STRUCTURAL GEOLOGY OF THE SINKING CREEK AREA,

GILES COUNTY, VIRGINIA

by

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Structural Geology of the Sinking Creek Area,
Giles County, Virginia

Abstract

Geologic structures in the Sinking Creek area include folds and faults in both competent sandstones and dolomites and incompetent limestones and shales. Prominent structural features which are topographically reflected embrace a major fault zone, an anticline, and a syncline. Drag folds associated with the Saltville fault zone are well exposed. Geomorphic features are controlled largely by structure. A breached anticline, a fault zone expressed by a valley, and large colluvial fans are noticeably developed. The formations studied, range from Upper Cambrian to Lower Devonian.

Purpose of Study

The Sinking Creek area was studied in order to gain an insight into the relationships of folds to major overthrust faults in an area of complicated structure. This study involved description and measurement of Upper Cambrian to Lower Devonian strata having an approximate thickness of 5,400 feet. The primary purpose of this investigation was to master the complex of techniques used in areal mapping of Appalachian structures in competent and incompetent beds.

Methods of Study

The investigation was primarily conducted to study geologic structure. Two considerations are presented with regard to the treatment of the stratigraphy. First, thickness of strata can only be approximated. Contortions of the formations that resulted from folding and faulting has caused indetermineable repetition and thickening of the beds. Secondly, paleontological data are not presented in this report. The change in lithology was considered varied enough so that a rather detailed structure map could be completed without the use of fossil evidence.

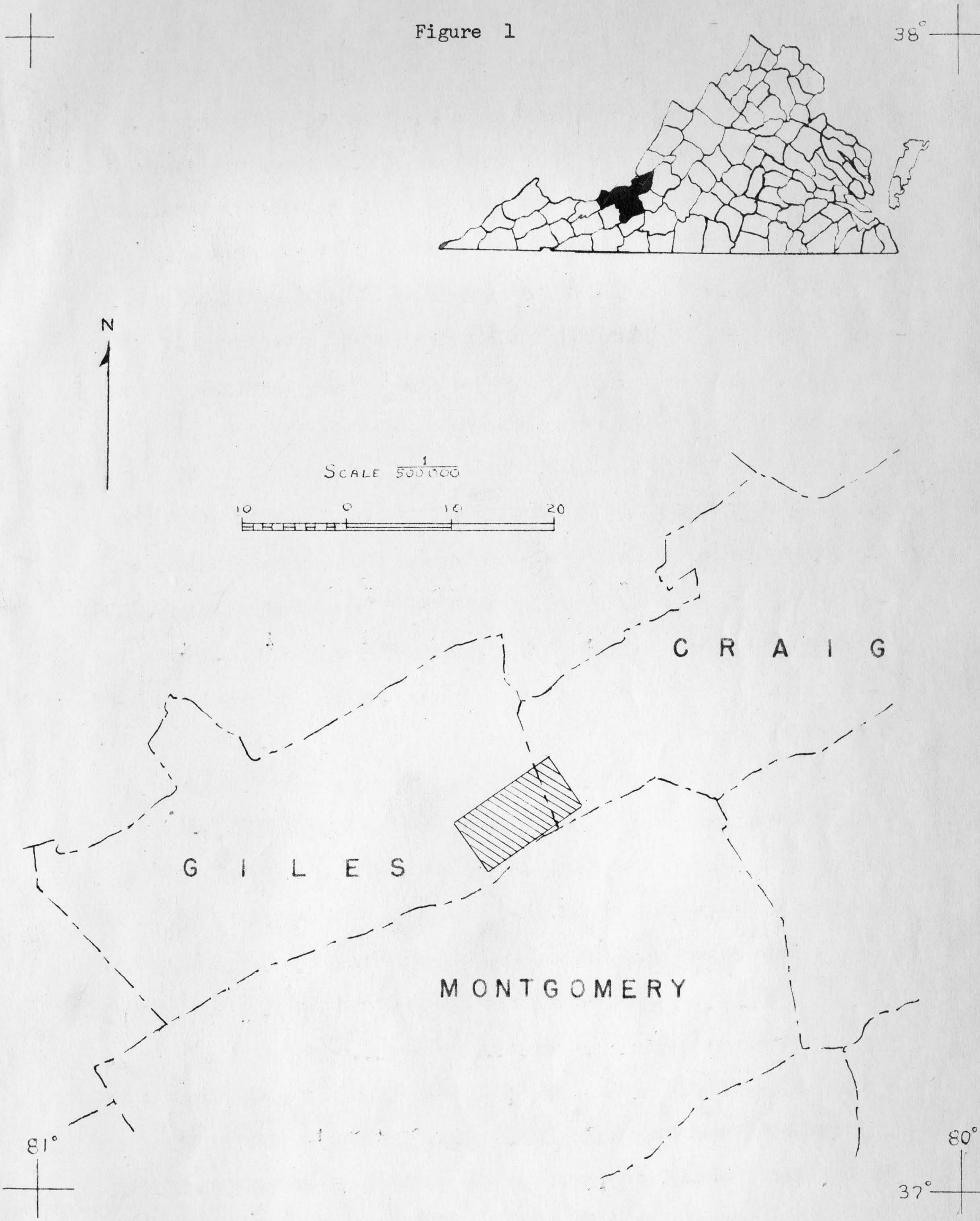
Location of Area

The Sinking Creek area is situated in the southeastern part of Giles County, and along part of the southwestern margin of Craig County, Virginia. It is named for Sinking Creek which flows through the southeastern portion. It is covered by the Pearisburg (1944) and Waiteville (1953) 15-minute topographic maps, both on a scale of one inch equals approximately one mile. Area consists of a strip eight miles long and four miles wide, which parallels the strike of the beds. Newport is the only town in the area.

Previous Work

Boyd (1881, p. 134-158) published the first summary of the geology of Giles County. The geology is said to be (Hubbard, G. D., Croneis, C. G., 1924) a "summarized... account...", of W. B. Rogers' "Geology of the Virginias" written in 1841. Iron ore, manganese, and limestone are stressed as economic minerals by Boyd. In addition to the geology, physical, social and cultural features and scenery are noted by the author .

Figure 1



LOCATION OF THE SINKING CREEK AREA

Watson (1907) referred to an iron furnace built in 1873 which operated near Newport. The ore was reported mined on the south side of Spruce Run Mountain. Stose and Miser (1922) published descriptions of the manganese prospects in Giles County, including the Carrie (1918), Laing (1918), and the Price prospects near Newport. Stose and Miser mention that manganese is found in residual yellow clay and chert and may have been formed on the Valley Peneplain.

Hubbard and Croneis (1924) published an outline of the geology of Giles County. Included in their report was a brief summary of physiography, stratigraphy, and economic resources. With data collected by students over a period of years, the authors have presented an article to arouse interest in the geology of Giles County, Virginia.

In 1929 the Engineering Extension Division of Virginia Polytechnic Institute in the "Industrial Survey of Giles County, Virginia", in which Dr. R. J. Holden, Professor of Geology, contributed notes on the natural resources, particularly iron ore and limestone.

Mathews (1934) described the marble prospects of Giles County with regard to economic possibilities. In his discussion a geologic map of the marble belts has been sketched. This report interprets the structure, stratigraphy, and origin of the marble. A. A. Pegau contributed a section of petrography of the marbles in Mathews' report.

B. N. Cooper (1944) published a survey of industrial limestone and dolomites of the New River-Roanoke River District, Virginia. The purpose of the report is to "... furnish accurate information on the location, thickness, character and chemical composition of available deposit of industrial limestone and dolomite". Several of the lower Middle Ordovician limestone occuring in the Sinking Creek area were described.

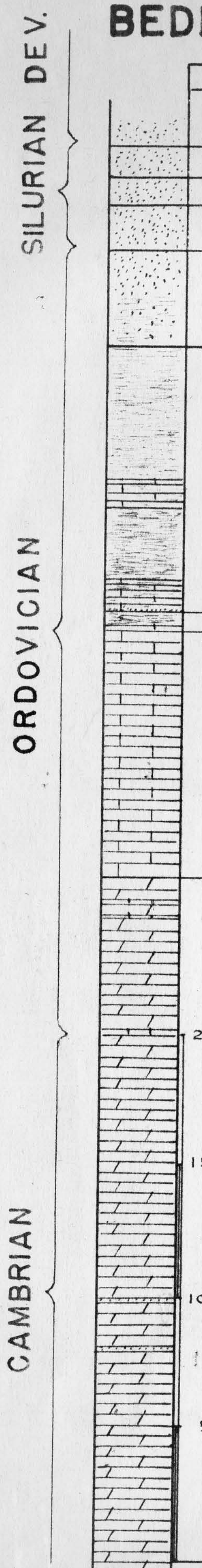
Most of the previous work has been written in conjunction with economic development of mineral resources. No record of detailed mapping of the Newport area occurs in the literature. Several maps (Boyd, C. R. 1881; Butts, 1933, 1940; Stose and Miser, 1922; and Mathews 1934) delineate the general areal geology of Sinking Creek, but good topographic maps were not available for use as bases for those studies.

Stratigraphy

General Statement. The strata in the Sinking Creek area, Giles County, Virginia, has approximately 5,400 feet of sedimentary beds, ranging in age from Upper Cambrian to Lower Devonian (Fig. 2). Dolomites and limestones make up the lower two-thirds of the column, and shales, siltstones, and sandstones make up the upper part. All of the sedimentary bedrock is marine in origin.

Knox Dolomite Group. The Cambro-Ordovician Knox dolomite group is predominantly dolomite, but contains a few layers of banded shaly dolomite. The dolomite is divided arbitrarily into three groups. The upper 600 feet of dolomite is underlain by a 10-foot bed of medium-gray fine grained limestone which forms the Cambrian-Ordovician boundary; above the limestone the light gray fine to medium-grained dolomite contains white chert and some limestone interbeds near the top (Plate 1). The middle 1000 feet of dolomite is light to medium-gray and fine to medium grained. The lower dolomite is capped by a white friable sandstone

BEDROCK FORMATIONS OF THE AREA



FORMATIONS	GEOMORPHIC SIGNIFICANCE
ROCKY GAP SANDSTONE	Nonresistant Forms dip slopes
KEEFER SANDSTONE	Resistant Ridge-former
CACAPON SANDSTONE Rose Hill	Resistant Partial ridge-former
CLINCH SANDSTONE Tuscarora	Resistant Ridge-former
JUNIATA FORMATION	Nonresistant Forms relatively steep slopes on spurs
MARTINSBURG FORMATION	Nonresistant The limestone member supports the valley spurs and the shale member forms gentle spur slopes
MOCCASIN FORMATION	Partially resistant, Supports spurs
MIDDLE ORDOVICIAN LIMESTONES	Mostly nonresistant The very pure members form low ridges. Karst topography is typical of this group.
KNOX DOLOMITE	Partially resistant Forms low ridges or supports low spurs

Figure 2

about three feet thick. Two hundred feet below this zone is another resistant light-tan sandstone bed about six feet thick. The dolomite in this zone ranges from dark-gray, medium grained to light-gray fine grained types. The lower 50 feet weathers pinkish. The dolomites show depositional banding, (which produces a shaly dolomite), granular texture, and cross-bedding. In thin section the light-gray Knox is a fine- to medium-grained, clastic dolomite with scattered dolomite eyes. The Knox dolomite is approximately 2600 feet thick.

Middle Ordovician limestones. The Middle Ordovician limestones are 920-940 feet thick. The texture of the limestones overlying the Knox dolomite varies greatly. There are four general types of limestone in the group. The lower phase is a medium- to dark-gray, medium-grained limestone that contains an abundance of black chert (Plate 2A). This phase recurs (approximately four times) in the lower part of the Middle Ordovician section. Two dove-gray, extremely fine-grained limestones (calcilutites) which exhibit cross bedding upon weathering have numerous stylolite seams that are parallel and/or transverse to the bedding plane. A third type is a blue-gray fine- to medium-grained limestone. Near the top of the section there is a succession of argillaceous ribbony limestone which grades into the overlying Moccasin formation. Several of the beds have a faint to a very strong petroliferous odor when freshly broken. The odor dissipates rather rapidly. The thin section study closely reflects the megascopic characteristics. The iron sulfide, calcite, dolomite, and chert relationships, however, are more evident (Plate 2B).

Moccasin formation. The Ordovician Moccasin formation is 50-70 feet thick. It may be divided into two phases, the lower phase is a olive-green to drab chocolate-red, extemely fine-grained limestone, commonly referred to as the marble or calcilutite member (Plate 3B). The upper phase is a drab chocolate-red limy claystone. This phase has well developed cleavage and often contains stringers of limestone which are similar to the lower member (Plate 3A). The limestone is slightly argillaceous and contains mudcracks and ripple marks. In thin section the lime matrix may be seen to be extremely fine grained with scattered calcite eyes.

Martinsburg formation. The Ordovician Martinsburg formation is 990-1020 feet thick (Plate 4A). The formation grades from a two to four foot basal sandy limestone through an argillaceous blue-gray medium grained limestone (about 100 feet thick) into a buff to ocher highly fissile shale. The sandy limestone is of special interest because in thin section it is seen to be composed of large subrounded grains of quartz, small angular to subangular grains of quartz and feldspar (plagioclase predominant), and a grain of epoditized quartz which may have had a Blue Ridge provenance.

Juniata formation. The Ordovician Juniata formation is 340-370 feet thick. The formation is composed of drab-red and olive-green shales and drab-red siltstones. The siltstone is nonresistant and therefore is crumbly. The shales are fissile. Cross-bedding is a prominent feature (Plate 4B). In thin section the siltstone contains angular to subangular grains of quartz, plagioclase, and opaque minerals (magnetite, illmenite, leucoxene) that are closely packed in an iron oxide matrix. The siltstone is cut by transverse veins of coarse quartz that contain an unidentified, finely divided, highly pleochroic green mineral. The plagioclase with the exception of a few fresh grains is altered to sericite.

Clinch sandstone. The Silurian Clinch sandstone is 150-170 feet thick. The sandstone is white to tan, except the zone near the Cacapon-Clinch contact which is mottled purple and white. The sandstone is fine-grained except for a conglomerate bed five feet thick, thirty feet above the Clinch-Juniata contact (Plate 5A). The upper forty feet of the Clinch sandstone is brittle. Sedimentary structures include cross-bedding, gradded-bedding, and ripple marks. In thin section the sandstone contains interlocking grains of quartz, some of which have outgrowths. A few grains of iron oxide are present.

Cacapon sandstone. The Silurian Cacapon sandstone is 90-110 feet thick. The Cacapon is composed of purple, fine- to medium-grained, brittle sandstone with a few purple shale beds (Plate 5B). The upper forty feet of strata are extremely thick and resistant (Plate 6A). The Cacapon is cross-bedded, has gradded-bedding, and is ripple marked. In thin section the sandstone is composed predominantly of angular to rounded grains of quartz in an iron oxide matrix. Subrounded tourmaline and rutile grains also are present. The quartz grains which are chiefly subrounded are scattered through the matrix which comprises more than 50 percent of the rock.

Keefer sandstone. The Silurian Keefer sandstone is 100-120 feet thick (Plate 6B). The sandstone is white or tan and commonly has red streaks. Cross-bedding and iron-staining are prominent locally. Near the base of the Keefer there are about 30 feet of a friable sandstone. In thin section the sandstone is similar to the Clinch sandstone.

Rocky Gap sandstone. The Lower Devonian Rocky Gap sandstone is a brown friable fine- to coarse-grained sandstone. Because of its friable nature, the sandstone rarely has outcrops.

Structure

General Statement. The geologic features in the Sinking Creek area include complicated faults and drag folds which are subsidiary contortions that resulted from the Saltville fault. The drag folds are developed on major and minor scales. Well defined flow and fracture cleavage are singular to the Moccasin formation.

Saltville fault zone. The fault zone is located on the southeastern slopes of Spruce Run and Clover Hollow mountains. The fault zone composed of two major parallel faults which trend with the strike of the beds is accompanied by minor fracturing in the Sinking Creek Valley (Figure 3). The faults dip approximately 60° to the southeast. The northwesterly break of this pair of faults is evident where Knox dolomite is thrust over younger Ordovician beds, or locally where manganese has penetrated the fault zone to yield a manganese-cemented breccia. Displacement along the fault varies from 500 to 1500 feet. The exposure of the Knox dolomite in the Sinking Creek Valley is greater than the normal 2600 feet. The other fault which is definitely present northwest of Newport on U.S. Route 460 is thought to continue northeastward up the Sinking Creek Valley parallel to the northwest member, but its outcrops are concealed

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by alluvium. Two definite zones of chert which are in the upper part of the Knox dolomite and silicified autoclastic breccia are evidence for the second fault.

__Clover Hollow Anticline.__ The anticline is located between Johns Creek and Clover Hollow mountains. The crest of the slightly asymmetrical trends approximately N. 55° E. and plunges approximately 6° to the northeast. The resistant Knox dolomite which is exposed along the crest is broken by tension and compressional joints, the former being transverse to the strike and the latter being parallel to the strike. Two structural terraces occur in the Middle Ordovician limestone on the southeastern side of the Clover Hollow anticline. Anticlinal folds are developed on the northwestern limb of the major anticline (Plate 7A). The Clover Hollow anticline on the southwest end is an anticlinorium with a prominent synclinal crease down the middle of the structure.

In the gap between Spruce Run and Clover Hollow mountains faults and drag folds in incompetent limestone, claystone, and shale, are minor effects of overthrust along the Saltville fault zone. Locally, between two parallel faults on the northwest side of Spruce Run Mountain Middle Ordovician limestones have been thrust over Moccasin and Martinsburg formations. In the gap there is a wide exposure of Moccasin and Martinsburg formations that is thought to be a broad syncline. In the syncline fracture cleavage in the limestone and slaty cleavage in the mudrock are well developed (Plate 8). (See "Minor structures", p. 10)

Clinch sandstone rims the edge of the mountains in the area. As the Clover Hollow anticline was being formed, the brittle Clinch reacted to the deforming forces partly by the development of shear. These faults are charcterized by Silurian Cacapon beds that are thrust against the Ordovician Juniata in a broken overturned fold in the Rocky Gap fault at Rocky Gap. On the southeast side of Kelly Knob a similar structural situation probably occurs.

Spruce Run Syncline. The syncline is marked by the southeastern mountain range trends with the strike of the beds. The Spruce Run syncline was formed by drag syncline along the foot wall of the northwest fault of the Saltville fault zone. The hanging wall (Plate 9) of the northwesterly fault block in the Saltville fault zone is thrusted, causing a drag fold in the foot-wall of the overriden block. The Knox dolomite of Cambro-Ordovician is brought in contact with Middle Ordovician limestones to Silurian sandstone.

The horizontal displacement of the offset fault in Clover Hollow Mountain is approximately 50 to 100 feet. The fault is reflected by fractures and joints in the Clover Hollow Valley. The relationship between the offset and the Saltville fault is obscured by colluvium

Minor Structures. Cleavage in the Moccasin is a paramount feature in the drag folding in the Sinking Creek area (Plate 8B). Flow cleavage, divided into slaty and axial plane cleavage by Billings, M. P. (1949), and fracture cleavage are forms of secondary foliation. Nevin, C. M. (1949) says flow cleavage "...occurs in the plane of maximum elongation" (strain ellipsoid) and fracture cleavage "...occurs in shear planes which should be inclined to that position." Lahee, F. H. (1952) distinguishes flow cleavage as having one well developed direction of cleavage planes.

Rowland, R. A. (1939) states that cleavage in the mudrock phase of the Moccasin formation in Sinking Creek is fracture cleavage. Above the limey claystone phase of the Moccasin which has developed axial plane cleavage, the more competent sandy limestone phase shows fracture cleavage. From field examination flow cleavage appears to be the type cleavage exhibited in the mudrock.

Geomorphology

General Statement. The Sinking Creek area covering approximately 35 square miles is located in the Valley and Ridge Province. The maximum relief in the area is approximately 2000 feet. The highest elevation is 3788 feet on the northeastern end of Kelly Knob Ridge and the lowest elevation is 1780 feet in Sinking Creek on the northwestern slope of Spruce Run Mountain. Three mountains, Spruce Run, Clover Hollow, and Johns Creek and two valleys, Sinking Creek and Clover Hollow (Plate 10).

New River is an outlet for the Sinking Creek drainage. Numerous tributaries empty into Sinking Creek from adjacent mountain slopes and Clover Hollow are major features.

Drainage Relationships. Structure controls the major geomorphic features of Sinking Creek. Breaching of the Sinking Creek anticline and the subsidiary Clover Hollow anticline has been aided by faults and fractures which parallel the bedding attitude and by solution work on soluble limestones, which, as a result contain numerous caverns (Plate 11).

The Sinking Creek area is located on the Atlantic-Gulf divide. Johns Creek Mountain forms the divide and Johns Creek is tributary to the James

River. The major portion of the drainage of the Sinking Creek area flows to the Gulf of Mexico. The upper end (southwest end) of Johns Creek Mountain is approximately 1000 feet below the highest elevation on the Atlantic Ocean side of the divide in Giles County.

Alluvium is found on stream terraces at 2350, 2100, and 1850 feet above sea level (Plates 12,13). The gravels derived from Silurian sandstones were mechanically weathered in a possible sub-humid climate. A thick gravel deposit related to the 2100 foot level of alluvium in the Sinking Creek Valley is located just west of Newport on a hillside adjacent to State Highway 42. The deposit may represent an old slip off slope of the New River. Several vein-quartz pebbles were found in with the thoroughly weathered Silurian sandstone gravels. Vein quartz is foreign to Giles County and could only have been brought to rest near Newport by New River. As no alluvium is found on the northwest side of the deposit which is below the top of the hillside, the drainage of the New River probably flowed through the gap where Sinking Creek flows. The New River which probably circled Spruce Run Mountain appears to have pirated itself with the aid of rapid cutting of Sinking Creek and its tributaries.

Colluvial fans occur above the 2350-foot level as the result of mechanical erosion (Plate 14). As the soft, nonresistant rock beneath the Silurian sandstones was eroded large blocks of sandstone broke off from bedrock and accumulated to form large colluvial fans.

Several present minor erosional features which include flood plains, stream meander, gullying, etc. are all active processes in the Sinking

Creek Area (Plates 15-17A).

Acknowledgements

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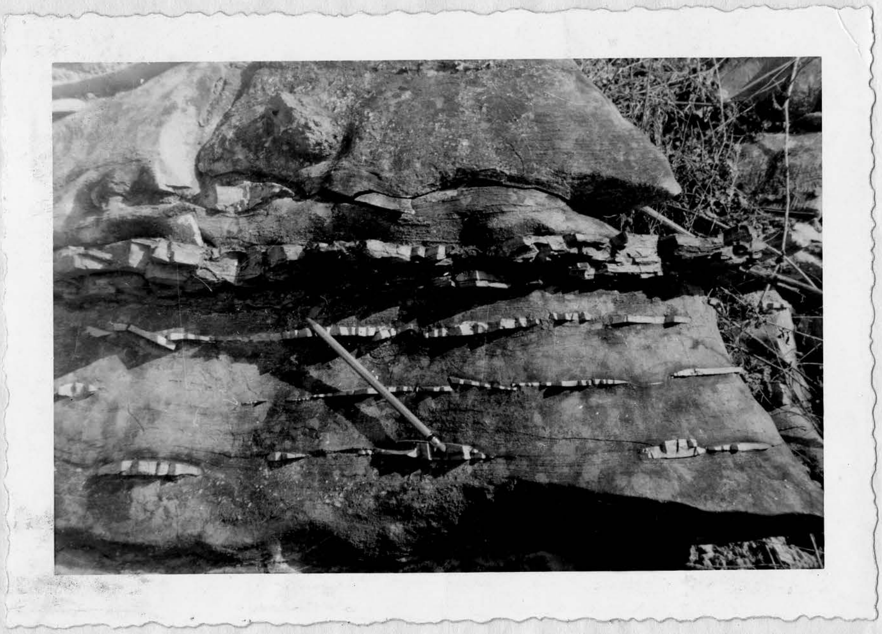
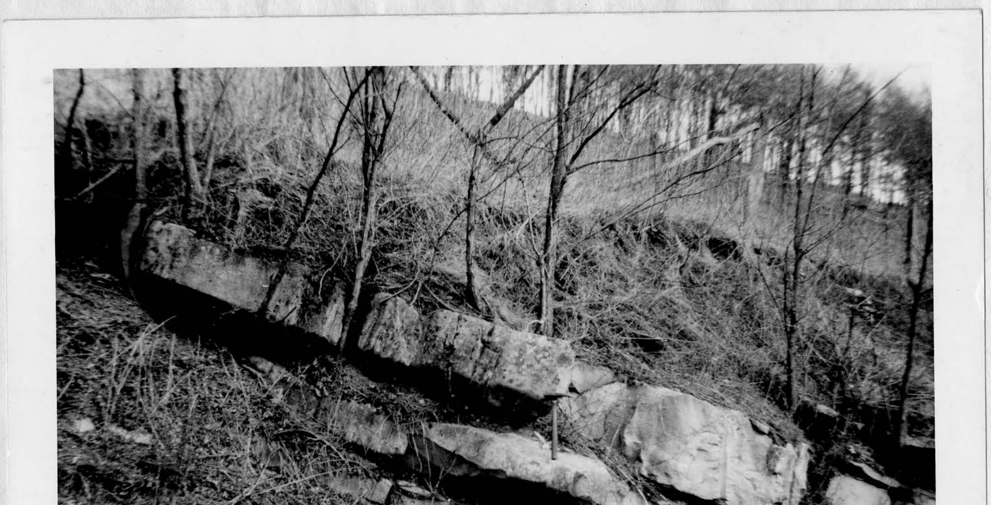
PLATE 1

A. Route 700, Giles County, Virginia, approximately 0.8 mile from junction Route U.S. 460 and Route 700 - White chert in Upper Knox Dolomite - Courtesy R. V. Dietrich.

B. Same as A. - Knox dolomite just below Knox-Middle Ordovician limestone contact.



A

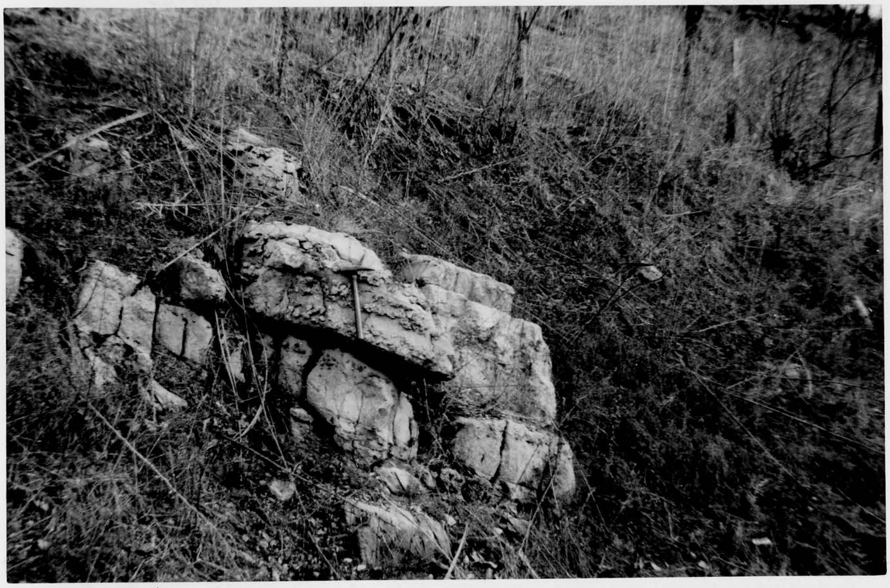


B

PLATE 2

A. Route 700, Giles County, Virginia, approximately 0.3 mile from junction Route U.S. 460 and Route 700 - Black chert in the basal Middle Ordovician limestones.

B. Just northeast of junction of routes 685 and 601, Giles County, Virginia - Lower calcilutite member of Middle Ordovician limestones showing solution work and stylolites.



A

B

PLATE 3

A. Just 0.2 mile southwest of junction of routes 601 and 602 - Upper limy claystone phase of Moccasin formation, and lower sandy limestone of the Martinsburg formation above the top group of sheep.

B. Just 0.1 mile southeast of junction of routes U.S. 460 and 700 - Lower limestone phase of the Moccasin formation.

A

B

PLATE 4

A. One half mile southeast of Craig-Giles county line on Route 601 - Limestone member of the Martinsburg formation.

B. One half mile northeast of Craig-Giles county line on Route 601 - Cross-bedding in overturned Juniata formation.

A

B

PLATE 5

A. One half mile northeast of Craig-Giles county line on Route 601 - Vertical conglomerate bed in the Clinch sandstone.

B. One half mile northeast of Craig-Giles county line on Route 601 - Fracture cleavage in the lower member of the Cacapon sandstone.

A

B

PLATE 6

A. One half mile northeast of Craig-Giles county line on Route 601 - Thick resistant beds of the Upper Cacapon sandstone .

B. One mile northeast of Craig-Giles county line on Route 601 - Resistant bed in the Keefer sandstone.

A

B

PLATE 7

A. Just southwest of junction of routes 601 and 602 on Route 602 Giles County, Virginia - Anticline on the northwest side of the Clover Hollow anticline showing the contact between the Middle Ordovician limestones and the Moccasin formation.

B. Wind gap in Gap Mountain looking south from Newport, Virginia.

A

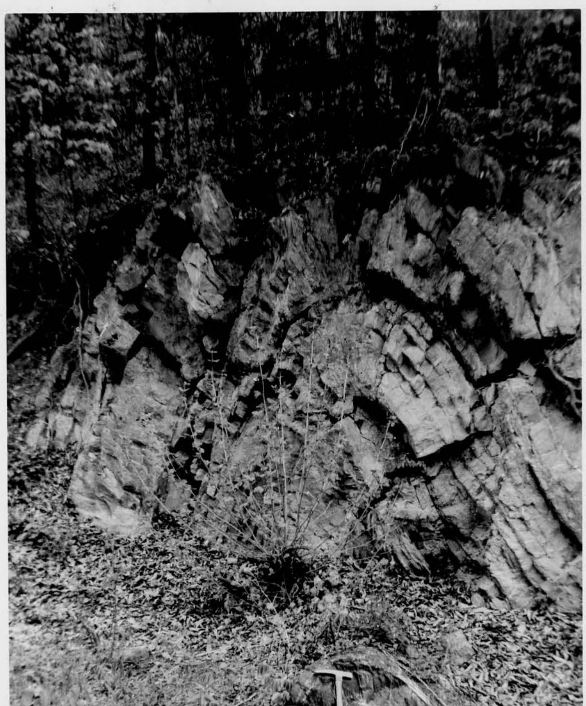
B

PLATE 8

A. At the foot of Spruce Run Mountain on the northeast side - Fracture cleavage in the upper argillaceous member of the Middle Ordovician limestones, note slippage of fracture joints

B. On Route 601 northeast of junction of routes 601 and 604, Giles County, Virginia - Asymmetric drag fold in the Moccasin formation showing fracture cleavage in the limestone member and axial plane cleavage in the limy claystone member.

A



B

PLATE 9

A. On Route U.S. 460 0.1 mile northwest of Newport, Virginia - Fault scarp of the southeastern fault block showing the hanging wall.

B. On Route U.S. 460 0.1 mile northwest of Newport, Virginia - Fault scarp of the southeastern fault block showing the hanging wall.

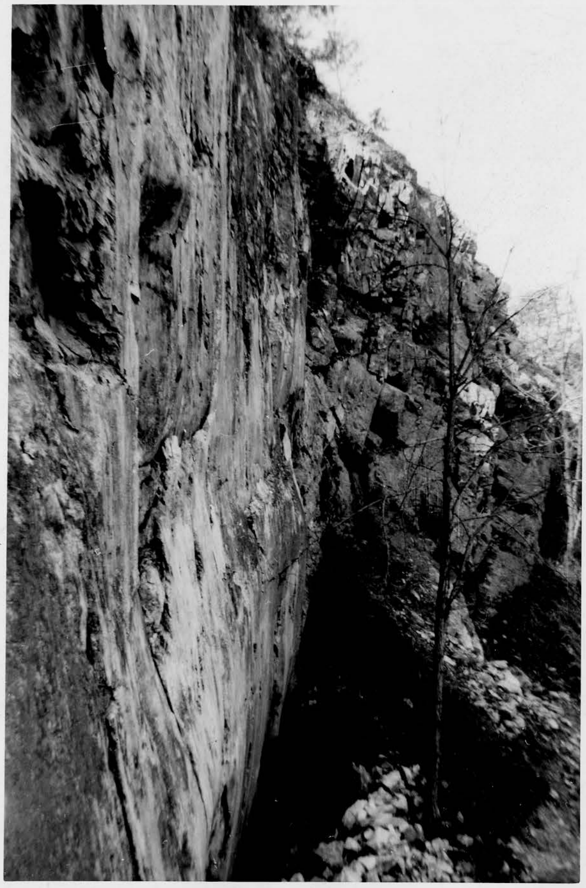


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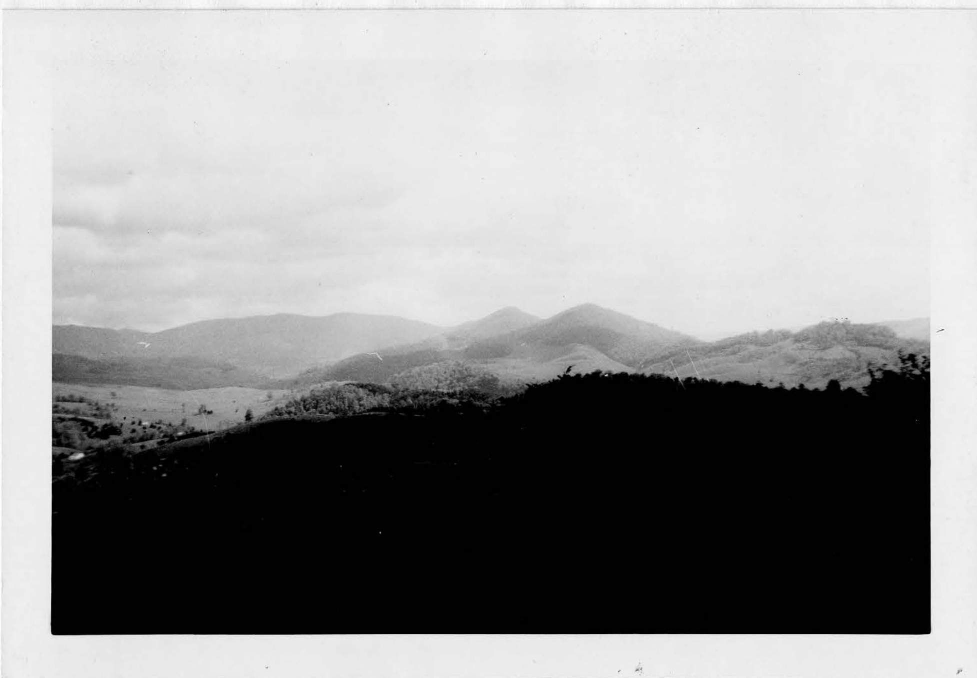
PLATE 10

A. The southwestern end of Johns Creek Mountain, Giles County, Virginia.

B. Clover Hollow Mountain, Giles County, Virginia.

A

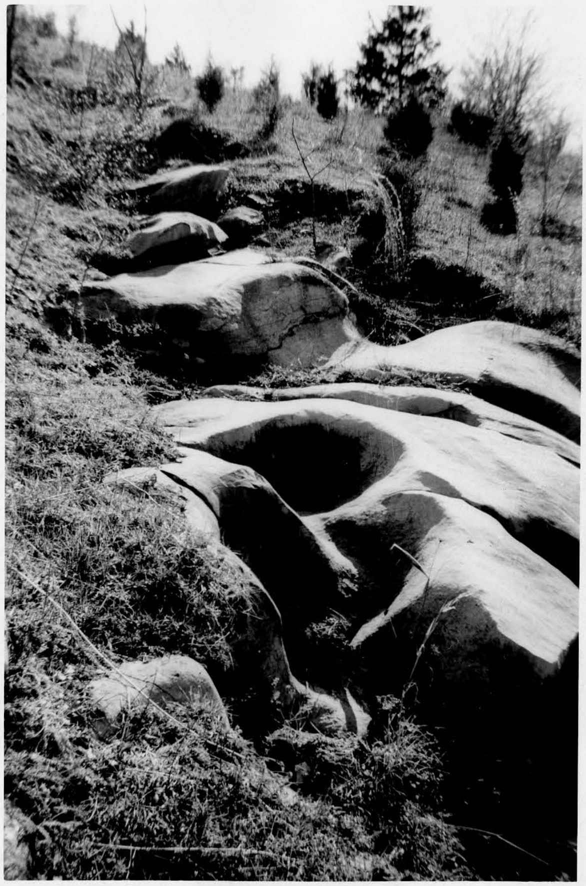


B

PLATE 11

A. Northeastern slope of Spruce Run Mountain, Giles County, Virginia - Potholes in Upper Middle Ordovician limestone.

B. On Route 602 just northeast of junction of routes 685 and 602 - Karst topography in Lower Middle Ordovician limestone of Giles County, Virginia.



A

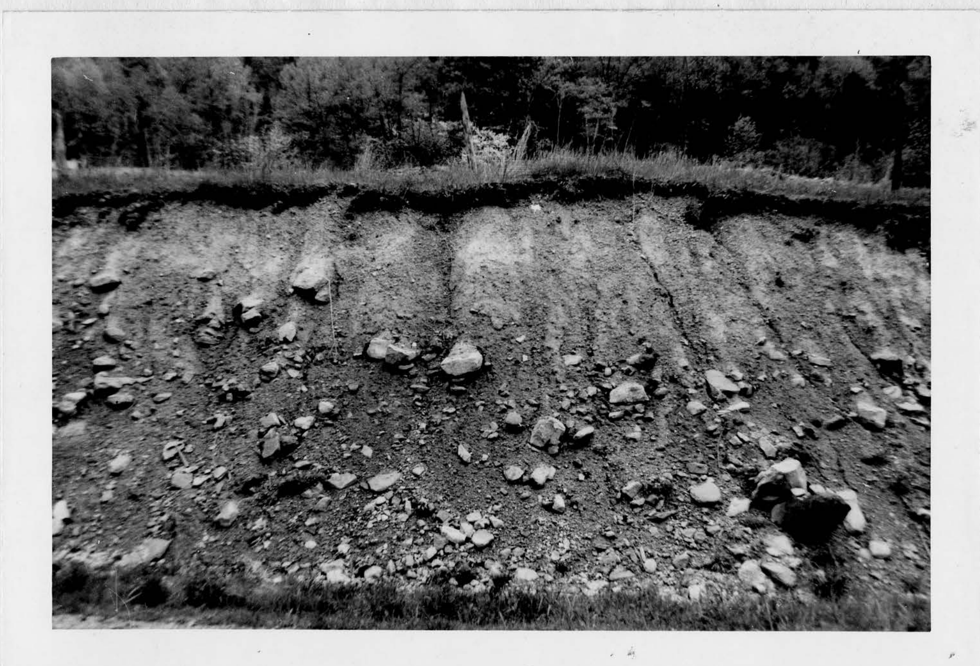
B

PLATE 12

A. At junction of routes 602 and 700 Giles County, Virginia - Terrace gravel at elevation 2350 feet.

B. On Route 700 one mile southeast of junction of routes 602 and 700, Giles County, Virginia - Terrace gravel at elevation 2100 feet.

A



B

PLATE 13

A. Just north of junction of routes U.S. 460 and 700, on route 700, Giles County, Virginia - Channel fill at elevation 1800 feet, limestone pinnacles in the upper calcilutite of the Middle Ordovician limestones below the fill.

B. On Route 601 one mile northeast of junction of routes 635 and 601, Giles County, Virginia - Stream gravel at elevation 2100 feet.

A

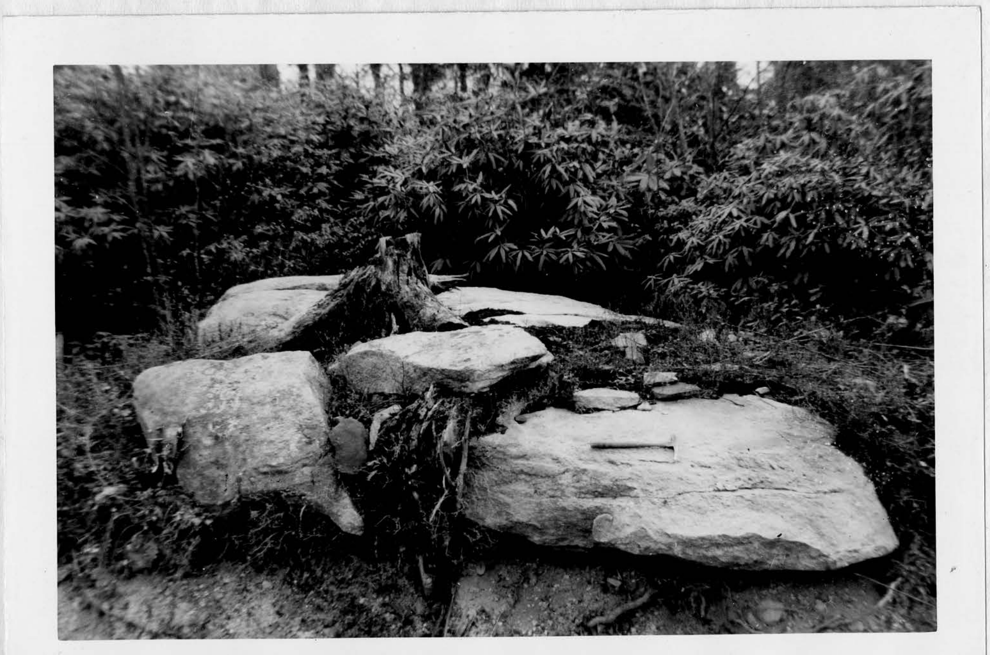
B

PLATE 14

A. Northwest slope of Clover Hollow Mountain, Giles County, Virginia - Colluvial fan of Clinch sandstone.

B. On Route 602 0.8 mile northeast of junction of routes 685 and 602, Giles County, Virginia - Clinch sandstone boulder weighing approximately four tons.

A



B

PLATE 15

A. On Route 601 just southwest of junction of routes 685 and 601, Giles County, Virginia - Flood plain in Clover Hollow Valley.

B. On Route 42 approximately 3 miles northeast of Newport, Virginia - Steep cut-in bank on a flood plain in Sinking Creek Valley (Trees growing on cut-in slope).

A

B

PLATE 16

A. Looking northeast to junction of routes 685 and 601, Giles County, Virginia - Stream meander of the Clover Hollow Creek.

B. At junction of routes 42 and 630, Craig County, Virginia - Stream meander of Sinking Creek, note abandoned channel just behind automobile.

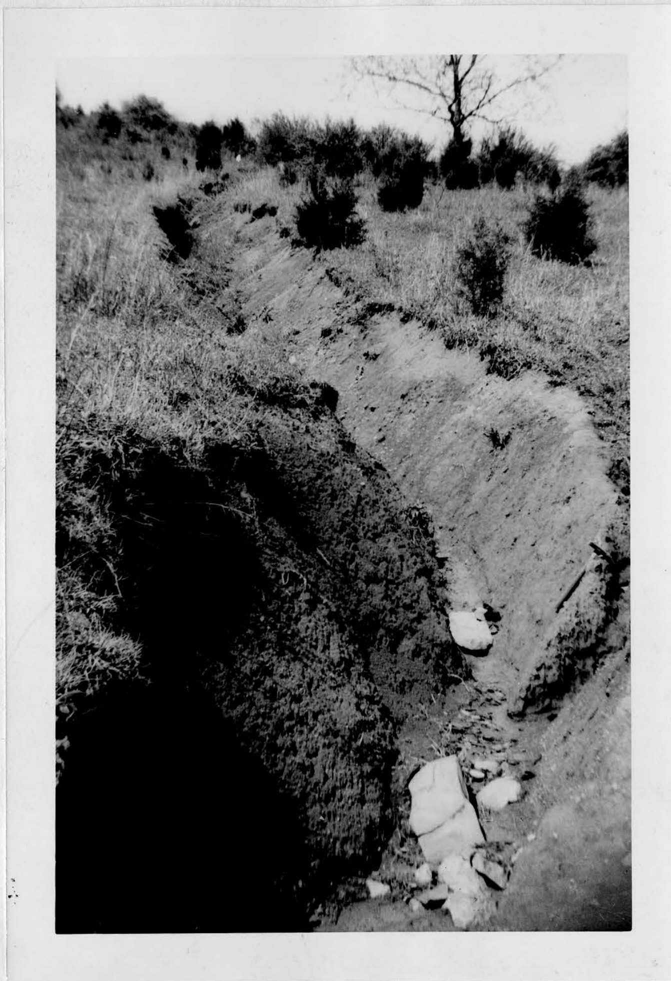
A

B

PLATE 17

A. Northeast slope of Spruce Run Mountain, Giles County, Virginia - Gullying in the limy claystone member of the Moccasin formation.

B. On Route 42 one mile northeast of Newport, Virginia - Algal weathering in the Lower Knox dolomite.



A

B

PLATE 18

A. Junction of routes 700 and 604, Giles County, Virginia - Abandoned limestone quarry in the Lower Middle Ordovician limestones.

B. Same as A. - Fault with eight foot displacement in quarry.

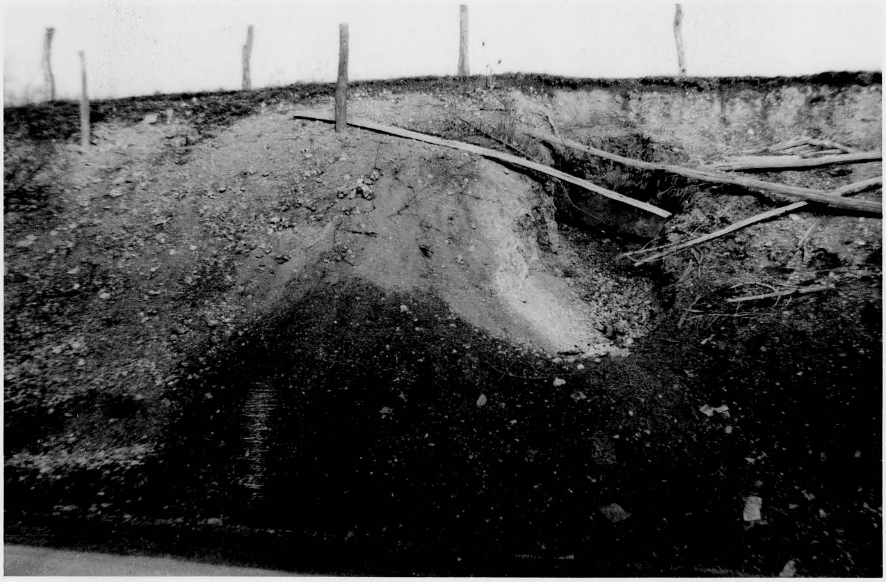
A

B

PLATE 19

A. On Route U.S. 460 0.2 mile northwest of Newport, Virginia - Prospect pit in fault zone; prospect - manganese.

B. On Route 42 approximately one mile northeast of Newport, Virginia - Boulder of autobreccia cemented with manganese.



A

B

PLATE 20

A. Johns Creek Mountain, Giles County, Virginia - Cross-bedding in the Cacapon sandstone.

B. On Route 604 0.2 mile northeast of junction of routes 700 and 604, Giles County, Virginia - Stylolites in the upper calcilutite member of the Middle Ordovician limestones.

A

B