clay material. Part of a large, rounded phenoclast of porphyritic rhyolite which contains a euhedral phenocryst of feldspar occurs on the left. Plane light, 50X.

PLATE 18



A



B

A. White, arkosic sandstone with authigenic matrix of quartz and feldspar apparently derived from larger grains of quartz and feldspar. Authigenic matrix material is penetrating light quartz grain left of center, and has apparently replaced right edge of dark grain of quartz right of center. Sample obtained from exposure of rocks within the upper member of the Iron Mountain Formation along U. S. Highway 21 south of Dry Run Gap, northern Grayson County, Virginia.

B. Quartz vein transecting a feldspar grain within white arkosic sandstone of the upper member of the Iron Mountain Formation south of Dry Run Gap, northern Grayson County, Virginia. Note authigenic feldspar protruding (center) from "wall" of feldspar grain into the vein. Crossed nicols, 57X.

PLATE 19



A



B

Phenoclasts.-- The compositions represented by the phenoclasts within the sandstone and conglomerate beds within the Iron Mountain Formation are predominantly quartzite and quartz. In sizes larger than 2.5 inches, quartzite predominates over quartz and other compositions rarely occur; in the size range from 1 to 2.5 inches, phenoclasts of quartzite and quartz are present in about equal numbers and comprise about 70 to 96 per cent of the phenoclasts present. Other types which constitute up to 30 per cent of the phenoclasts in this size range are: rhyolite porphyry and tuffaceous argillite similar to those of the Mount Rogers Group, granite, gneiss, quartz-tourmaline aggregates, granule breccia, siltstone, microcline, jasper, and phenoclasts which megascopically resemble chert but are actually igneous, sedimentary, and metamorphic rocks which have been silicified, tourmalinized, chloritized, epidotized, or otherwise altered.

Samples, each consisting of 100 phenoclasts within the size range from 1 to 2.5 inches, were collected from the stratigraphically lowest conglomeratic beds within the Iron Mountain Formation at seven localities: Little Laurel Creek (lower member), Locust Ridge (lower member), Houndshell Gap (lower member), Dry Run Gap (middle member), Horseshoe Bend (middle member), Green Cove Creek (upper member), and at exposures about 2.5 miles southwest of

Taylors Valley (middle? member). These samples, although by no means representative of all the phenoclasts contained in the Iron Mountain Formation, represent the earliest deposition at these localities of phenoclasts of a particular size range and, therefore, reflect to some degree the relative availability of materials in the source area.

The samples indicate that the lithologies which megascopically resemble chert are the most common phenoclasts other than quartzite and quartz. Although they are rare to absent in the samples collected at Locust Ridge, Houndshell Gap, and Horseshoe Bend, they constitute from seven to nine per cent of the phenoclasts from the sampled exposures at the four other localities. The next most common type is rhyolite porphyry which is absent from the sample collected at Houndshell Gap, present in small amounts (1 - 2 per cent) at the other localities except Dry Run Gap where about seven per cent of the phenoclasts samples are of this type. Phenoclasts of granitic and jasperoid compositions are present at all exposures sampled except Locust Ridge and southwest of Taylors Valley, each comprises from one to four per cent of the samples. Other phenoclast types are more or less randomly distributed and constitute no more than one per cent of any sample, except for siltstone phenoclasts which constitute about five per cent of the phenoclasts collected at Dry Run Gap.

The following descriptions of phenoclast types are based on laboratory and field data pertaining to phenoclasts of all sizes.

Quartz is white to tan and breaks easily because of an irregular, splintery fracture. It is typically coarse-grained with interlocking boundaries between grains. Optically discrete units have undulatory extinction.

There are several varieties of quartzite, most of which can be distinguished on the basis of color and degree of grain shape. The quartzites break with smooth, conchoidal fractures and are vitreous. They are very tough in comparison to quartz and would withstand more transport. The most common types of quartzites, an apparently related series of orthoquartzites which range from white to very dark gray, are fine- to medium-grained, and well-sorted. They are composed of well-rounded quartz grains; rare, well-rounded rutile; sub-rounded garnet; blebs of chlorite; and diverse amounts of magnetite and/or ilmenite. The black opaque minerals range from dust-size material to medium sand-size and are angular to well-rounded. The amount of opaque minerals and the grain size determine the colors of the individual phenoclasts. A second type of quartzite phenoclast is vitreous medium-grained pinkish white dense metaquartzite which is distinguished from quartz chiefly by the presence of rounded detrital abrasion-

resistant minerals such as zircon. A third quartzite phenoclast type is red fine-grained quartzose iron-stained metaquartzite with sand-size grains of magnetite and/or ilmentite. This last type resembles jasper.

The megascopically chert-like phenoclasts, although they may resemble chert in color, hardness, fracture, texture, and/or characteristics of abrasion, are actually highly silicified, epidotized, chloritized, and/or tourmalinized sediments, metasediments, or volcanic rocks. These phenoclasts range in color from white to brown or black. Color mottling and color or textural banding (Plate 20) are common, but not typical. The white, tan, and brown varieties are most commonly silicified magnetite-bearing siltstone (Plate 21) in which original minerals and texture exhibit replacement by irregular aggregates of quartz and/or chalcedony crystallites. Sporadic sericite flakes are common, although not quantitatively important, throughout the light colored phenoclast varieties (Plate 22B). The dark brown varieties of chert-like phenoclasts are most typically quartzites in which chlorite, rather than sericite, is present. The gray and black varieties of chert-like phenoclasts are chiefly quartzites in which the quartz grains are replaced by vermiform chlorite and/or epidote (Plate 22A), or tourmaline (Plate 23). Some dark varieties are aphanitic igneous rocks in

which chlorite replaced the original minerals and partially obliterated the original texture (Plate 24A).

The phenoclasts of porphyritic rhyolite (Plate 24B) are purple to purplish brown and in thin section exhibit phenocrysts of potassium feldspar and irregular aggregates of quartz and/or feldspar contained in an aphanitic matrix. Argillite phenoclasts are red-brown, typically weathered, and constituted by clay-size material. Both the rhyolite and argillite phenoclasts resemble rocks contained in the Mount Rogers Group.

Siltstone phenoclasts at Dry Run Gap range through various hues of tan and gray. They are well-sorted and commonly exhibit textural and color banding. Incipient to moderate silicification is evident in thin sections.

The granitic igneous phenoclasts are coarse-grained microcline-andesine adamellite, and are similar to rocks exposed near Azen Church, Washington County, Virginia.

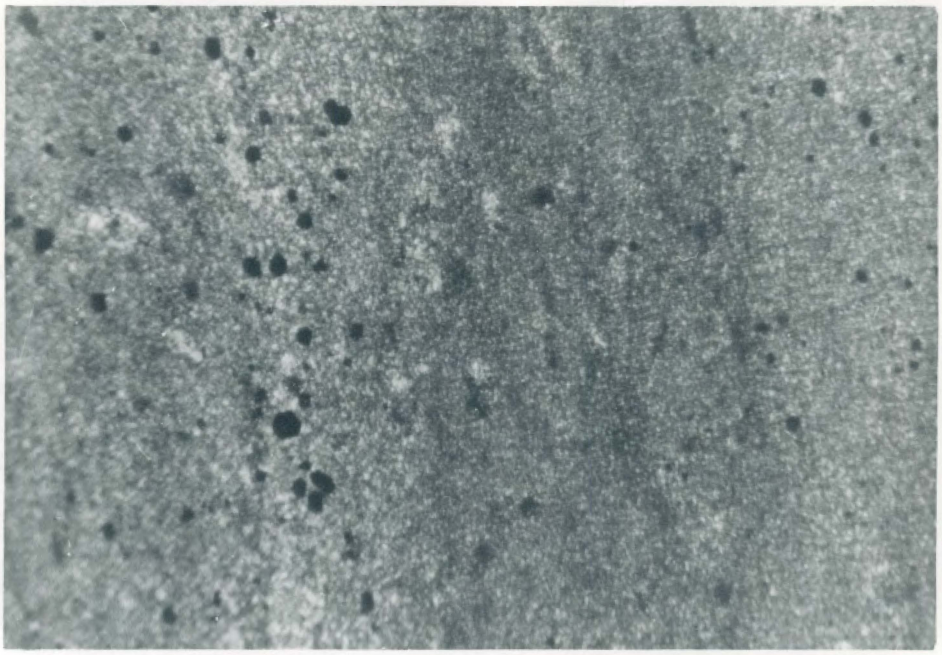
Microcline phenoclasts are fresh and perthitic (string or rod), and though coarser grained than any now exposed there, resemble the string perthites within the rocks at the Azen Church locality. Phenoclasts of this type were found to occur in samples collected at Green Cove Creek and Little Laurel Creek.

One phenoclast of quartz-schorlite aggregate (Plate 25B), which was contained in the sample collected at

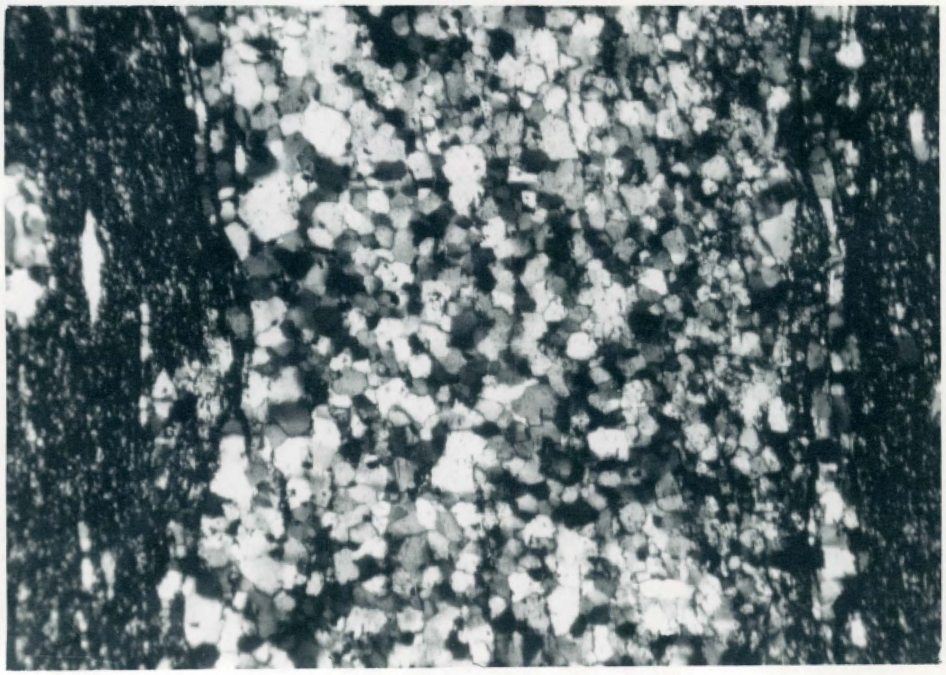
A. Photomicrograph of phenoclast megascopically identified as chert. Textural banding results from different grain sizes, garnets (or iron oxide pseudomorphs) in the coarser grained bands, and chlorite in the finer grained bands. Crossed nicols, 50X.

B. Photomicrograph of phenoclast megascopically identified as chert. Distinct banding results from alternating laminae of quartzite and finer grained opaque black material. Graded texture, ripple marks, and other possibly sedimentary features occur. Crossed nicols, 50X.

PLATE 20



A



B

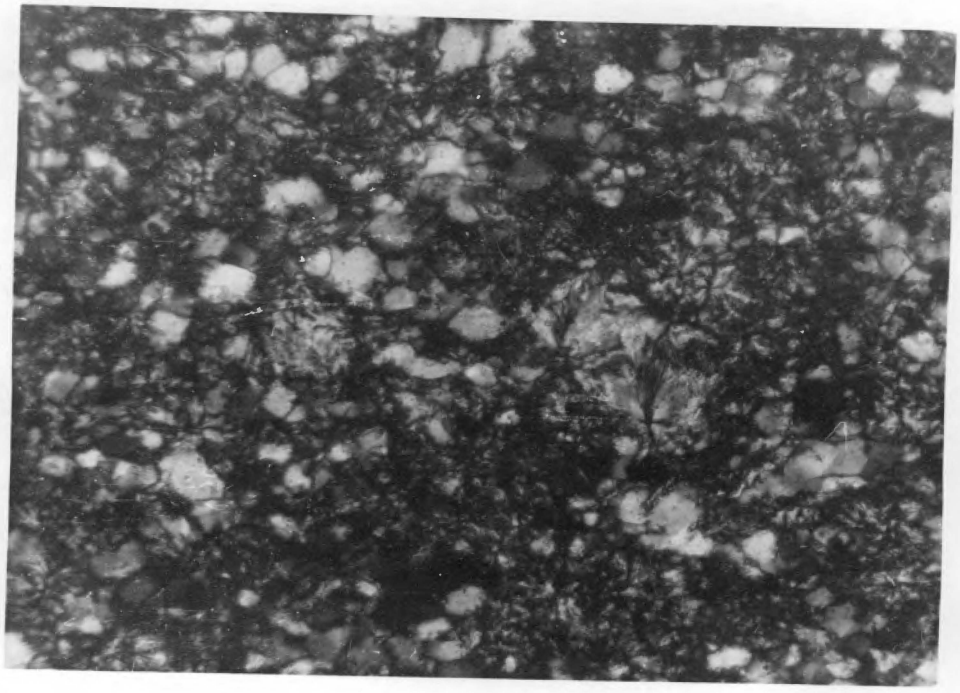
A. Photomicrograph of phenoclast megascopically identified as chert. Spherulitic chalcedony and irregularly oriented quartz microlites appear to be replacing and obliterating a fine-grained clastic texture of a quartzose metasediment. Crossed nicols, 50X.

B. Photomicrograph of phenoclast megascopically identified as chert. Spherulitic aggregates and random flakes of chlorite obliterate the clastic texture of the quartzose sediment. Crossed nicols, 55X.

PLATE 21



A

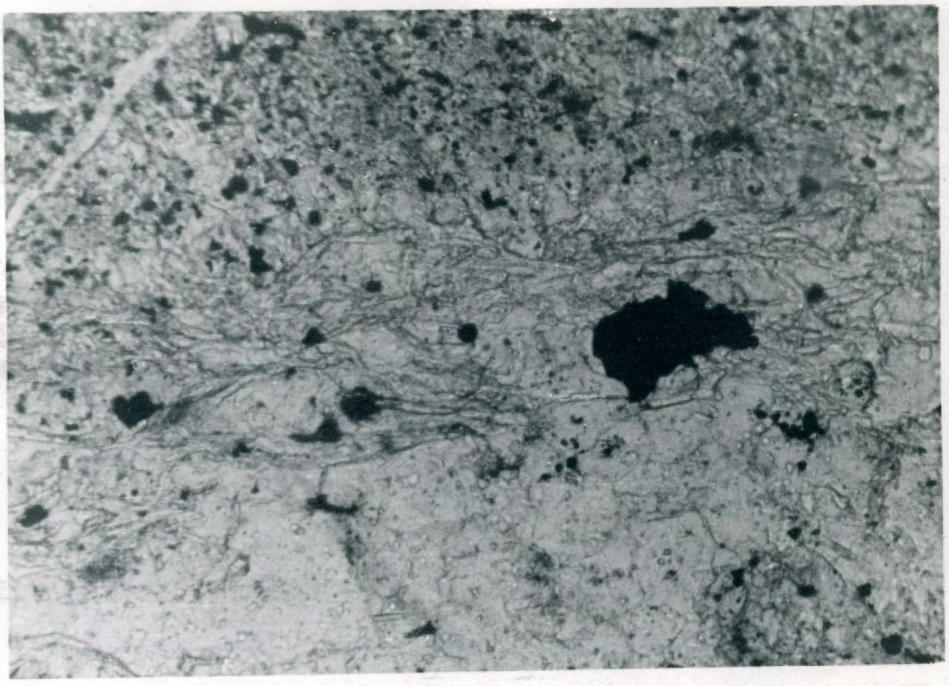


B

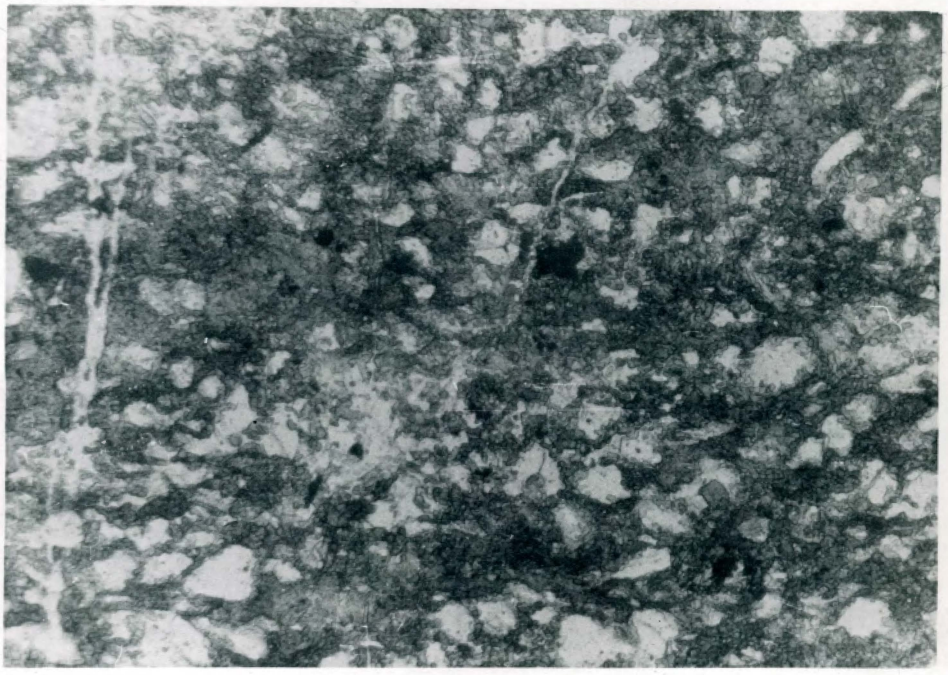
A. Photomicrograph of phenoclast megascopically identified as chert. Irregularly oriented sericite flackes and bands are present throughout the fabric of the quartzose metasediment. Dark grains are magnetite and/or ilmenite. Plane light, 55X.

B. Photomicrograph of phenoclast megascopically identified as chert. The clastic texture of a metaquartzite is apparently replaced and obliterated by epidote. Plane light 50X.

PLATE 22



A

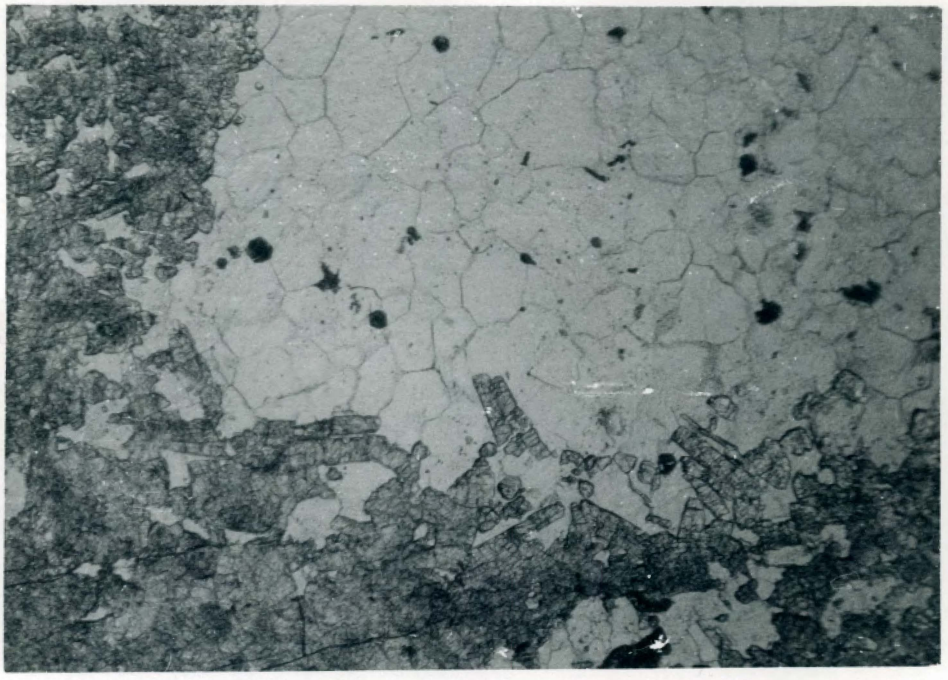


B

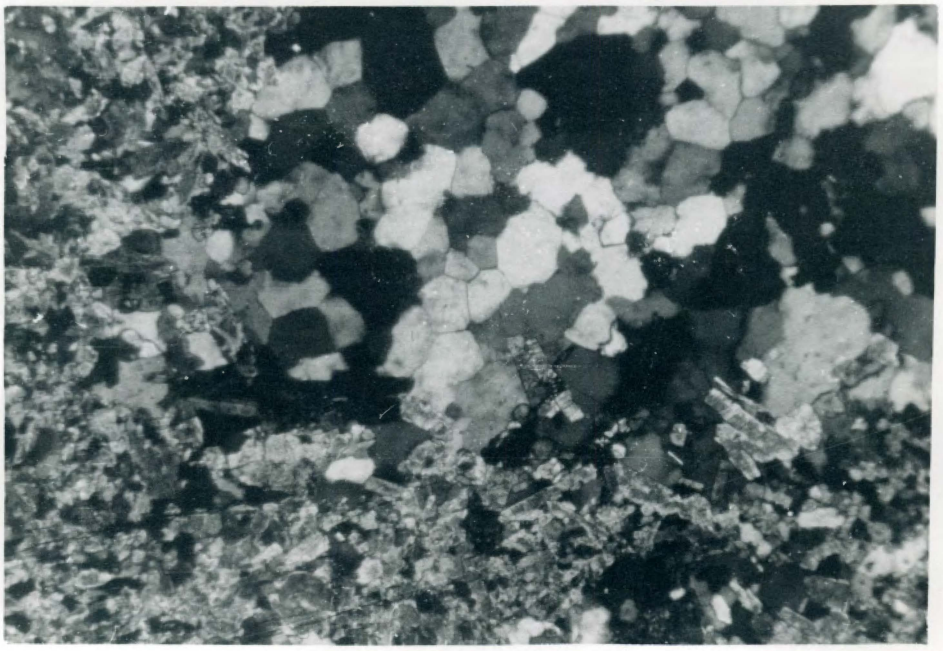
A. Photomicrograph of phenoclast megascopically identified as chert. Quartz grains of a metaquartzite are apparently replaced by tourmaline (tentatively identified as elbaite by optical characteristics). Plane light, 50X.

B. Photomicrograph of phenoclast megascopically identified as chert, pictured in "A". Crossed nicols, 50X.

PLATE 23



A



B

A. Photomicrograph of phenoclast megascopically identified as chert. Chlorite is apparently replacing and obliterating the minerals and texture of an aphanitic igneous rock. Laths are untwinned feldspar. Crossed nicols, 55X.

B. Photomicrograph of phenoclast of porphyritic rhyolite thought to have been derived from the Mount Rogers Group. Phenocrysts of potassium feldspar are within a groundmass of feldspar and quartz. Sporadic aggregates of variously oriented anhedral grains are quartz. Crossed nicols, 50X.

PLATE 24



A

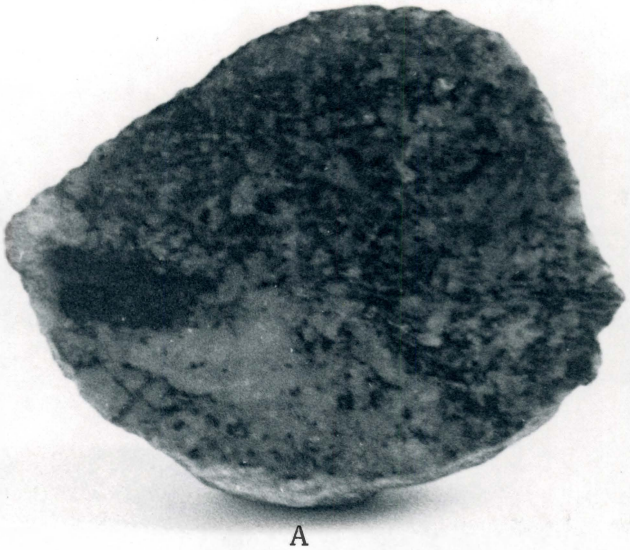


B

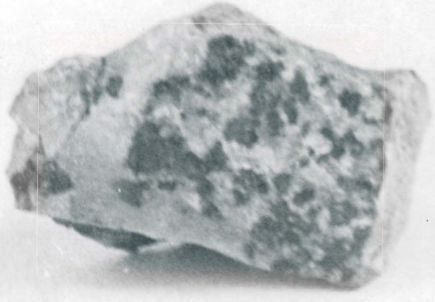
A. Phenoclast of granule breccia in which angular fragments of white, tan, and reddish quartz are within a finer grained matrix of magnetite (or ilmenite) and quartz.

B. Phenoclast of quartz-schorlite aggregate which is comprised by about 60 per cent clear white quartz and about 40 per cent tourmaline.

PLATE 25



A



B

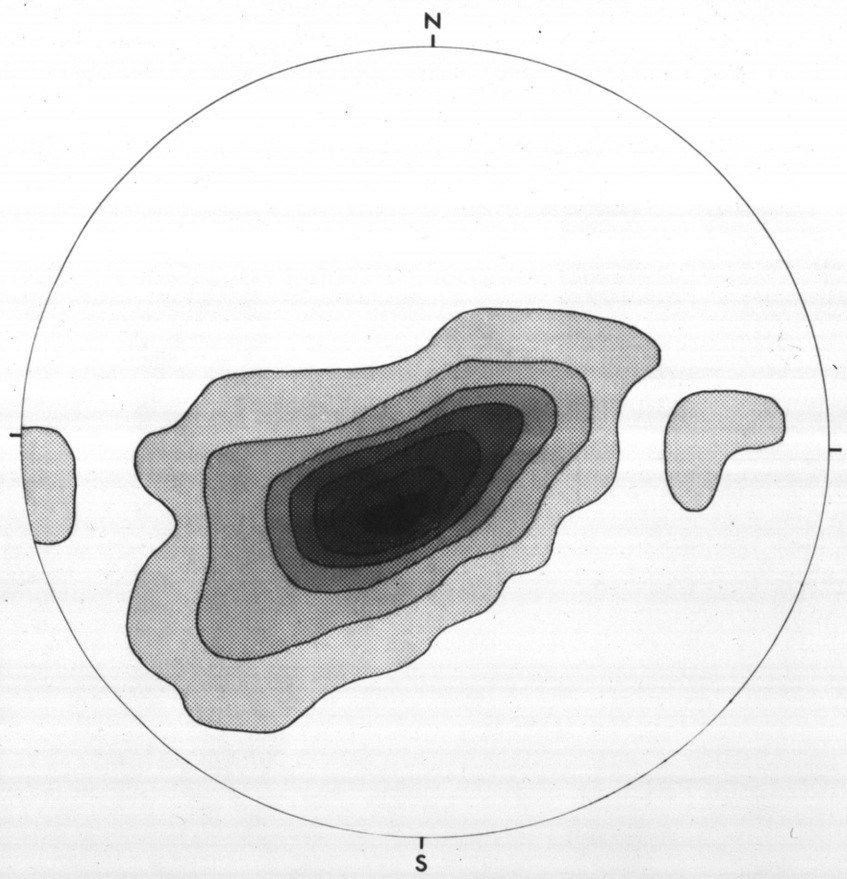
Little Laurel Creek, is composed of about 60 per cent clear white quartz and about 40 per cent schorlite. The minerals are fresh. The tourmaline grains typically are about one millimeter in cross section.

A granule breccia phenoclast (Plate 25A) was found to occur in samples collected at Horseshoe Bend and Green Cove Creek. It is a black and white irregularly spotted rock in which angular fragments of white, tan, and reddish quartz are within a finer grained matrix of magnetite (or ilmenite) and quartz.

Discoid and rod-shaped phenoclasts constitute a significant proportion of the phenoclasts contained in the conglomeratic beds of the Iron Mountain Formation (Plates 10B, 11B). Measurements of the plunge of the short axes of the discoid, and the long axes of the rod-shaped phenoclasts contained in the lowest conglomeratic beds at Horseshoe Bend (Plate 26A), Beartree Gap (Plate 26B), and Locust Ridge (Plate 27) were plotted; the resultant fabric diagrams indicate that a definite imbrication exists. The imbrication suggests that currents affected the attitude of the phenoclasts during deposition and that up-current directions ranging from north to northwest were most effective. There is also a suggestion that weaker currents moved in the opposite direction.

PLATE 26

A. Orientation diagram (lower hemisphere) of the plunge of short axes of discoid phenoclasts in the middle member of the Iron Mountain Formation at Horseshoe Bend.





B. Orientation diagram (lower hemisphere) of the plunge of short axes of discoid phenoclasts in the middle member of the Iron Mountain Formation at Beartree Gap.

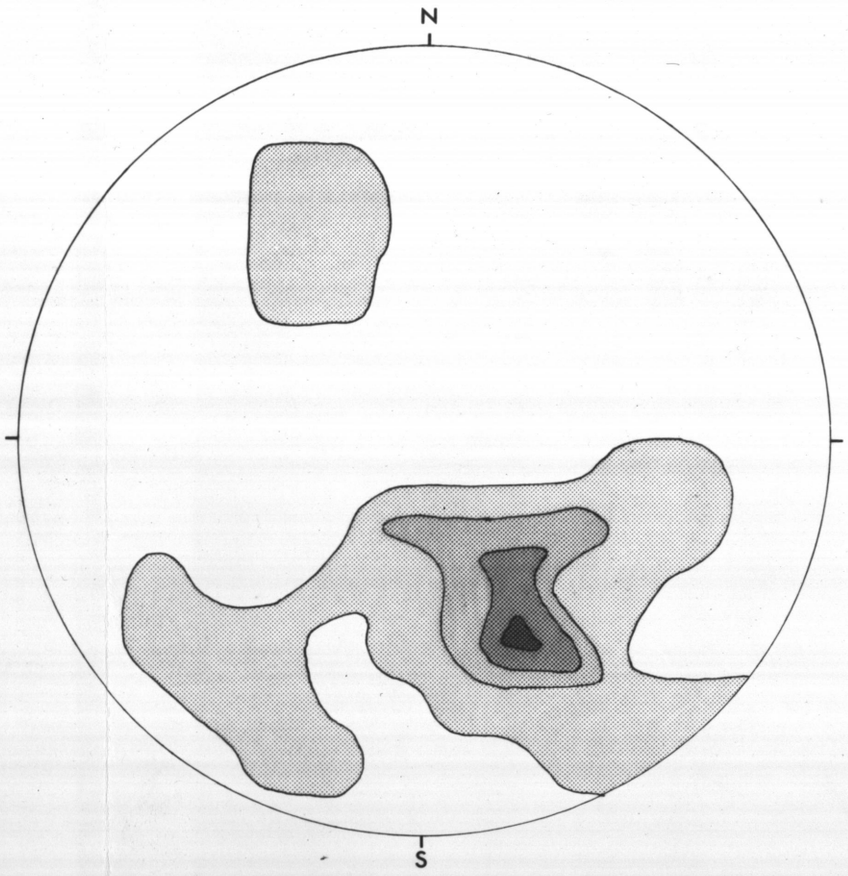
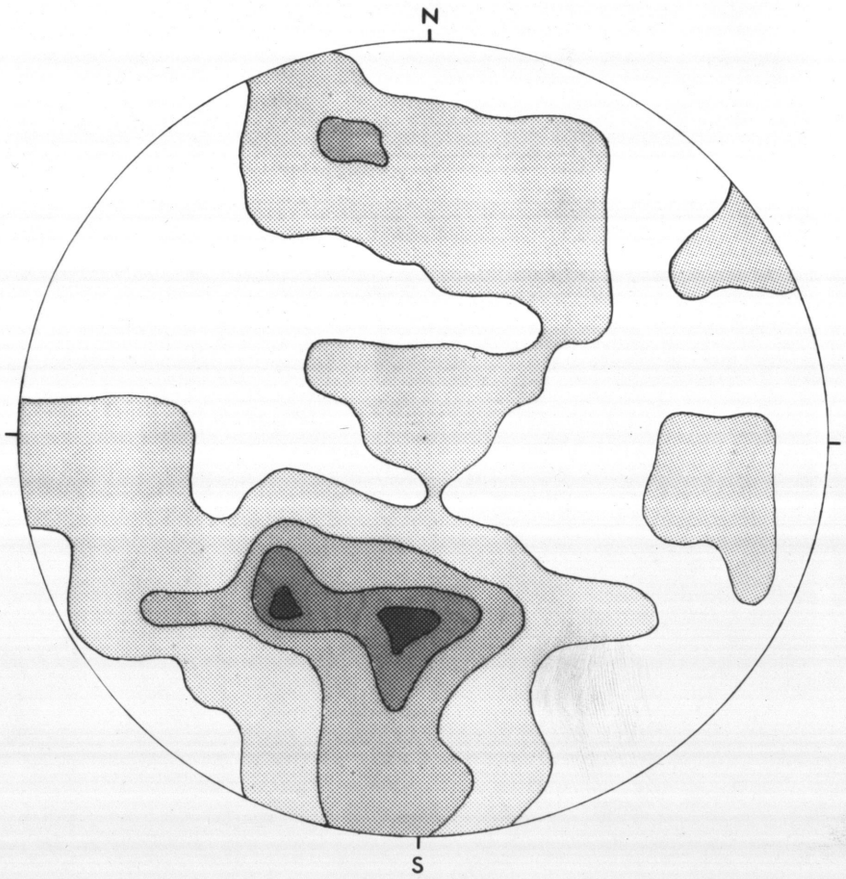
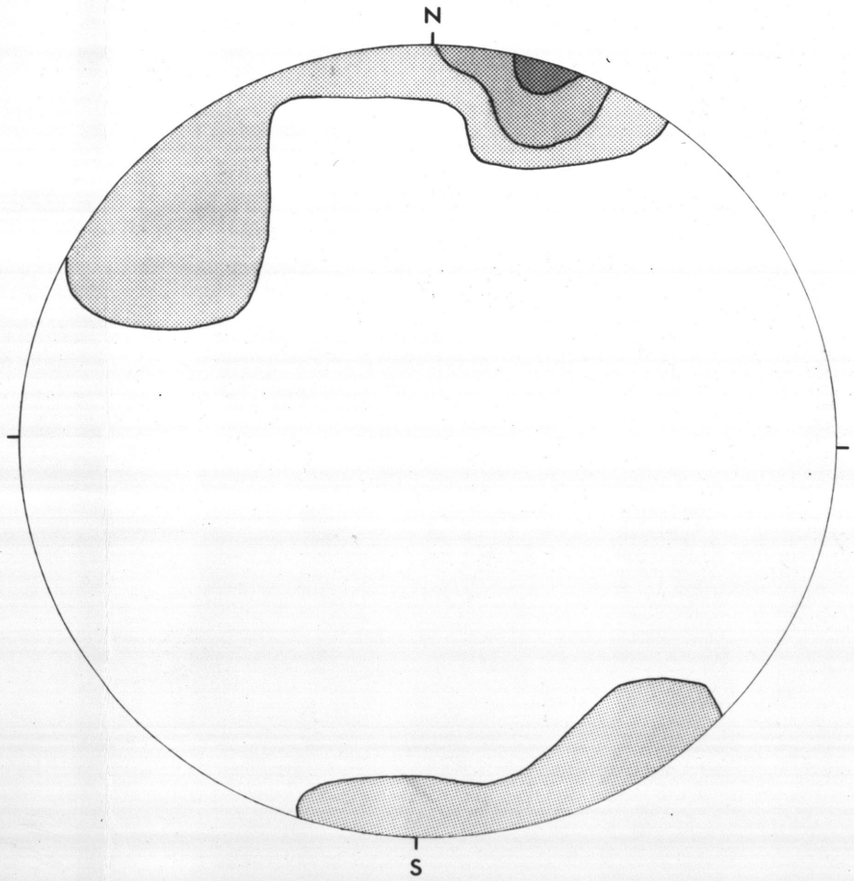


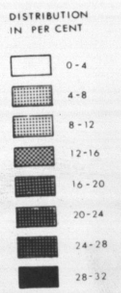
PLATE 27

A. Orientation diagram (lower Hemisphere) of the plunge of the short axes of discoid phenoclasts in the lower member of the Iron Mountain Formation at Locust Ridge.



B. Orientation diagram (lower Hemisphere) of the plunge of the long axes of rod-shaped phenoclasts in the lower member of the Iron Mountain Formation at Locust Ridge.





Siltstones.-- Mineralogically the siltstones contained in the Iron Mountain Formation are similar to the sandstones in that the minerals are predominantly quartz, with up to one-third microcline, and up to one-quarter plagioclase. The minerals are typically less altered in the siltstones than in the sandstones. The grains are present as angular, curved, platy and splintery fragments (Plate 28A). The cementing material between the grains ranges from 20 to 50 per cent of the rock and is largely clay material. Within the matrix there are partially chloritized, commonly bent flakes of brown biotite. Many siltstones exhibit lamination as the result of concentrations of sub- to well-rounded magnetite and associated "heavy", or abrasion-resistant minerals such as zircon, sphene, tourmaline, and hypersthene.

Shales.-- Although no "pure" clay shales have been noted, some shales do contain as little as 10 per cent silt-sized material. Muscovite flakes, which are barely visible megascopically, typically impart a "sheen" to the bedding surfaces. Sorting is generally poor; irregularly lenticular aggregates of rounded sand grains are relatively common.

Mineralogically, the shales contain significant proportions of, and in similar percentages, the same minerals as the sandstones and siltstones. The clay material which

constitutes as much as 90 per cent of the shales has been identified by x-ray and differential thermal analysis as predominantly illite with minor amounts of kaolinite. Iron oxide is common and veins of hematite, chlorite, and/or quartz commonly cut irregularly across the lamination.

Tuffaceous Shales and Argillites.-- The tuffaceous sediments which occur within the upper member and locally within the middle member are commonly deep red-brown to maroon and range from fissile to dense. Where fissile the tuffaceous material is either admixed or thinly interbedded with clay or silt. In such shales graded bedding is relatively common. The tuffaceous rocks are more resistant to weathering than the other rocks within the middle and upper members, and where covered, their presence is marked by brittle red-brown shale chips in the soil.

The tuffaceous shales and argillites are composed predominantly of submicroscopic opaque red-brown to very dark brown material. Fine chips of the tuffaceous clays are magnetic. Chemical tests indicate that trivalent iron and magnesium are present. X-ray and differential thermal analyses of samples of the tuffaceous material show that illite and minor amounts of kaolinite are present, but no iron and/or magnesium oxide mineral was identified. The opaque material has a dark red-brown streak similar to

that of hematite. It is believed that the material may be finely disseminated magnesioferrite and hematite.

Angular to sub-rounded grains of quartz, microcline, albite, and sparse grains of what appears to be devitrified, vesicular material occur within the opaque material in amounts up to 20 per cent. Shreds and blunt-ended books of iron oxide-stained talc are present in amounts up to 30 per cent and occur (Plate 28B), typically parallel to the chief lamination. Some grains, however, have their middle portions discordant with the lamination but their extremities parallel to and within adjacent laminations. Other grains are wholly discordant to lamination. The grains are lenticular in cross-sections viewed parallel to cleavage. Most grains are dark brown in their central portions and clearer nearer their borders. Some grains are somewhat pleochroic from light to dark brown. Large, relatively clear grains contain minute inclusions which appear to be bits of the same opaque material as that comprising the major part of the rock.

The tuffaceous shales were probably deposited in shallow marine water, as suggested by ripple marks, graded beds, and the predominance of illite over kaolinite in the clay fraction (Allen and Johns, 1960; Grim and others, 1949; Murray and Sayyab, 1955; and Pryor and Glass, 1961). The author believes that the stratigraphic interval within

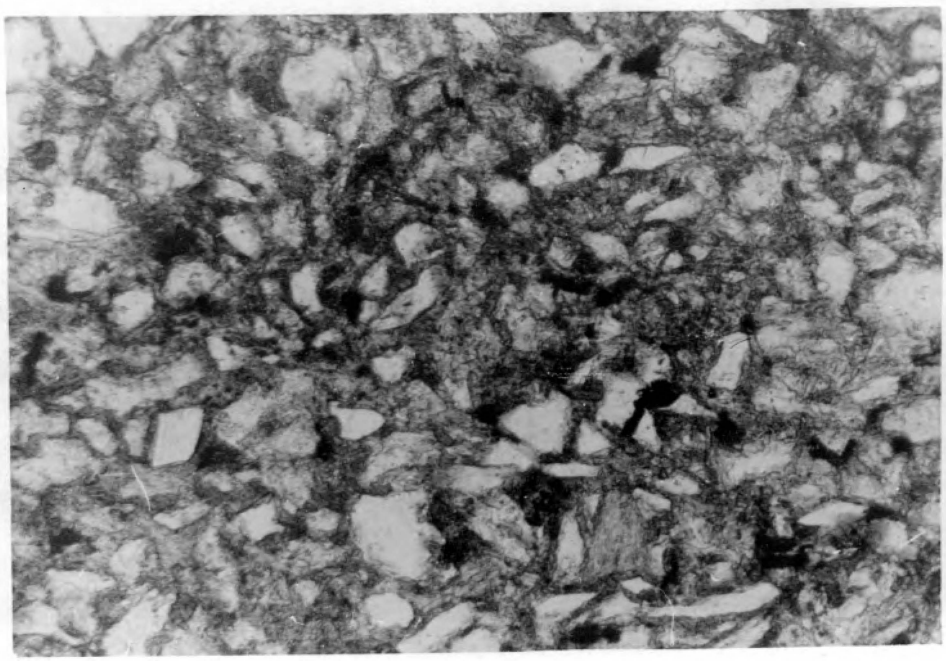
A. Photomicrograph of talc "booklets" within an opaque, very fine grained matrix of tuffaceous material. Talc is believed to have been altered from biotite. Non-opaque, angular grains of quartz and feldspar occur sporadically. Sample obtained from the upper part of the upper member of the Iron Mountain Formation in exposures along U. S. Highway 16 north of Trout Dale, Virginia. Crossed nicols, 50X.

B. Photomicrograph of siltstone within the upper member of the Iron Mountain Formation in exposures along U. S. Highway 21 south of Dry Run Gap, northern Grayson County, Virginia. Angular grains are quartz and feldspar within a matrix of chlorite, sericite and black opaque grains. Crossed nicols, 50X.

PLATE 28



A



B

the Iron Mountain Formation which contains tuffaceous shales and/or argillites is a time-stratigraphic unit and clearly reveals the time-transgressive nature of the lower, middle, and upper members of the formation.

Origin

The sedimentary rocks constituting the Iron Mountain Formation were probably deposited in an environment wherein broad, flat, alluvial fans coalesced to form an alluvial plain which lay adjacent to a highland source area to the southeast and which coincided at times with a marine strand zone. Although data is inconclusive, the trend of the strand zone was probably generally parallel to the trend of the present outcrop belts of the formation. Repeated uplift of major magnitude of the source area resulted in three consecutive progradational accumulations of coarse clastic materials; these three alluvial plain deposits may now be distinguished as the lower, middle, and upper members of the Iron Mountain Formation.

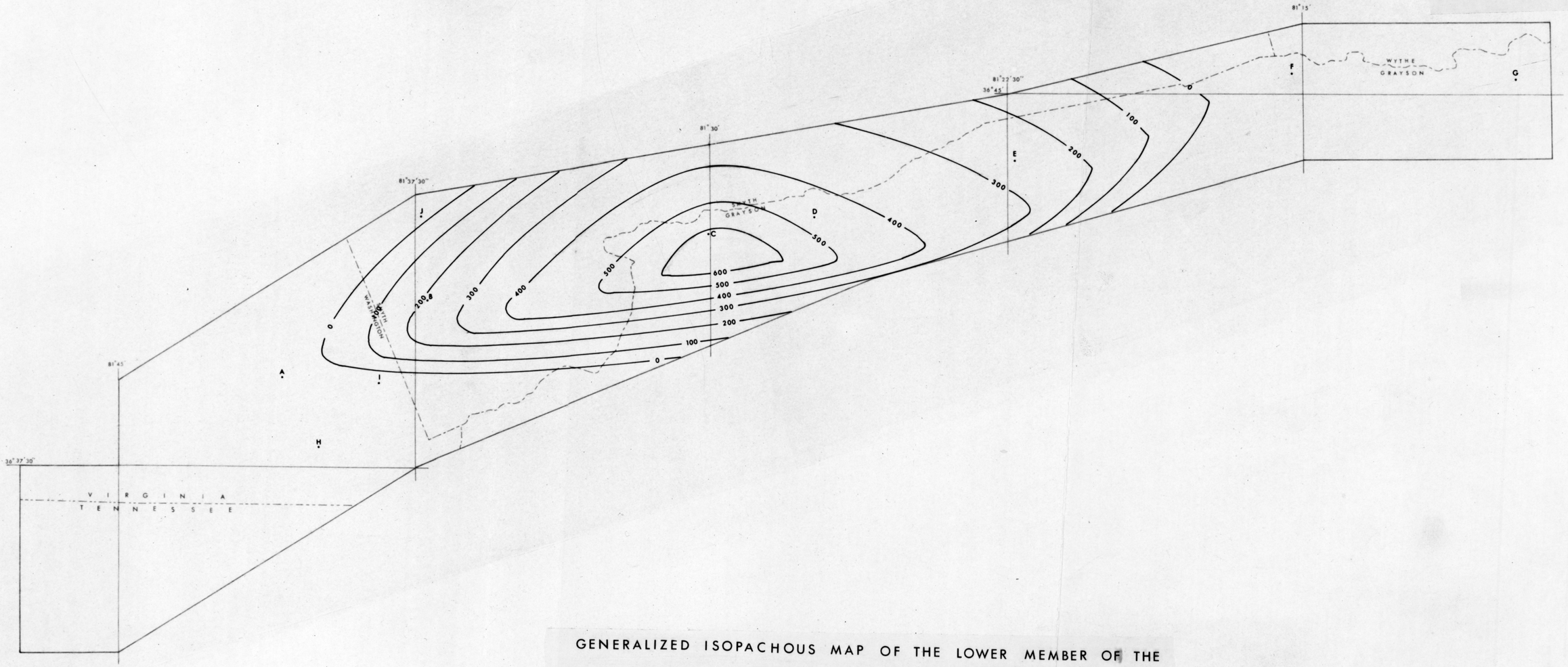
Preceding deposition of sediments of the Iron Mountain Formation, the region was topographically mature and had scattered, relatively shallow lakes. Irregular subsidence allowed accumulation of thick deposits of tuffaceous sediments and igneous extrusives, the Mount Rogers Group, from nearby volcanic sites to the southeast. Distribution of

thicknesses of the tuffaceous sequence suggests that within the mapped area, in late Mount Rogers time at least, the greatest amount of subsidence probably occurred between Locust Ridge and Taylors Valley.

Uplift of the source area to the southeast resulted in the formation of alluvial fan deposits of poorly sorted gravelly sands in which some cobbles were as much as six inches across. The alluvial fans, some of which may have been centered near Little Laurel Creek and Trout Dale, spread and coalesced to form an alluvial plain which extended for approximately twenty miles in a northeast-southwest direction between, but not including Beartree Gap and Blue Spring Gap (Plate 29). The northwestern limits of the deposits are unknown, but the feather-edge of the deposits may have extended as far as Horseshoe Bend. The southeastern limit (Plate 29) of the deposits probably extends eastward from a point just north of Beartree Gap to south of Little Laurel Creek, Locust Ridge, Trout Dale, and Houndshell Gap, from whence it trends northeastwardly through points north of Blue Spring Gap and Dry Run Gap.

The coarse unsorted nature of the materials, torrential cross-bedding, and lensing of the strata attest to the rapidity of deposition. Sole markings and cut-and-fill structures indicate that many of the sediments were deposited within or near the foreshore; imbrication of

PLATE 29



GENERALIZED ISOPACHOUS MAP OF THE LOWER MEMBER OF THE IRON MOUNTAIN FORMATION

phenoclasts and concentration of phenoclasts into restricted horizons which resemble lag gravels may indicate wave and/or current activity and consequent selective sorting and re-arrangement of material after initial deposition.

Lowering of the source area by erosion and continued subsidence of the depositional area resulted in the deposition of progressively finer grained material in progressively deeper, although still probably relatively shallow, water. Thus at any locality the sediments, which are distinguished as the lower member of the Iron Mountain Formation, exhibit a gradation from very coarse-grained at their base to very fine-grained at their top. Smaller gradational sequences within the depositional unit probably reflect recurrent minor uplifts or floods within the source area.

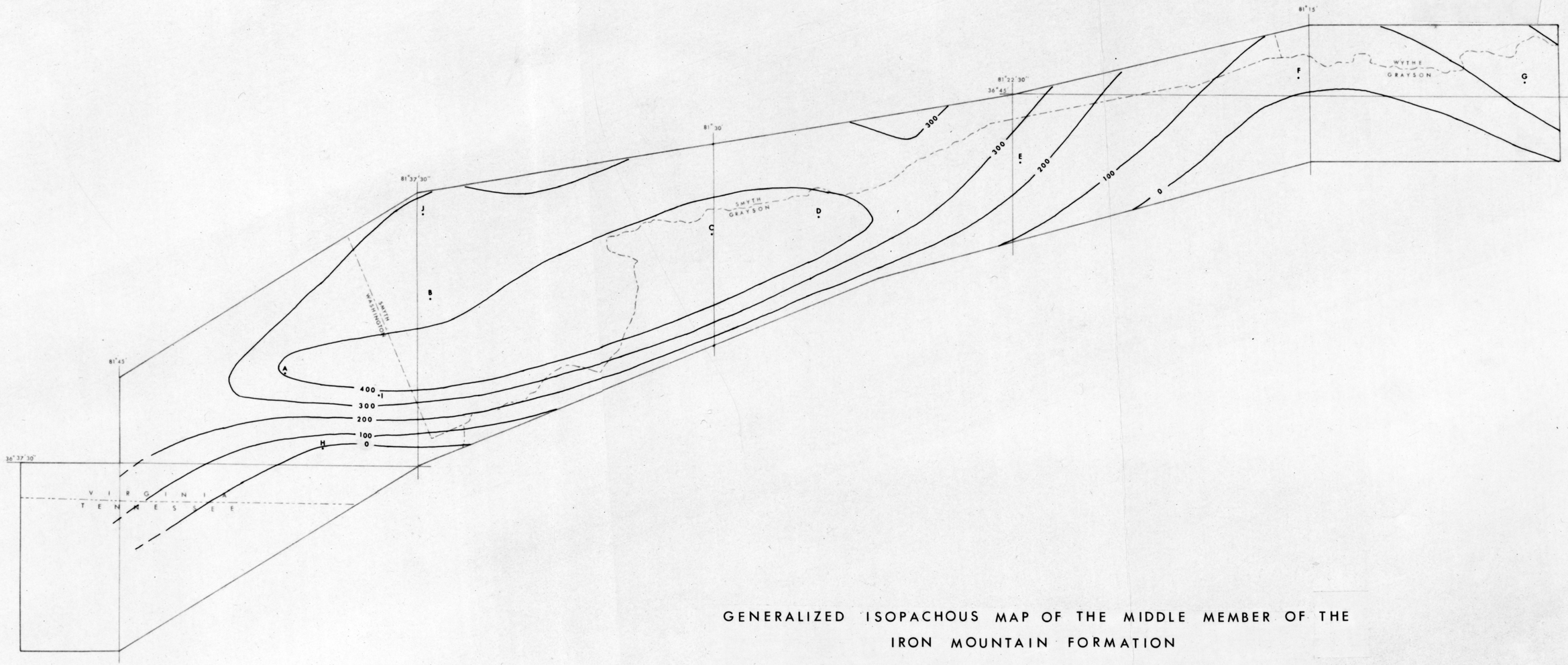
Renewed uplift on a major scale in the source area, probably accompanied by continued subsidence of the depositional area, resulted in the formation of a second sheet of alluvial plain deposits which was more extensive than the first. These deposits extended in a consistently thick sheet from Trout Dale southwestwardly, probably as far as Taylors Valley, and like the older deposits contained unsorted materials which ranged from clays to cobbles as large as five inches across. Northeast of Trout Dale the deposits covered areas which had previously

remained high, and thus gained some of their irregularities in thicknesses. These deposits extended for an undetermined distance northeast of Dry Run Gap. Saprolite developed on a topographically high area south of Blue Spring Gap were thinly covered late during this period of deposition and its preservation may indicate subaerial deposition of the overlying coarse clastics. These deposits also extended farther north than the older ones and covered the vicinity of Horseshoe Bend with thicknesses of materials which were comparable to the thicknesses farther southeast. The southeastern limits of deposition (Plate 30) lay between Big Hill and Green Cove Creek, and continued southeastwardly of the limits of the older deposits to points south of Blue Spring Gap and Dry Run Gap.

Environmental conditions were similar to those which prevailed during deposition of the older alluvial plain materials. In addition to such factors as the topography and erosion of the source area and the distance and conditions of transportation, the greater volume of silt and fine-grained arkosic sand may reflect position within the environment of deposition, and deposition of materials which were selectively removed by wave action from previously unsorted clastics deposited farther to the southeast.

Again, continued or additional subsidence in the area

PLATE 30



GENERALIZED ISOPACHOUS MAP OF THE MIDDLE MEMBER OF THE IRON MOUNTAIN FORMATION

of deposition and a probable lowering of the source area by erosion resulted in deposition of very fine-grained material in shallow marine water. This alluvial plain deposit which is similar to the older one in that it grades, in general, from coarse-grained sediments at its base to very fine-grained sediments at its top, is distinguished as the middle member of the Iron Mountain Formation.

Tuffaceous sediments which apparently reflect volcanism similar to that which occurred during Mount Rogers time were deposited along with the sediments of the middle member at Beartree Gap, Horseshoe Bend, and Dry Run Gap. These tuffaceous sediments appear to indicate that when this volcanism began, renewed deposition of coarse clastic material (upper member) was well under way to the southeast while waning deposition of sediments within the middle member was occurring to the northeast, north, and west.

The early focus for deposition of the third alluvial plain apparently was located southeast of Blue Spring Gap and the sediments spread to the northeast, north, and west from that area. Near Trout Dale, where deposit thickness is minimal, subsidence was apparently not so rapid as in the areas to the northeast and southwest. At the beginning of active volcanism, alluvial plain deposits had accumulated a thickness of about 500 feet at

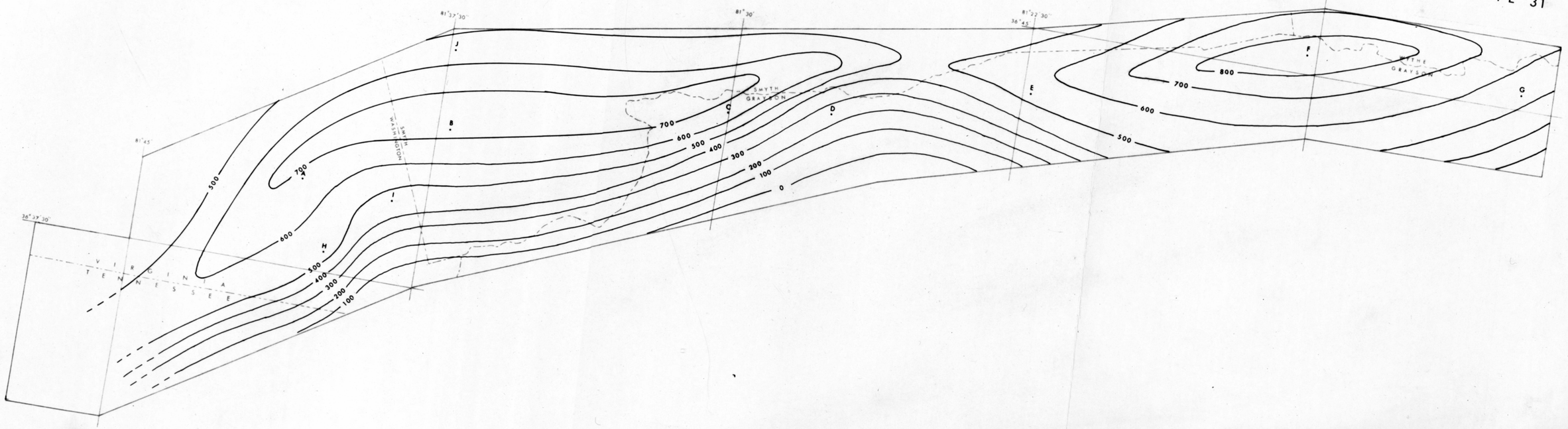
Blue Spring Gap, 400 feet at Houndshell Gap, 150 feet at Trout Dale, 200 feet at Locust Ridge, and 50 feet at Little Laurel Creek (Plate 31). To the northwest, about 150 feet of sediments had accumulated at Horseshoe Bend, and to the southwest, about 75 feet at Big Hill and 50 feet at Green Cove Creek.

As volcanism proceeded, sediments continued to arrive from the uplifted source area, and the site of major sediment accumulation shifted northeastward to an area southeast of Dry Run Gap. A second major site of deposition was probably located south or southeast of Little Laurel Creek.

The sediments spread from these foci of accumulation, i.e., southeast of Dry Run Gap and southeast of Little Laurel Creek, to coalesce near Trout Dale.

Deposition of the Iron Mountain Formation sediments was interrupted by a great outpouring of basaltic lava, which spread over the relatively flat alluvial plain, and at some localities (Horseshoe Bend, Trout Dale, and southwest of McQueen Gap) flowed into shallow (marine?) water. Although this, and two later outpourings of basaltic lava did not mark the end of development of the third alluvial plain or the termination of volcanism in the source area, the base of the first basalt flow does mark the top of the upper member of the Iron Mountain Formation, the unit

PLATE 31



GENERALIZED ISOPACHOUS MAP OF THE UPPER MEMBER OF THE IRON MOUNTAIN FORMATION

that was the subject of this investigation.

Structure

General

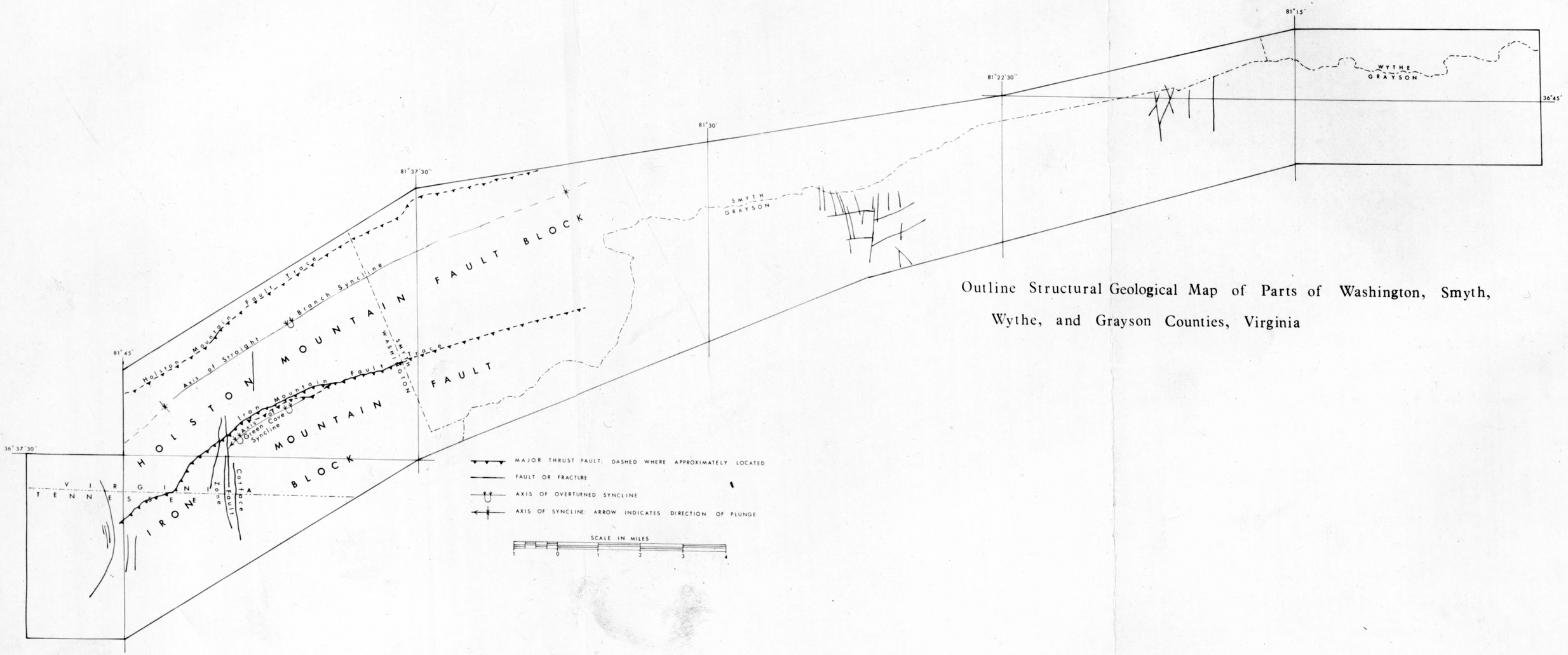
The structure of the area of study is relatively simple on a gross scale. It consists of two major thrust blocks, each bounded on the northwest by a thrust fault, and each consisting in part of an overturned syncline (Plate 32). On a smaller scale, the structure is complicated by zones of fracturing and probable normal, cross faulting which intersect one or both thrust blocks.

Of particular significance is that the interpretations of the northeastern extension of the Mountain City window (see, for example, King and Ferguson, 1960; King, et al., 1944; Rodgers, 1953; and Milici, et al., 1963) need modification. This structure is actually a southwestwardly plunging syncline the northwestern limb of which has been removed by faulting.

Holston Mountain Fault Block

The Holston Mountain fault block, which is bounded on the northwest by the Holston Mountain thrust fault, consists chiefly of the southeastern limb of a generally northeastwardly trending syncline. The southeastern limb between Beartree Gap and Little Laurel Creek is vertical

PLATE 32



Outline Structural Geological Map of Parts of Washington, Smyth, Wythe, and Grayson Counties, Virginia

to strongly overturned (Plate 1A-A') where the strata dip 65 degrees to the southeast. Southwest of Beartree Gap the strata dip normally to the northwest and from Taylors Valley to the Tennessee State Line they dip from 20 to 35 degrees to the northwest. From Little Laurel Creek northeastward to Blue Spring Gap the strata in the southeastern limb dip normally from 50 to 60 degrees to the northwest. From Blue Spring Gap to the vicinity of Dry Run Gap, dips steepen to vertical or slightly overturned.

Locally, from Horseshoe Bend southwestward to Feathercamp Lookout Tower (Plate 1), the northwestern limb of the syncline is present. The strata in the northwestern limb exhibit normal dips from 30 to 60 degrees to the southeast. Progressively more of these strata appear to be removed by faulting northeast of Horseshoe Bend and southwest of Feathercamp Lookout Tower.

Thus, the northeastern part of the syncline, herein called the Straight Branch syncline, loses its obvious synclinal character and is constituted by sequences of generally northwestwardly dipping strata including the Rome Formation and underlying strata down to the rocks of the Precambrian Injection Complex. The synclinal nature of the structure is better defined southwest of Longtitude 81°35'W., where sedimentary rocks of the Erwin and Hampton formations are included in the axial portion

of the fold. In the northwestern limb, southwestward dips prevail in the sedimentary strata down to and including the middle member of the Iron Mountain Formation. In the southeastern limb, northwestern dips prevail down to and including rocks of the Injection Complex.

The Holston Mountain fault trends west-southwestwardly from north of Dry Run Gap to a point northwest of Horseshoe Bend, from where it trends irregularly southwestward to about 2500 feet east of Feathercamp Lookout Tower. Here sedimentary rocks within the Iron Mountain Formation, which strike northeast and dip southeast, are in fault contact with quartzites of the Erwin Formation on the west and northwest. The Erwin quartzites strike east-west, and dip to the south. Several north-trending, high-angle, sinistral, tear faults occur in this area; they may reflect differential movement of the thrust sheet.

From the vicinity of Feathercamp Lookout Tower the Holston Mountain fault trends southwestwardly to pass through Damascus, Virginia (King and Ferguson, ibid., Derby, 1961, and Milici, et al., ibid.). The dip of the Holston Mountain fault is believed by the author to be to the southeast because the fault trace swings to the southeast where the fault coincides with a topographically low area.

The Holston Mountain fault block is bounded on the

southeast by the Iron Mountain fault southwest of Azen Church. The Iron Mountain fault has not been traced northeast of that area although areal photographs suggest that it may extend to within a mile of the boundary between Smyth and Grayson counties. Between Azen Church and its probable northeastern extremity the fault separates rocks within the Mount Rogers Group contained within both the hanging wall and footwall blocks, and is thus indistinct.

In the northeastern part of the mapped area, Stose and Stose (1957, Plates 1 and 60) show the area directly south of the main outcrop belt of the Iron Mountain Formation (Plate 1) to contain several eastwardly trending faults, some of which are normal fualts (Stose and Stose, ibid., Plate 60, Section F-F'). Most of the faults are within the rocks of the Injection Complex but a few also affect rocks of the Mount Rogers and Unicoi groups.

Just west of Trout Dale and southwest of Blue Spring Gap complex patterns of faulting and/or fracturing occur, and consist of at least two sets of faults which affect rocks of the Mount Rogers and Unicoi groups. The most prominent set is constituted by north trending faults which range in length from less than 100 feet to as much as two miles. Southwest of Blue Spring Gap, just north of Roberts Cove, these faults displace rocks within the Unicoi Group as much as 1000 feet. Northwest of Trout

Dale at least one of the north trending faults affects Iron Mountain Formation sedimentary rocks in the measured section (Plate 2) and, although the fault plane is not exposed, the position of the fault zone is suggested by a sequence of distorted, fractured, and highly epidotized arkosic sandstones.

The second set of faults in the vicinities of Trout Dale and Blue Spring Gap constitute a less well defined pattern in which fault trends range from N.65°E. to N.15°E. and in which individual faults intersect, and are intersected by, faults of the north trending set.

It appears that these two sets of faults are syngenetic because they mutually offset each other at different localities. Their nearly straight traces indicate that the attitudes of the fault zones are nearly vertical.

Iron Mountain Fault Block

The Iron Mountain fault block was mapped only in the southwestern part of the area of study (Plates 1, 32) where it is clearly bounded on the northwest by the Iron Mountain thrust fault. Northeast of Azen Church the Iron Mountain fault is less distinct because it cuts rocks contained within the Mount Rogers Series. The northeastwardly and southwestwardly extent of the Iron Mountain fault block were not determined by the author.

The part of the Iron Mountain fault block that was mapped during this study (Plates 1, 32) is composed of the locally overturned southeastern limb of a southwestwardly plunging syncline (herein called the Green Cove syncline) which has been thrust onto the southeastern limb of the Straight Branch syncline. The Green Cove syncline contains sedimentary rocks from the Erwin and Hampton formations in its axial part down to and including rocks of the Mount Rogers Group. The contact between rocks of the Mount Rogers and Unicoi groups trends generally northeastwardly from the McQueen Gap area (Plate 1) but near Big Hill trends in a more northwardly direction around the nose of the Green Cove syncline. The rocks adjacent to the contact dip about 50° to the northwest near Big Hill but are overturned (Plate 1) and dip about 60° to 65° to the southeast at and southwest of Green Cove Creek.

About one-half mile east of Taylors Valley the rocks within the Green Cove syncline are transected by several northwardly trending faults which probably comprise the Catface fault zone (Plate 32). Rocks within the Rome Formation and Shady Dolomite on the west are in fault contact with older rocks of the Erwin Formation down to and probably including Iron Mountain Formation on the east. The rocks contained within the Iron Mountain fault block west and southwest of the Catface fault zone were not

mapped.

The Iron Mountain fault, as mapped by the author, trends southwestwardly from the vicinity of Azen Church, through Taylors Valley, to near the junction of Elliot Branch with Laurel Creek. The dip of the fault plane is apparently to the southeast as is indicated by exposures along Laurel Creek about two miles south of Laureldale, Virginia, and by the intersections between the fault plane and topographical features.

At least two faults within the Catface fault zone intersect and displace the Iron Mountain fault and adjacent rocks east of Taylors Valley. The faults within the Catface fault zone, as suggested by the areal distribution of the rocks involved (Plate 1) are ones in which movement has been principally parallel to dip and in which the hanging wall block in each is to the east.

A fault zone which exhibits an arcuate pattern generally parallel to Laurel Creek occurs from about one-half mile south of Laureldale, Virginia, to about one mile northwest of Laurel Bloomery, Tennessee. The relationship of the Iron Mountain fault to this fault zone is not known and the type of movement along the faults comprising the fault zone was not determined. The Iron Mountain fault was not traced southwest of Laurel Creek.

Rocks within the Iron Mountain Formation are exposed

in an irregular, northeastwardly trending belt which extends from about 1.5 to 3.5 miles northeast of Taylors Valley (Plate 1). These rocks are within the Iron Mountain fault zone (Plate 1) and are bounded on the northwest by rocks within the Mount Rogers Group and on the southeast by rocks within the Erwin and Hampton formations. Although the attitude of the rocks is probably only locally significant, the strike in exposures along Green Cove Creek near Creek Junction is about N.60°E. and the dip is about 70 degrees to the northwest. The rocks were probably part of the northwestern limb of the Green Cove syncline prior to faulting. Neither the top nor the bottom of the Iron Mountain Formation is exposed in this outcrop belt.

SUMMARY

Field and laboratory investigations of the coarse clastic sediments of the basal part of the Unicoi Formation in southwestern Virginia indicate that the Unicoi should be raised to the rank of group and that the type section remain as indicated by King and Ferguson (1960) in exposures on the Nolichucky River southeast of Unaka Springs, Tennessee. The Unicoi Group consists of at least three lithologically distinct rock sequences which are, in ascending order: arkosic sandstone and conglomeratic formation, basalt formation, and orthoquartzite formation.

No names are proposed for the basalt and orthoquartzite formations. Iron Mountain Formation is proposed for the arkosic sandstone and conglomerate sequence, which corresponds to the lower member of the Unicoi Formation as mapped by Ordway (1948) and by Stose and Stose (1957). The base of the formation is defined as the top of the underlying Mount Rogers Group; the upper contact is coincident with the base of the lowest basalt flow within the basalt formation of the Unicoi Group. Exposures on the southeastern flanks of the component ridges of the Iron Mountains in Smyth and Grayson counties, Virginia, are designated as the type section of the Iron Mountain Formation, specifically those exposures along Smyth County

Road 600 on the western end of Grave Mountain about 1.75 miles northeast of Konnarock, Virginia, along an unnumbered Grayson County road crossing the western end of Locust Ridge about a mile west of Fairwood, and along roadcuts at Houndshell Gap, Grayson County, about 5.5 miles northeast of Trout Dale.

The formation ranges from about 520 to 1320 feet thick. It is exposed in four outcrop belts, three of which were the subject of this study. The main outcrop belt trends generally northeastward from the Taylors Valley area, Washington County, Virginia, for about 35 miles to the Dry Run Gap area, northern Grayson County, Virginia. This outcrop belt is on the southeastern flanks of the component ridges which comprise the Iron Mountains. The formation crops out locally on the northwestern flank of the Iron Mountains at Horseshoe Bend, Smyth County, Virginia, but is believed to be absent within a few miles to the northeast and southwest of that point because of faulting. The third outcrop belt of the formation is on the southeastern flanks of Chestnut and Lost mountains, Washington County, and is generally parallel to the two above-mentioned belts. The fourth belt of exposures, which was not studied except in a cursory manner, is included within the Iron Mountain fault zone from about 1.5 to 3.5 miles northeast of Trout Dale. Neither the top

nor bottom fo the Iron Mountain Formation was found to be present within this fourth outcrop belt.

Three lithologic members are distinguished within the Iron Mountain Formation. The members are similar in that each consists of a relatively poorly sorted gradational sedimentary sequence which contains conglomerates at or near its base which grade, in general, upward through arkosic sandstones to siltstones and/or clay shales at its top.

The lower member occurs only in exposures in the middle half of the main outcrop belt. From a maximum thickness of about 525 feet near Trout Dale, the member thins to a feather edge to northeast of Houndshell Gap and to southwest of Little Laurel Creek. The contact between the lower member and the underlying Mount Rogers Group is apparently gradational in at least two exposures. The member is characterized by medium- to coarse-grained sandstones which are interbedded with conglomerates and siltstones. The conglomeratic beds are gradational in that the largest phenoclasts are contained in their base and smaller ones in their top. Phenoclasts up to six inches across are contained in the lowest conglomeratic beds in the member. Siltstones are nearly restricted to the upper part of the member and are gradational into the overlying shale horizon the top of which coincides with

the top of the member.

The middle member is present in all exposures in all three outcrop belts, except those along Green Cove Creek. The member ranges in thickness from about 375 to 450 feet except in the northeastern part of the main outcrop belt where it overlies rocks within the Mount Rogers Group unconformably. The member thins to the northeast along the main outcrop belt and to the southwest along the southeasternmost belt. The rocks and their sequential arrangements comprising the middle member are similar to those which make up the lower member, except the largest phenoclasts contained in the lower part are only locally as large as five inches across, and more siltstones are interbedded with other lithologies throughout the member. Also, at three exposures, Dry Run Gap, Horseshoe Bend, and Beartree Gap, tuffaceous shales which signify the outbreak of volcanism, probably in the source area, occur in the upper part of the member.

The upper member occurs in all exposures in all three outcrop belts and is underlain by the middle member except at Green Cove Creek, where it is underlain by rocks of the Mount Rogers Group. Its thickness ranges from about 250 to 900 feet; minimal thickness of the member occurs at Trout Dale. The rocks contained within the upper member are similar to those constituting the lower

and middle members, except that the largest phenoclasts contained near its base are only up to one inch across, and even more siltstones and tuffaceous shales are interbedded with other lithologies. Although tuffaceous shale beds are restricted to the upper quarter to half of the member in exposures between Locust Ridge and Blue Spring Gap, they occur sporadically throughout the member at all other exposures examined. The sequential order of the rocks are different from that of the older members in that no shale horizon marks the top of the member. Rather, it is overlain by the lowest basalt flow within the basalt sequence.

The boundary between the Iron Mountain Formation and the Mount Rogers Group therefore is apparently gradational in the central half of the main outcrop belt, but represents an increasing amount of non-depositional and/or erosional time in all directions from that area.

The rocks constituting the three members of the Iron Mountain Formation represent three phases of alluvial plain development, each of which was distributed more widely than older alluvial plain deposits and each of which probably resulted from renewed uplift of the source area to the southeast. The depositional area was one of irregular but continuous subsidence and coincided in part with the strand zone or foreshore of a sea to the northwest.

Tuffaceous shales which reflect volcanic activity within the source area indicate that the individual members within the formation are time-transgressive and, as deposition of sediments comprising one member waned in some areas, sediments included in a younger member were being deposited nearer the source. Areas underlain by rocks of the Mount Rogers Group were uplifted and supplied material to be deposited within the alluvial plains and thus were part of the source area. In addition the source area contained igneous and metamorphic rocks similar to those contained in the present-day Blue Ridge and Piedmont provinces, e.g., rocks similar to those exposed near Azen Church, Washington County, Virginia.

Structurally, the mapped area constitutes part of two major fault blocks, the Holston Mountain fault block and the Iron Mountain fault block, each of which is bounded on the northwest by a thrust fault and each of which consists in part of an overturned syncline. The northwesternmost block, the Holston Mountain fault block, which is bounded on the northwest by the Holston Mountain fault, consists chiefly of the southeastern, but locally of the northwestern limb of the northeastwardly trending Straight Branch syncline. The main belt of outcrop of the Iron Mountain Formation is exposed in the southeastern limb of the syncline. The outcrops at Horseshoe Bend constitute

exposures of the formation in the northwestern limb. The Iron Mountain fault block is bounded on the northwest by the Iron Mountain fault and has been mapped only in the southwestern part of the area of this study. The southeasterly outcrop belt of the Iron Mountain Formation constitutes exposure of rocks contained in the southeastern limb of the southwestwardly plunging Green Cove syncline.

Sets of generally northwardly trending faults, some of which are younger than and displace the Iron Mountain fault, occur south of Laureldale, east of Taylors Valley, northwest of Trout Dale, and southwest of Blue Spring Gap. At the Trout Dale and Blue Spring Gap localities other faults which trend northeastwardly to eastwardly displace and are displaced by the north-trending faults, and thus were developed syngenetically with those contained in the north-trending fault set.

APPENDIX

Geologic Section A

Section of Iron Mountain Formation exposed along highway cuts, U. S. Highway 58, on the southeastern flank of Straight Mountain, Washington County, Virginia.— The top of the described section (Plate 2A) is the base of the lowest basalt flow within the Unicoi Group, which is located about 2.7 miles west of Konnarock, about one-half mile east of Beartree Gap and about one-half mile northwest of the junction of Whitetop-Laurel and Green Cove creeks.

Iron Mountain Formation (Total thickness: 1092 feet)

Upper Member (Thickness: 690 feet)	Thickness (feet)
12. Sandstone, medium to dark gray, medium grained, and arkosic	20
11. Covered zone. Soil and residual fragments indicate the bedrock to be arkosic sandstone .	150
10. Sandstone, light gray to white, coarse-grained, arkosic, with sporadic, rounded pebbles to one-half inch across. Red-brown tuffaceous shales in indistinct zones up to six inches thick are sporadically inter-	

		Thickness (feet)
	calated. About 20 feet below the top there is a two-feet thick bed of red-brown tuffaceous shale	98
9.	Covered zone, with float blocks of coarse-grained arkosic sandstone and with reddish shale chips in soil	98
8.	Sandstone, light gray to white, coarse-grained, arkosic, with intercalated red-brown tuffaceous shale beds up to nine inches thick	143
7.	Sandstone, light tan to light gray, coarse-grained, arkosic, interbedded irregularly with siltstones and clay shale beds	90
6.	Shale, tan, silty clay with interbedded siltstones	17
5.	Sandstone, light- to medium-gray, coarse-grained, with sporadically interbedded siltstones	74

Middle Member (Thickness: 402 feet)

4. Shale, clay with interbedded siltstones. At the top is a four-feet thick red-brown tuffaceous shale bed. The upper 80 feet contains at least six tuffaceous shale beds which range up to one foot thick. Lower

		Thickness (feet)
	40 feet is tuff-free	120
3.	Conglomerate, with rounded phenoclasts to 1.5 inches across in a coarse-grained arkosic sandstone matrix. Cross-bedding is common	63
2.	Sandstone, medium to dark gray, medium- to coarse-grained, cross-bedded. Conglomeratic in the lower one-third, with rounded phenoclasts up to three inches across. Grades upward into pebble-free arkosic sandstones in the upper one-third	182
1.	Sandstone, medium to dark gray, medium-grained, even textured, pebbly and non-pebbly, arkosic	32

Mount Rogers Group

Geologic Section B

Section of Iron Mountain Formation exposed along roadcuts on Washington County Road 600 on the southeastern flank of Grave Mountain Smyth County, Virginia, and adjacent to Little Laurel Creek.— The top of the described section (Plate 2B) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 1.75 miles northeast of Konnarock, Virginia, and about one mile north of the junction of Little Laurel and Big Laurel creeks.

Iron Mountain Formation (Total thickness: 1319 feet)

Upper Member (Thickness: 720 feet)	Thickness (feet)
15. Sandstone, medium to dark gray, medium- to coarse-grained, arkosic, cross-bedded, and in beds up to ten feet thick. Rounded pebbles up to one-half inch across	46
14. Shale, red-brown, tuffaceous	0.5
13. Sandstone, medium to dark gray, medium- to coarse-grained, arkosic, cross-bedded, with rounded pebbles up to one-half inch across .	10
12. Shale, red-brown, tuffaceous	2
11. Sandstone, medium to dark gray, medium-grained, arkosic. Pebbly in the upper one-third, grades downward to tan silty shale	

		Thickness (feet)
	in the lower one-third	3
10.	Sandstone, medium gray, medium- to coarse-grained, arkosic, pebbly and non-pebbly, alternating irregularly with white medium-grained quartzites, non-pebbly feldspathic sandstones, and white micaceous silty shales .	211
9.	Shale, red-brown, tuffaceous	1.5
8.	Sandstone, interbedded medium- to coarse-grained, arkosic and feldspathic, in beds to 10 feet thick. Thin four- to six-inch, red-brown, tuffaceous shales occur sporadically. Ridge forming, vitreous gray feldspathic and arkosic sandstones occur in lower one-third	446

Middle Member (Thickness: 364 feet)

7.	Shale, silty clay, light greenish-white, interbedded with thin siltstone beds	63
6.	Sandstone, medium gray, coarse-grained, arkosic, pebbly and non-pebbly, alternating irregularly with fine-grained non-pebbly arkosic sandstones	74
5.	Covered zone, with arkosic sandstone float blocks	103

	Thickness (feet)
4. Sandstone, medium to dark gray, coarse-grained, cross-bedded, with rounded phenoclasts to two inches across.	21
3. Sandstone, medium gray, coarse-grained, conglomeratic, irregularly interbedded with non-pebbly sandstones	103

Lower Member (Thickness: 235 feet)

2. Shale, silty clay, white to light tan, with interbedded siltstones in thin beds	28
1. Sandstone, medium gray, conglomeratic, arkosic, with rounded phenoclasts in upper half to four inches across. Largest phenoclasts in lower half about one inch across	207

Mount Rogers Group

Geologic Section C

Section of Iron Mountain Formation exposed along roadcuts on an unnumbered dirt road which crosses the west end of Locust Ridge, Grayson County, Virginia.— The top of the described section (Plate 2C) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 3300 feet north of Grayson County Road 603 and about one mile west of Comers Creek Church.

Iron Mountain Formation (Total Thickness: 1273 feet)

Upper Member (Thickness: 634 feet)	Thickness (feet)
14. Sandstone, medium gray, fine- to coarse-grained, arkosic, with conglomeratic interbeds. Rounded phenoclasts to one-half inch across. Cross-bedding common . . .	298
13. Shale, red-brown, tuffaceous. Chips scattered in soil and saprolite, thickness undetermined	2?
12. Sandstone, medium gray, fine- to medium-grained, arkosic, pebbly and non-pebbly, interbedded with arkosic siltstones	55
11. Shale, red-brown, tuffaceous. Chips scattered in soil and saprolite, thickness undetermined	2?

		Thickness (feet)
10.	Sandstone, medium to dark gray, fine- to coarse-grained, arkosic, pebbly and non-pebbly	45
9.	Shale, red-brown, tuffaceous. Scattered chips in soil and saprolite, thickness undetermined	27
8.	Sandstone, medium gray, coarse-grained, arkosic, irregularly interbedded conglomerates, pebbly and non-pebbly arkosic sandstones, and siltstones. More conglomeratic toward base; finer grained toward the top. Rounded phenoclasts up to one inch across in lower beds	230

Middle Member (Thickness: 457 feet)

7.	Shale, white to gray, clay. Silty and sandy toward base	25
6.	Sandstone, medium gray, coarse-grained, arkosic, cross-bedded, with rounded phenoclasts to one-half inch across in upper one-third. Medial beds contain greater numbers of phenoclasts to one inch across, and basal beds are conglomeratic in lower 20 feet, with phenoclasts	

	Thickness (feet)
up to 1.5 inches across	222
5. Sandstone, medium gray, fine- to medium-grained, arkosic, cross-bedded, irregularly interbedded with conglomerates, pebbly and non-pebbly arkosic sandstones, and siltstones. Rounded phenoclasts up to one inch across	210
Lower Member (Thickness: 182 feet)	
4. Shale, white silty clay, grading upward to clay shale	10
3. Sandstone, medium to dark gray, coarse- to medium-grained, arkosic, conglomeratic and non-pebbly, interbedded irregularly with coarse-grained siltstone in upper portion . .	120
2. Sandstone, medium gray, medium-grained, arkosic, largely non-pebble, but with sporadic pebble beds	22
1. Conglomerate, medium gray, with rounded phenoclasts up to six inches across in basal portion. Coarse-grained arkosic sandstone matrix. Cross-bedding common. One-pebble-thick pebble beds occur as interbeds	30

Mount Rogers Group

Geologic Section D

Section of Iron Mountain Formation exposed along roadcuts on U. S. Highway 16 on south flank of Straight Mountain, Grayson County, Virginia.— The top of the described section (Plate 2D) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 300 feet north of the corporate limits of Trout Dale, Virginia.

Iron Mountain Formation (Total Thickness: 2505 feet)

Upper Member (Thickness: 261 feet)	Thickness (feet)
15. Covered zone. Red-brown soil containing scattered quartz pebbles up to one-half inch across	22
14. Sandstone, medium gray, coarse-grained, arkosic, with many beds of red-brown tuffaceous shale up to 12 inches thick. Tuffaceous shale bed at top is about three feet thick	102
13. Sandstone, medium gray, coarse-grained, arkosic, cross-bedded, with sporadic rounded pebbles up to one-half inch across. Beds from one to ten feet thick	137

		Thickness (feet)
Middle Member (Thickness: 452 feet)		
12.	Covered zone. Red-brown soil containing shale chips in upper part and scattered pebbles up to one-half inch across in lower part	81
11.	Sandstone, medium gray, fine- to medium-grained, arkosic, pebbly and non-pebbly. Thin beds of arkosic siltstone in upper one-third. Torrential cross-bedding common	371
Lower Member (Thickness: 426 feet)		
10.	Shale, tan to white clay alternating with thin siltstone beds. Shale contains mica flakes along bedding planes	64
9.	Sandstone, medium gray, coarse-grained, arkosic, cross-bedded, pebbly and non-pebbly, with conglomerate beds in lower part and siltstone beds in the upper part. Rounded phenoclasts up to two inches across near base	362
8.	Fault(?). Covered zone. Red-tan soil containing scattered rounded pebbles up to one-half inch across	254

		Thickness (feet)
7.	Sandstone, medium gray, coarse-grained, arkosic, cross-bedded, with irregularly interbedded pebbly and conglomeratic sandstones. Rounded phenoclasts up to one inch across	221
6.	Fault(?). Sandstone, light green-gray, medium-grained, highly epidotized and fractured, with sporadic phenoclasts to 0.75 inch across	280
5.	Covered zone. Red-tan soil with rounded pebbles up to 1.25 inches across	87
Lower Member, Repeated (Thickness: 611 feet)		
4.	Shale, white to gray clay, interbedded with siltstone. Thickness estimated on basis of soil zone with shale chips	10
3.	Covered zone with scattered exposures of conglomeratic arkosic sandstone. Phenoclasts up to two inches across	203
2.	Covered zone with scattered outcrop of coarse-grained, arkosic, conglomeratic sandstone. Phenoclasts up to three inches across	192

	Thickness (feet)
1. Sandstone, medium tan to medium gray, medium-grained, feldspathic	119

Mount Rogers Group

Geologic Section E

Section of Iron Mountain Formation exposed in roadcuts along unnumbered, all-weather surfaced Grayson County road on south flank of Hickory Ridge, Grayson County, Virginia.— The top of the described section (Plate 2E) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 500 feet north of Benchmark N 13 at Houndshell Gap, and about 1200 feet northwest of Burton Chapel.

Iron Mountain Formation (Total Thickness: 1007 feet)

Upper Member (Thickness: 531 feet)	Thickness (feet)
10. Covered zone. Sporadic outcrops of medium-grained, dark gray, arkosic, pebbly sandstone. Phenoclasts up to one-half inch across	42
9. Siltstone, medium to dark gray, fine- to coarse-grained, feldspathic and arkosic. Interbedded with arkosic, fine-grained sandstones and red-brown tuffaceous shales. About 35 feet from the top is a four-feet thick tuffaceous shale bed; about 69 feet from the top is a five inches thick tuffaceous shale bed; the lower 42 feet contains numerous, less than two-inches thick, tuffaceous	

	Thickness (feet)
shale beds	135
8. Sandstone, medium gray, medium- to coarse-grained, arkosic, pebbly and non-pebbly, in beds up to three feet thick. Cross-bedding is common. Phenoclasts are well-rounded, and up to 0.75 inch across	354
Middle Member (Thickness: 215 feet)	
7. Shale, clay interbedded with thin siltstones .	25
6. Sandstone, medium gray, medium- to coarse-grained, arkosic, locally pebbly, cross-bedded. Beds up to six feet thick. Phenoclasts up to 1.5 inches across	76
5. Covered zone. Tan soil with scattered rounded pebbles up to 0.75 inches across . .	51
4. Sandstone, medium to dark gray, medium- to coarse-grained, arkosic, beds less than one foot thick, grading upward into irregularly alternating pebbly and non-pebbly sandstones .	63
Lower Member (Thickness: 261 feet)	
3. Shale, clay grading upward to silty clay . .	28
2. Sandstone, conglomeratic and arkosic, alternating irregularly with medium- to	

		Thickness (feet)
	coarse-grained, feldspathic and arkosic sandstone. Phenoclasts in basal beds up to three inches across; few phenoclasts more than one inch across in upper beds . . .	156
1.	Covered zone. Red-tan soil with scattered, rounded cobbles up to 2.5 inches across . . .	77

Mount Rogers Group

Geologic Section F

Section of Iron Mountain Formation exposed along roadcuts and in fields on south flank of Iron Mountains southeast of Blue Spring Gap, northern Grayson County, Virginia.— The top of the described section (Plate 2F) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 3300 feet southeast of Benchmark N 48 at Blue Spring Gap, and about 1.25 miles northwest of Comers Rock community.

Iron Mountain Formation (Total Thickness: 898 feet)

Upper Member (Thickness: 860 feet)	Thickness (feet)
18. Sandstone, medium gray, medium- to coarse-grained, arkosic, with intercalated pebble beds. Rounded phenoclasts up to 0.75 inch across	38
17. Shale, red-brown tuffaceous clay interbedded with buff siltstone beds. Cross-bedding common	0.5
16. Sandstone, light gray, fine- to medium-grained, arkosic, with pebbles up to one-half inch across. Intercalated, thin beds with silty shales	2
15. Shale, red-brown, tuffaceous clay, dense . . .	3.5

		Thickness (feet)
14.	Sandstone, light to medium gray, medium-grained, with rounded quartz pebbles up to one-half inch across	23
13.	Sandstone, white, coarse-grained, arkosic, with rounded pebbles up to one-half inch across	11
12.	Shale, red-brown, tuffaceous clay alternating with buff silty shales	0.5
11.	Sandstone, light to medium gray, medium-grained, arkosic, interbedded with buff to gray silty shales	2
10.	Shale, red-brown, tuffaceous clay	1
9.	Sandstone, medium gray, feldspathic, grading from coarse-grained at base to fine-grained at top	145
8.	Conglomerate, medium gray, with arkosic sandstone matrix. Rounded phenoclasts up to 0.75 inch across	0.5
7.	Sandstone, medium gray, medium- to coarse-grained, arkosic, with several intercalated pebbly beds	73
6.	Shale, red-brown, tuffaceous clay alternating with buff silty clay shale	1.5
5.	Sandstone, medium gray, medium- to coarse-	

	Thickness (feet)
grained, arkosic, cross-bedded, containing phenoclasts up to 0.75 inch across	46
4. Shale, white clay interbedded with very fine-grained siltstones	0.5
3. Sandstone, medium to dark gray, medium- to coarse-grained, arkosic, cross-bedded, with rounded pebbles up to 0.75 inch across . . .	512

Middle Member (Thickness: 38 feet)

2. Shale, white silty clay grading upward to clay shale	28
1. Conglomerate, with arkosic sandstone matrix. Rounded phenoclasts up to three inches across .	10

Mount Rogers Group

Geologic Section G

Section of Iron Mountain Formation exposed in road-cuts on U. S. Highway 21 on the south flank of Iron Mountains, Grayson County, Virginia.— The top of the described section (Plate 2G) is the base of the lowest basalt flow, within the Unicoi Group, which is located about one mile southeast of Dry Run Gap.

Iron Mountain Formation (Total Thickness: 646 feet)

Upper Member (Thickness: 510 feet)	Thickness (feet)
12. Sandstone, light gray to white, medium- to coarse-grained, arkosic with rounded pebbles up to one-half inch across. Beds are up to ten feet thick	50
11. Shale, red-brown, tuffaceous clay intercalated with very fine grained siltstone and silty clay shale	2
10. Sandstone, light gray to white, medium- to coarse-grained, with rounded pebbles up to one-half inch across. Grades downward to very coarse-grained, locally conglomeratic, arkosic sandstones. Beds to 20 feet	94
9. Sandstone, gray-green, medium- to coarse-grained, arkosic, pebbly and locally	

		Thickness (feet)
	conglomeratic, with chloritic clayey matrix. Rounded phenoclasts up to 0.75 inch .	198
8.	Covered interval	45
7.	Sandstone, similar to 9	86
6.	Argillite, red-brown, tuffaceous, interbedded with silt lenses which are up to 0.3 inch thick. Graded- and cross-bedding common	5
5.	Granule conglomerate, medium gray, vitreous, and arkosic	30

Middle Member (Thickness: 136 feet)

4.	Shale, white to tan, clay interbedded with silty clay and red-brown tuffaceous clay. Tuffaceous shale bed 2.5 feet thick at base .	9
3.	Granule conglomerate, as in 5, with erosional surface which exhibits up to two feet of relief on upper contact	5
2.	Shale, white, clay in upper part; gray-green siltstones interbedded with clay shales and red-brown tuffaceous clay shales in middle part. Lower ten feet is red-brown tuffaceous shale	70
1.	Conglomerate, with phenoclasts up to two	

	Thickness (feet)
inches across, and with arkosic sandstone matrix, alternating irregularly with arkosic, locally pebbly sandstones. Beds up to 10 feet thick	52

Mount Rogers Group

Geologic Section H

Section of Iron Mountain Formation exposed along Norfolk and Western Railway cuts, and in banks and bed of adjacent Green Cove Creek, Washington County, Virginia.— The top of the described section (Plate 2H) is the base of the lowest basalt flow, within the Unicoi Group, which is located about one mile northwest of Green Cove Church, and about three miles southwest of Konnarock, Virginia.

Iron Mountain Formation (Total Thickness: 520 feet)

Upper Member (Thickness: 520 feet)	Thickness (feet)
15. Covered zone. Soil and sporadic outcrops indicate arkosic, pebbly sandstone. Pebbles well-rounded and up to 0.75 inch across . . .	74
14. Sandstone, white to light tan, coarse-grained, arkosic, grading downward into similar sandstone which contains rounded cobbles up to two inches across. Cross-bedding common. Beds to six feet thick . . .	11
13. Shale, red-brown, tuffaceous silty clay, interbedded with arkosic siltstone	0.5
12. Sandstone, white to light tan, coarse-grained, arkosic and feldspathic, in beds up to 12 feet thick	47

		Thickness (feet)
11.	Shale, red-brown, tuffaceous, with rhythmically graded bedding and crude cross-bedding in siltstone interbeds	1.5
10.	Sandstone, light gray to tan, medium grained, arkosic	4
9.	Shale, red-brown, tuffaceous, dense	2
8.	Sandstone, medium greenish gray, coarse-grained, arkosic, and pebbly. Irregularly interbedded with conglomerates containing phenoclasts up to 1.5 inches across	162
7.	Conglomerate, with rounded phenoclasts up to two inches across in a coarse-grained arkosic sandstone matrix. Grades upward into medium- to coarse-grained arkosic sandstone	30
6.	Sandstone, medium to dark gray, coarse-grained, locally pebbly. Sporadic, irregularly intercalated siltstone beds up to three feet thick	52
5.	Sandstone, medium gray, coarse-grained, arkosic. Sporadic, intercalated conglomerate beds with rounded phenoclasts up to one inch across occur as beds up to six feet thick	80

		Thickness (feet)
4.	Sandstone, light to medium gray, medium-grained, arkosic, grading upward through arkosic siltstone to two-inch thick red-brown tuffaceous shale at top	6
3.	Sandstone, medium greenish gray, coarse-grained, arkosic to feldspathic, locally pebbly. Thin beds of conglomerate containing rounded phenoclasts up to 0.75 inches across occur sporadically	15
2.	Sandstone, medium greenish gray, coarse-grained, arkosic, with pebble beds up to eight inches thick. Sporadic, rounded phenoclasts up to two inches across	25
1.	Conglomerate, with rounded phenoclasts up to four inches across in matrix of coarse-grained medium greenish gray arkosic sandstone. Several zones exhibit cross-bedding. Layers of pebbles only one pebble thick are common	10

Mount Rogers Group

Geologic Section I

Section of Iron Mountain Formation exposed along roadcuts on U. S. Highway 58 on north flank of Big Hill, Washington County, Virginia.— The top of the described section (Plate 2I) is the base of the lowest basalt flow, within the Unicoi Group, which is located about one mile south of Konnarock, Virginia.

Iron Mountain Formation (Total Thickness: 906 feet)

Upper Member (Thickness: 449 feet)	Thickness (feet)
14. Covered zone, with float blocks of coarse-grained, arkosic pebbly sandstone	24
13. Sandstone, light tan to medium gray, medium-grained, pebbly, arkosic, with cross-bedding. Phenoclasts up to one-half inch across	60
12. Sandstone, light tan to medium gray, medium-grained, arkosic, with scattered phenoclasts up to one-half inch across. Cross-bedding common	115
11. Shale, red-brown, tuffaceous clay	0.5
10. Sandstone, medium gray, medium-grained, cross-bedded, arkosic, with sporadic phenoclasts up to one-half inch across . . .	5

		Thickness (feet)
9.	Shale, red-brown, tuffaceous clay	0.5
8.	Sandstone, similar to that in 10 but with phenoclasts up to 0.75 inches across	87
7.	Sandstone, similar to 8 and 10, but contains eleven interbeds of red-brown tuffaceous shale in beds from three inches to two feet thick	77
6.	Sandstone, light tan to medium gray, medium-grained, arkosic, cross-bedded, with rounded phenoclasts up to 0.75 inch across	80

Middle Member (Thickness: 457 feet)

5.	Shale, clay with interbeds of siltstone, white to light green. Bedding up to 1.5 inches thick	56
4.	Covered zone	121
3.	Conglomerate, with rounded phenoclasts up to five inches across within coarse-grained arkosic sandstone matrix. Interbedded with locally pebbly arkosic sandstone. Cross-bedding and graded bedding are common	186
2.	Sandstone, medium to dark gray, medium- to coarse-grained, locally pebbly with rounded	

	Thickness (feet)
phenoclasts up to one inch across	84
1. Conglomerate, with rounded phenoclasts up to three inches across within a coarse-grained arkosic sandstone matrix. Cross-bedding and graded bedding are common	10

Mount Rogers Group

Geologic Section J

Section of Iron Mountain Formation exposed in road-cuts along Smyth County Road 600 on the northwest flank of Straight Mountain, Smyth County, Virginia.— The top of the described section (Plate 2J) is the base of the lowest basalt flow, within the Unicoi Group, which is located about 1200 feet south-southwest of Horseshoe Bend, about 3500 feet northwest of Skulls Gap, and about 2.5 miles north-northeast of Konnarock Girls' School.

Iron Mountain Formation (Total Thickness: 930 feet)

Upper Member (Thickness: 563 feet)	Thickness (feet)
14. Sandstone, medium greenish gray, medium-grained, arkosic, with sporadic, rounded pebbles up to one-half inch across. Bedding up to five feet thick	17
13. Shale, red-brown, tuffaceous clay, dense, with splintery fracture	4
12. Sandstone, medium greenish gray, medium- to coarse-grained, arkosic, cross-bedded, locally pebbly. Interbedded with feldspathic sandstone and siltstone	65
11. Shale, red-brown, tuffaceous clay, interbedded with silty shale	8

		Thickness (feet)
10.	Sandstone, similar to that in 12. Bedding to 10 feet	235
9.	Sandstone, similar to that in 12, but with twelve interbeds of red-brown tuffaceous clay shales in beds up to one foot thick. At top is a two-feet thick tuffaceous shale bed and at bottom a 2.5-feet thick bed	100
8.	Sandstone, similar to that in 12	134
Middle Member (Thickness: 367 feet)		
7.	Shale, tan, silty clay overlying 20 feet of white silty clay	94
6.	Sandstone, medium greenish gray, medium-grained, arkosic, with rounded phenoclasts up to 0.75 inch across. Cross bedding common .	32
5.	Shale, red-brown, tuffaceous clay. Two, six-inches thick beds separated by one foot of medium-grained arkosic sandstone	2
4.	Sandstone, similar to that in 5, but containing rounded phenoclasts up to one inch across	13
3.	Shale, red-brown, tuffaceous clay, dense, with splintery fracture	2

	Thickness (feet)
2. Sandstone, medium greenish gray, coarse-grained, arkosic, with rounded phenoclasts up to 1.5 inches across	66
1. Conglomerate, with rounded phenoclasts up to 2.5 inches across within coarse-grained arkosic sandstone matrix. Irregularly interbedded with sporadically pebbly, arkosic sandstones	158

Alluvium and Slope Wash, Probably Covering Holston Mountain Fault

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ABSTRACT

The Precambrian or Cambrian Unicoi Formation in southwestern Virginia consists of at least three lithologically distinct rock sequences which can be distinguished as formations. The Unicoi therefore should be raised to the rank of group. The lowest rock sequence is named Iron Mountain Formation; the middle sequence, consisting of three basalt flows and inter-layered clastic sedimentary rocks, and the upper sequence of clastic sedimentary rocks are not named.

The Iron Mountain Formation was mapped in four generally parallel outcrop belts in the Unaka Mountain Group in parts of Washington, Smyth, Wythe, and Grayson counties, Virginia. Three of the belts were the subjects of concentrated study. The formation consists of three distinct sedimentary rock sequences, each of which grades from very coarse-grained at its base to very fine-grained at its top. They are designated the lower, middle, and upper members of the Iron Mountain Formation. Each of the two upper members are more widely distributed than its subjacent member and each directly overlies rocks of the underlying Mount Rogers Group progressively farther from the site of initial deposition of sediments within the formation.

The rocks constituting the Iron Mountain Formation represent three distinct phases of alluvial plain development, each of which apparently resulted from renewed uplift of the source area to the southeast. The depositional area was one of irregular but continuous subsidence and coincided in part with the strand zone, or foreshore, of a sea which was located to the northwest. Stratigraphic relationships of tuffaceous shales which are contained within the middle and upper members, and which reflect volcanic activity probably within the source area, indicate that individual clastic members within the Iron Mountain Formation are time-transgressive and that some of the sediments contained within the upper part of a member are probably of the same age as some of the sediments within the lower part of the suprajacent member.

The boundary between the Iron Mountain Formation and the subjacent Mount Rogers Group is apparently gradational in the central part of the mapped area, but represents a disconformity of increasing magnitude in all directions from that area.

The source area, as suggested by laboratory studies of phenoclasts contained within the formation, probably consisted chiefly of rocks similar to those within the present-day Blue Ridge and Piedmont provinces, but more specifically contained rocks similar to those exposed

near Azen Church, Washington County, Virginia, and within the Mount Rogers Group. Some phenoclast lithologies which megascopically resemble chert are actually highly silicified, tourmalinized, epidotized, chloritized, or otherwise altered igneous rocks or quartzose metasediments.

Structurally, the mapped area consists of the Holston Mountain fault block to the northwest and the Iron Mountain fault block to the southeast. The Iron Mountain fault block was mapped only in the southwestern part of the area, where it has previously been mapped as the northeastward extension of the Mountain City window.

The Holston Mountain fault block, bounded on the northwest by the Holston Mountain fault, consists chiefly of the locally northwestwardly overturned, northeastwardly trending Straight Branch syncline in the southwestern part of the mapped area. Only the locally northwestwardly overturned southeastern limb is present in the northeastern part of the mapped area.

The Iron Mountain fault block, bounded on the northwest by the Iron Mountain fault, consists chiefly of the locally northwestwardly overturned southeastern limb of the Green Cove syncline in the mapped area. Part of the northwestern limb of the syncline is contained within the Iron Mountain fault zone northeast of Taylors Valley.

The Green Cove syncline has been thrust onto the southeastern limb of the Straight Branch Syncline.

The Iron Mountain fault which has been traced from about 2.5 miles north of Laurel Bloomery, Tennessee, northeastward to the Azen Church area near the boundary of Washington and Smyth counties, Virginia, is believed to continue northeastward from that area for as much as five miles within rocks of the Mount Rogers Group. Within this group its trace is indistinct to unrecognizable.

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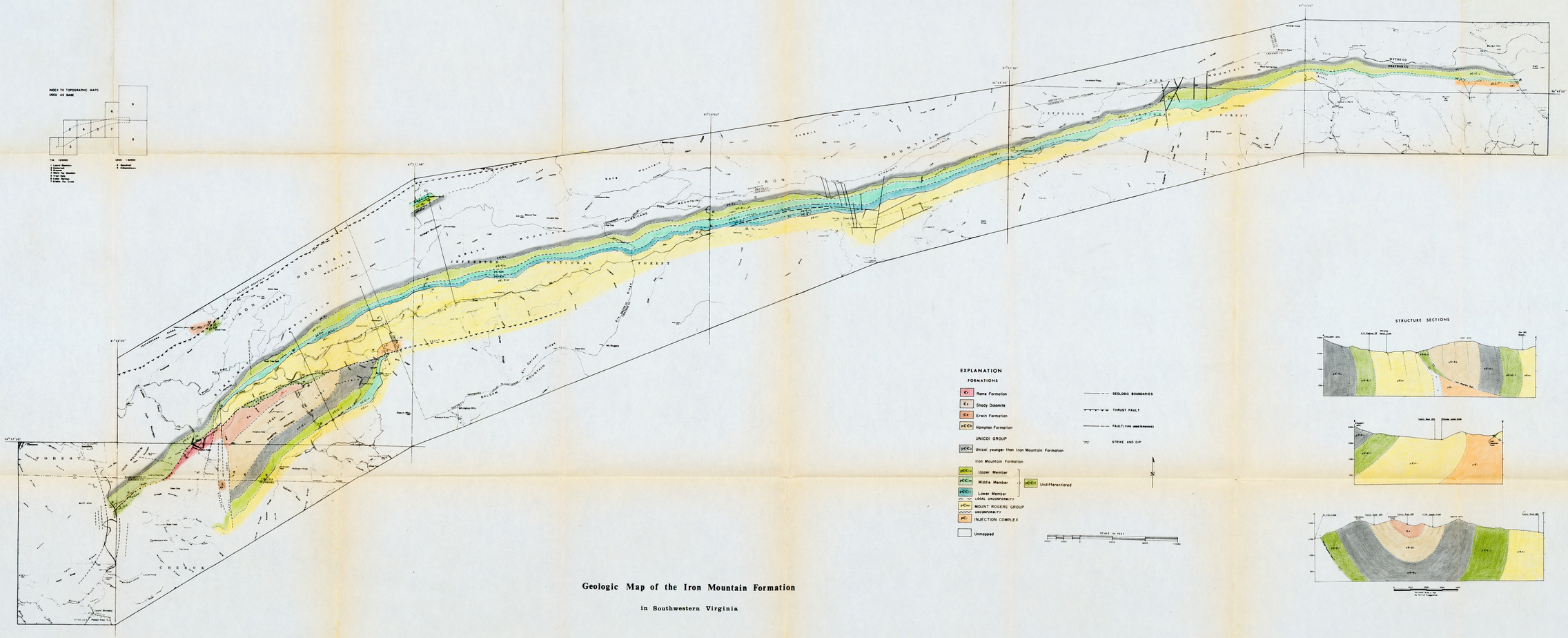
Thomas Jack Carrington
Stratigraphy and petrography of the Iron Mountain formation...

PLATE 1

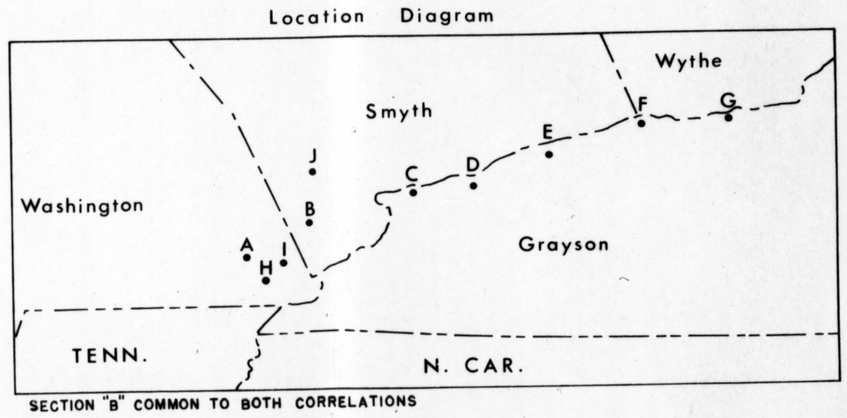


STRUCTURE SECTIONS

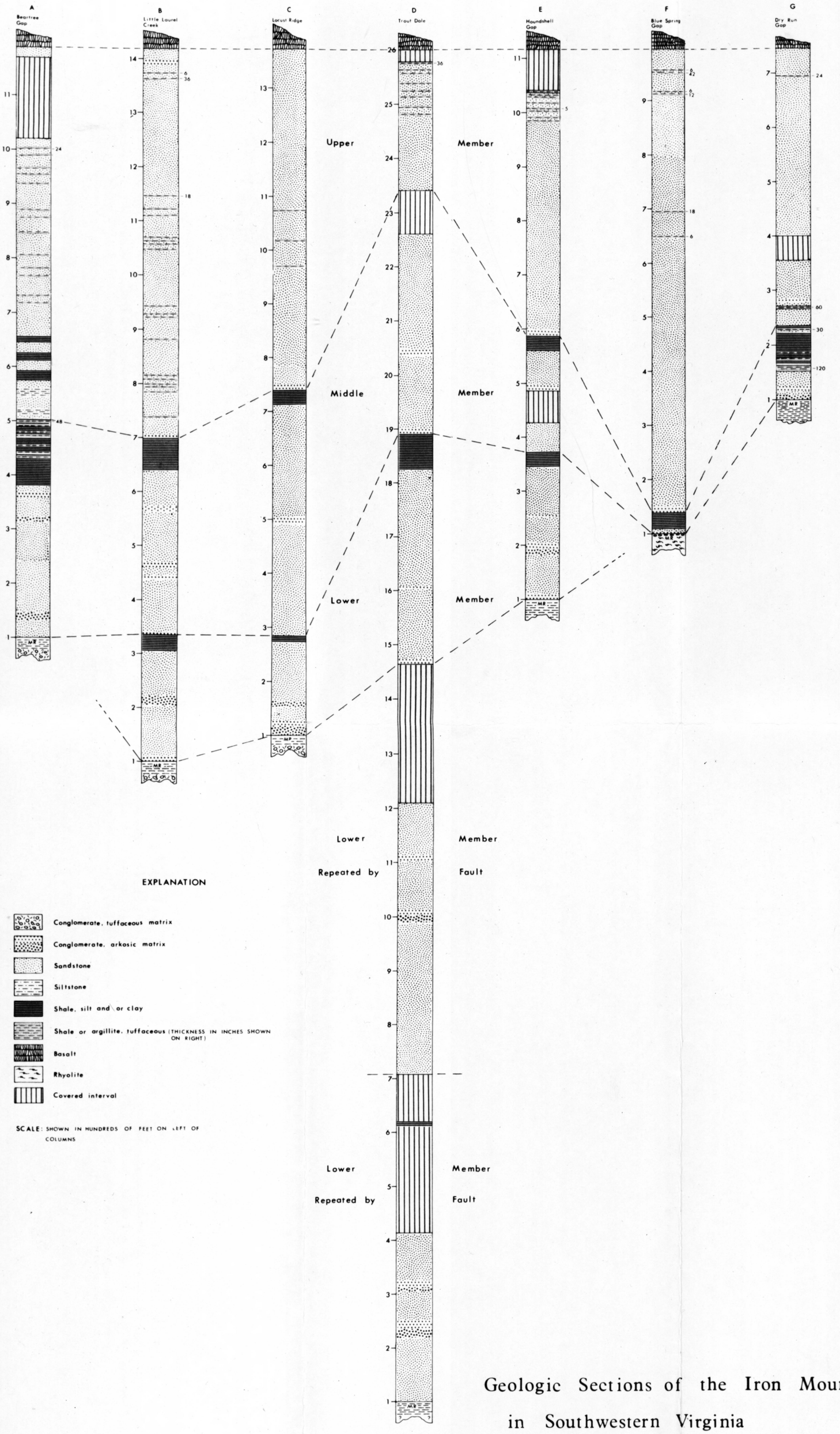
Geologic Map of the Iron Mountain Formation

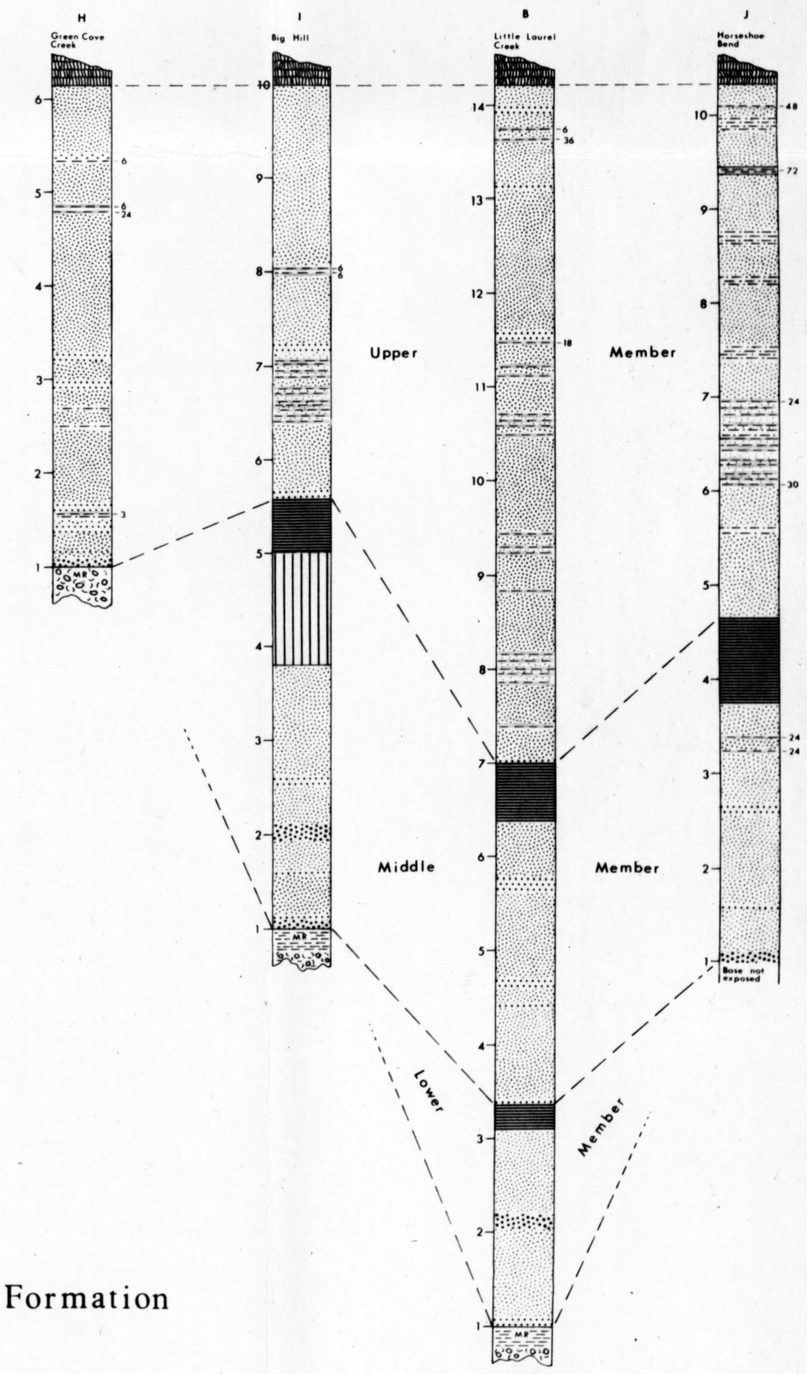
in Southwestern Virginia

PLATE 2



SECTION "B" COMMON TO BOTH CORRELATIONS





EXPLANATION

- Conglomerate, tuffaceous matrix
- Conglomerate, arkosic matrix
- Sandstone
- Siltstone
- Shale, silt and\or clay
- Shale or argillite, tuffaceous (THICKNESS IN INCHES SHOWN ON RIGHT)
- Basalt
- Rhyolite
- Covered interval

SCALE: SHOWN IN HUNDREDS OF FEET ON LEFT OF COLUMNS

Geologic Sections of the Iron Mountain Formation in Southwestern Virginia