VIRGINIA DIVISION OF MINERAL RESOURCES
OPEN-FILE REPORT 88-3

Virginia Department of Mines Minerals and Energy

MINERAL AND ENERGY RESOURCES OF SOUTHWEST VIRGINIA

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES
Robert C. Milici, Commissioner of Mineral Resources and State Geologist
CHARLOTTESVILLE, VIRGINIA

and

DIVISION OF MINED LAND RECLAMATION
Danny R. Brown, Commissioner
BIG STONE GAP, VIRGINIA

1988

DEPARTMENT OF MINES, MINERALS AND ENERGY

O. Gene Dishner, Director
RICHMOND, VIRGINIA

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MINERAL AND ENERGY RESOURCES OF SOUTHWEST VIRGINIA
Ramada Inn, Duffield, VA
May 4-5, 1988

Wednesday May 4, 1988: Presentations

9:00 - 9:10	Welcoming Remarks	Gene Dishner, Director DMME
9:10 - 9:15	Overview of Symposium	Bob Milici, State Geologist, DMR
9:15 - 9:45	Non-fuel mineral resources	Gerry Wilkes, DMR
9:45 - 10:15	Virginia carbonate-rock sampling project	Bill Giannini, Bill Whitlock, DMR
10:15 - 10:30	Coffee break	
10:30 - 11:00	Sandstone aggregate and high-silica resources in Scott County, Virginia	Jim Lovett, DMR
11:00 - 11:30	Overview of the GEOHY geologic-mapping program	Tom Gathright, DMR
11:30 - noon	Remaining coal resource estimates for Lee County, Virginia as calculated using NCRDS computer programs	Elizabeth Campbell, DMR
noon - 12:30	Coal resources available for development: a new study in southwest Virginia	Nancy Gardner, USGS
12:30 - 1:30	Lunch on own	
1:30 - 2:00	Non-fuel mineral industry and products in southwest Virginia	Jim Lovett, DMR
2:00 - 2:30	An Overview of DMME Geologic Data System	Jan Zentmeyer, DMLR
2:30 - 3:00	Groundwater occurrence and guidelines for exploration in the Appalachian Plateau of southwestern Virginia	Anthony Scales, DMLR
3:00 - 3:15	Coffee break	
3:15 - 3:45	Historical perspectives of oil and gas development in southwest Virginia	Milford Stern, DGO
3:45 - 4:15	Mississippian structure and hydrocarbon potential of Buchanan, Dickenson, and Wise counties, Virginia	Frank Jacobeen, DMR
4:15 - 4:45	Potential oil and gas prospects along the northwest edges of the Hunter Valley/ Clinchport thrust sheets, Scott County, Virginia	Bob Diffenbach & Bill Henika, DMR

Participants:
- DMME - Department of Mines, Minerals & Energy, Richmond
- DMR - Division of Mineral Resources, Charlottesville
- DMLR - Division of Mined Land Reclamation, Big Stone Gap
- DGO - Division of Gas and Oil, Abingdon
- USGS - U. S. Geological Survey, Reston

Thursday May 5, 1988: Field Trip

8:00 Leave Duffield, Ramada Inn
Six exposures of major sandstone units and of coal in the Middlesboro Member of the Lee Formation will be examined in Scott County. The Sandstones may have potential use as construction materials, and for glass manufacture and metallurgical applications.

Arrive Bristol for lunch

Leave Bristol for Marion area
Two barite occurrences will be visited. Barite is useful for paint and paper fillers, as a weighting agent for oil and gas drilling and for medical uses.

5:00 End field trip, Holiday Inn, Marion

NON-FUEL MINERAL RESOURCES

Gerald P. Wilkes

Virginia Division of Mineral Resources

There have been many changes with respect to mineral development in Southwest Virginia since earliest activity in the 1700's. Some minerals, once profitably developed, are presently not feasible to mine and conversely, mineral deposits undeveloped at present may become valuable in the future.

Southwest Virginia may be divided into four areas for the purpose of defining these varied mineral resources: the Gossan Lead district (copper, manganese, pyrrhotite); the sulfide area of Floyd County (nickel, gold, arsenopyrite, cobalt); the Cumberland Plateau (sandstone, clay, shale); and the Valley and Ridge province (barite, manganese, iron, lead, zinc, gypsum, halite, sandstone, clay, shale, limestone, dolomite). Each area represents unique geologic conditions that were necessary to create particular mineral deposits.

The Division of Mineral Resources has projects designed to identify and evaluate mineral deposits and make that information accessible to the mineral industry. These projects include the Mineral Resources Data System (MRDS) in cooperation with the U.S. Geological Survey, the high-silica sandstone study, the sandstone aggregate study, and the carbonate analyses study.

VIRGINIA CARBONATE-ROCK SAMPLING PROJECT

William F. Giannini
and
William W. Whitlock

Virginia Division of Mineral Resources

Since the first recorded use of limestone to construct the great Egyptian pyramids about 4,600 years ago, uses of limestone and dolomite rocks have realized a continuous growth to the present. These rocks form a large portion of the surface formations in the northwestern and southwestern belts in the Valley and Ridge province of Virginia. Minor occurrences are also found in the Piedmont province as limestone and marble and in the Coastal Plain province as shell deposits.

The carbonate rock sampling project was begun in 1981 to determine the chemistry and reflectance (whiteness-brightness) values of Virginia's carbonate rocks and will continue until all carbonate rocks have been sampled statewide. To date, approximately 3,500 samples have been collected and 3,300 chemically analyzed. Of those analyzed, 77 qualify as high-reflectance material. This database will provide valuable information to private individuals, companies, consultants, and local and state governments.

Virginia possesses abundant reserves of carbonate rocks, especially along the northwestern and southwestern portions of the state. Fifty-two quarries and three underground mines are currently active. Production in 1985 was 19,117,000 short tons valued at $76,395,000.

Major usages for high-purity limestone supplied by Virginia operations include lime production (captive) and lime to treat water and sewage, to use in the paper and steel industries, enhance soil fertility, and to stablilize soil. Other markets utilizing high-purity carbonate-rock products include cement-mortar manufacture, glass and steel industries, fillers and extenders such as in fertilizer, animal feed, wallboard joint compound, paint, rug backing, anti-stick agents, the manufacture of chemicals, and in rubber. Environmentally oriented markets include coal-mine dust and acid-control stone. Major markets not requiring high-purity carbonate rocks include aggregate stone for concrete, asphalt and macadam, highway base mix, concrete block, railroad ballast, and soil-fertility enhancement.

SANDSTONE AGGREGATE AND HIGH-SILICA RESOURCES IN SCOTT COUNTY, VIRGINIA

James A. Lovett

Virginia Division of Mineral Resources

Scott County, Virginia, is rich in sandstone and silica resources. Major sandstone-bearing units were examined to identify the potential for use as coarse-aggregate in bituminous surface material (non-polishing surface road stone), as high-silica glass-grade sand and metallurgical-grade material, and for miscellaneous uses such as filter sand and hydraulic fracturing sand.

Eight sandstone units in the Plateau and Valley and Ridge provinces of southwest Virginia were sampled. These include: the upper quartzarenite of the Middlesboro Member of the Lee Formation; the lower quartzarenite of the Middlesboro Member of the Lee Formation; the Tallery Sandstone Member of the Hinton Formation; the Stony Gap Sandstone Member of the Hinton Formation; and undivided sandstone units in the Pennington Formation, Fido Sandstone, Wildcat Valley Sandstone, and Clinch Sandstone.

Geologic descriptions, physical-properties testing, sieve analyses and chemical analyses for composite samples from selected localities are presented. These data will assist in evaluating the commercial potential of the sandstone resources. Los Angeles-abrasion and soundness testing indicate that selected coarse-aggregate material qualifies for use as bituminous surface material. Chemical analyses of quartzite samples indicate good potential for use as high-silica resources. Silica content of these unbeneficated samples ranges from 95 to 98 percent, but the samples contain alumina and iron compounds. Most samples show the required grain-size range for use in glass sand. Beneficiation would be necessary to wash and size the sand material for use as glass-grade, filter, or hydraulic-fracturing sand.

OVERVIEW OF THE GEOHY GEOLOGIC-MAPPING PROGRAM

Thomas M. Gathright, II

Virginia Division of Mineral Resources

Geologic mapping for the GEOHY project is creating an accurate three-dimensional model of the rock units and coal beds in the southwestern Virginia coalfields. The geologic information, as it becomes available, is being provided as conventional geologic maps and cross sections and as digital data that can be manipulated to provide specific information on selected areas. The completed geologic data base will form a framework in which ground-water potential, coal and rock chemistry, coal resources and non-coal economic deposits may be evaluated.

To date, two-thirds of the project area has been mapped and eleven quadrangles are published or at the printers; three additional quadrangles will be committed for printing this fiscal year. An area equivalent to seven and one-half quadrangles, and comprised of parts of 15 quadrangles largely in Buchanan and Tazewell counties, is yet to be mapped. This mapping will be accomplished within the project period.

The discovery of major fault systems, the lateral pinch-out of rock units, and the recognition of marine "marker" beds and an extensive volcanic ash bed in the Upper Banner coal here led to revision of the stratigraphic detail and coal bed correlation in southwest Virginia.

REMAINING COAL RESOURCE ESTIMATES FOR LEE COUNTY, VIRGINIA AS CALCULATED USING NCRDS COMPUTER PROGRAMS

Elizabeth M. Campbell

Virginia Division of Mineral Resources

The original and remaining coal resources for Lee County, Virginia, were calculated using the PACER and GARNET computer programs written for the National Coal Resources Data System (NCRDS) of the U.S. Geological Survey. This study incorporates data from 111 drill holes and 475 surface locations and utilizes underground mine maps, digitized coal outcrops as mapped by R. L. Miller of the U.S. Geological Survey, and the U.S. Geological Survey Digital Elevation Models (DEM's) of the topographic surface. New stratigraphic correlations developed from drill-hole data and recent geologic mapping in adjacent Wise County have improved the Lee County data base for resource estimates. Coal resources were calculated for categories based on coal thickness, amount of overburden, and occurrence probability.

COAL RESOURCES AVAILABLE FOR DEVELOPMENT: A NEW STUDY IN SOUTHWEST VIRGINIA

M. Devereux Carter

and

N. K. Gardner

and

J. R. Eggleston

U.S. Geological Survey

The total coal resources of the United States are rather well documented and the amount is large. However, the quality and quantity of coal that will be available for the production of energy in the future are not known with any degree of precision; there has never been a concerted, systematic attempt to determine what percentage of the total coal resources of the conterminous States is actually available for development.

Previously, National and State coal-resource assessments were concerned with the total coal remaining in the ground within certain minimum parameters of bed thickness, data reliability, and depth of burial. The inclusion of additional considerations such as environmental and technologic restrictions to mining coal will enhance present information and provide a more realistic basis for energy policy planning.

Working in cooperation with the Kentucky Geological Survey, the U.S. Geological Survey initiated a pilot study to determine the available coal resources of a 7.5-minute quadrangle in the central Appalachian Basin. Local mining engineers and state government experts provided information on restrictions and mining practices in the immediate study area. Data were collected, stored, and analyzed in the National Coal Resources Data System of the U.S. Geological Survey.

Environmental and technologic restrictions that affect minability at the surface and at depth for the Matewan quadrangle were analyzed. Environmental factors included as surface restrictions were immovable obstacles such as: (1) major powerlines and pipelines; (2) cemeteries; (3) oil and gas wells; (4) streams; and (5) towns. Technologic factors that influence minability at depth include: (1) minimum bed thickness; (2) maximum overburden; (3) thickness and characteristics of interburden between beds; (4) proximity of mining directly above or below the coal; and (5) the presence of barrier pillars around underground mine workings.

Preliminary estimates of the available resources in the Matewan quadrangle indicate that, of the total resources, only 62 percent of the coal is currently available for mining. Of the available coal, approximately 44 percent meets the standard of compliance coal.

The cooperative program is continuing with the three State geological agencies of Virginia, West Virginia, and Kentucky. A total of five quadrangles will be completed this year, including the Vansant quadrangle in Buchanan County, Virginia. The results of this work will present a new perspective on the coal resources available for development in the central Appalachian region.

NON-FUEL MINERAL INDUSTRY AND PRODUCTS IN SOUTHWEST VIRGINIA

James A. Lovett

Virginia Division of Mineral Resources

Southwest Virginia is most commonly known for abundant coal and gas resources. In addition, the region also has many non-fuel mineral resources and supports a relatively strong and stable minerals industry.

West of 81^{o} longitude, there are nineteen operations which quarry limestone and/or dolomite from formations of Cambrian, Ordovician, Silurian, and Mississippian age. Three operations work Cambrian-age sandstone and sand from recent alluvial deposits. Three operations quarry shale and clay from Cambrian and Ordovician formations. Other operations mine gypsum from Mississippian-age rocks, and quarry Precambrian gneiss.

These operations produce a wide variety of mineral products. Limestone and dolomite are quarried for rip-rap, for aggregate used in asphalt and highway base mix, and to produce rock dust and agricultural lime. Sandstone and sand are used as aggregate material and sand is also used in concrete. Shale and clay are worked to produce brick products and clay dummies. Gypsum is mined to produce wallboard and related products. Gneiss is quarried to produce aggregate that is used as asphalt and highway base mix.

AN OVERVIEW OF THE DMME GEOLOGIC DATA SYSTEM

Jan P. Zentmeyer

Virginia Division of Mined Land Reclamation

The Virginia Department of Mines, Minerals and Energy has established a geologic data system aimed at improving mine planning, land reclamation, and development. The building of the data system is a cooperative effort of several state and federal agencies and private interest groups. The system contains a significant amount of stratigraphic information derived from a variety of sources, and a sophisticated mapping package that produces high quality, 2- and 3-dimensional maps and cross-sections. Both geologic and geographic data from the southwestern Virginia coalfields are continually being added to the data set. The system enables the user to apply information from many sources to regional problems and studies.

GROUNDWATER OCCURRENCE AND GUIDELINES FOR EXPLORATION IN THE APPALACHIAN PLATEAU OF SOUTHWESTERN VIRGINIA

Anthony S. Scales

Virginia Division of Mined Land Reclamation

Within the Appalachian Plateau of Southwestern Virginia, groundwater occurrence is primarily associated with stress-relief and tectonic fracturing, i.e., the formation of secondary porosity and permeability. Coal seams are the only units that may be considered as aquifers in the sense that they are horizontally continuous, both hold and transmit water, and are underlain by relatively impermeable strata. Artesian conditions can exist on the periphery of the relatively undeformed Pennsylvanian strata. Water quality is a function of contact time with potentially contaminating materials and oxygen.

Groundwater availability increases with decreasing elevation and amount of fracturing. With increasing elevation, wells must be deeper to provide adequate supplies; however, this increases the likelihood of quality problems. Similarly, valley-bottom wells can experience salinity problems with increasing depth. Surface and deep mining operations can increase groundwater recharge and storage. Abandoned underground mines can act as groundwater collection galleries, and may be significant groundwater sources in the future. A trend to below-average precipitation over the past 17 years has signficantly affected marginal supplies.

HISTORICAL PERSPECTIVE OF OIL AND GAS DEVELOPMENT IN SOUTHWEST VIRGINIA

Milford J. Stern

Virginia Division of Gas and Oil

Southwest Virginia has enjoyed an increase in drilling activity and gas production in the past few years. Southwest Virginia, however, is not a newcomer to oil and gas production. The Early Grove Field in Scott and Washington counties commenced gas deliveries to Bristol, Virginia, in the winter of 1937 and in 1942 oil began to flow at the B. C. Fugate #1 well in Lee County, Virginia.

Currently, there are about 700 producing gas wells in the Plateau area of Southwest Virginia and 31 oil wells in Lee County. Along with this production, several companies have located in Southwest Virginia to operate and service the growing oil and gas activity in Virginia.

If the past is any indication, Southwest Virginia will receive growing attention by the oil and gas industry.

MISSISSIPPIAN STRUCTURE AND HYDROCARBON POTENTIAL OF BUCHANAN, DICKENSON, AND WISE COUNTIES, VIRGINIA

Frank H. Jacobeen, Jr.

Virginia Division of Mineral Resources

Correlation of Mississippian-age rocks in over 500 petrophysical logs in the interval from the top of the Greenbrier Limestone through the Berea Sandstone and the construction of four structure maps and four isopach maps show that structure is not a prime factor in controlling gas production in Buchanan, Dickenson, and Wise counties, Virginia. A total of 889 wells have tested 26 percent of the acreage in these three counties; operators completed 781 of these as gas wells. Through December, 1986, cumulative gas production from these counties is reported to be 147 billion cubic feet. Remaining proven producible reserves in Mississippian-age horizons are 235 billion cubic feet of gas. The average completed well ultimately should produce over 500 million cubic feet of gas. Based on this record it is estimated that an additional 815 billion cubic feet of recoverable gas is to be found on the undrilled 74 percent of the area of Buchanan, Dickenson, and Wise counties.

POTENTIAL OIL AND GAS PROSPECTS ALONG THE NORTHWEST EDGES OF THE HUNTER VALLEY/CLINCHPORT THRUST SHEETS, SCOTT COUNTY, VIRGINIA

Robert N. Diffenbach
and
William S. Henika

Virginia Division of Mineral Resources

Recent detailed mapping along the northwest edges of the Hunter Valley and Clinchport thrust sheets in the East Stone Gap, Fort Blackmore and Dungannon 7.5-minute quadrangles suggest the presence of at least two closed structural highs. These highs appear to be located above subsurface tectonic ramps postulated to have developed beneath the overturned limb of the Stone Mountain syncline along the upturned Hunter Valley thrust. Three lines of evidence based on surficial structure along the Hunter Valley thrust point to the presence of structural highs beneath the Stone Mountain structure: (1) anomalously northwest-dipping strata on the upright limb of the Stone Mountain syncline; (2) the locally nearly horizontal axial plane of the syncline; and (3) three linear domains of bedding attitudes on the overturned limb of the syncline that suggest late rotation of bedding by underlying arching. Another high that is incompletely mapped has been recognized as a similar imbricate structure located southeast of the Rye Cove syncline and hidden beneath the upturned Clinchport thrust in the southeastern corner of the East Stone Gap quadrangle.

Structure sections based on deep seismic data indicate that the postulated tectonic ramps beneath the Hunter Valley and the Clinchport thrusts developed above the Pine Mountain fault on detachments in Devonian or Ordovician shale formations.

Devonian shales that underlie and are probably involved in these upper-level detachment structures are of sufficient organic richness and thermal maturity to provide a low source potential for oil and a moderate to high source potential for gas according to J. B. Roen (1983). Potential Mississippian reservoir rocks, including the Greenbrier Limestone and the Berea Sandstone, crop out on the overturned limb of the Stone Mountain syncline and are probably involved in underlying structural highs along the upturned edge of the Hunter Valley thrust sheet. Deeper reservoir objectives may include the Trenton Limestone (Ordovician) and sandstone and dolomite beds in the underlying Copper Ridge and Rome formations (Cambrian) beneath the gently arched Clinchport thrust. The extensive fracturing commonly found at the crest of structural highs presents favorable and relatively shallow hydrocarbon prospects in these formations.

DESCRIPTIONS OF FIELD TRIP STOPS IN SCOTT AND SMYTH COUNTIES

INTRODUCTION

The purpose of this field trip is to examine selected mineral and fuel resources found in southwest Virginia. Stops will be made at sandstone and coal exposures in Scott County (Figure 1), and at two abandoned barite mines in Smyth County (Figure 2).

STRATIGRAPHY

The rock units will be described in descending stratigraphic order as they will be examined during the field trip.

LEE FORMATION

The Middlesboro Member of the Lee Formation (Pennsylvanian) is found in the northern portion of Scott County, along Stone Mountain and Hunter Ridge on the southeastern flank of the Powell Valley anticline. Because the Bee Rock Sandstone Member is not present in this area, the top of the Lee Formation is marked by the upper quartzarenite tongue of the Middlesboro Member. The Middlesboro Member of the Lee Formation is conformably overlain by the Norton Formation.

The upper quartzarenite of the Middlesboro Member is 100 to 200+ feet thick. The full thickness of the unit is usually not present in Scott County because the upper section is removed by erosion. Five samples from the upper quartzarenite unit were analyzed for potential use as coarse aggregate in bituminous surface material (non-polishing road stone). Los Angeles abrasion loss ranged from 34.7 to 93.0 percent. Soundness loss of Grade A Stone ranged from .09 to 11.1 percent. One sample qualified for use as coarse aggregate in bituminous surface material. Three samples were analyzed for potential use as glass sand. The disaggregated sand is fine to medium grained. Silica content of all three samples is 98.0 percent. One sample was analyzed for potential use as metallurgical-grade material. Silica content is 98.0 percent. Because of time and access limitations, no stops will be made in the upper quartzarenite of the Middlesboro Member of the Lee Formation.

The middle siltstone unit of the Middlesboro Member is a 330- to 700-foot thick sequence of dark-to medium-gray clay shale, siltstone, and sandstone that lies between the upper and lower quartzarenite units. The interval contains several traceable coal beds in Scott County. The most important commercial coals in this area are the Cove Creek coal bed found at the base of the unit, and the Stock Creek coal bed that lies about 100 feet above the base. There is a prominent marine marker just above the Little Fire Creek coal (about 300 feet above the base of the middle siltstone unit) which delineates the top of the mineable coal sequence. Coal beds above this fossil-bearing shale zone tend to be thin and discontinuous, and are commonly cut out beneath overlying sandstone units. Gamma logs of the upper part of the middle siltstone demonstrate a sequence that coarsens upwards and culminates in the upper quartzarenite unit of the Middlesboro Member.

The lower quartzarenite of the Middlesboro Member of the Lee Formation is 150 to 250 feet thick and lies below the middle siltstone unit. The quartzarenite may locally be interbedded with shales, siltstones, and coal beds. Seven samples from the lower quartzarenite unit were analyzed for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss ranged from 38.5 to 67.5 percent. Soundness loss of Grade A Stone ranged from 5.6 to 50.4 percent. No samples fully qualified for use as coarse aggregate in bituminous surface material. One sample was analyzed for potential use as metallurgical-grade material. The silica content is 97.0 percent.

HINTON FORMATIOMN

The Hinton Formation (Mississippian) is found in northern Scott County, south and west of the Lee Formation. The Hinton Formation ranges from 550 to 700 feet thick and is generally divided into four units: the Tallery Sandstone Member, the Little Stone Gap Member, the Middle Red Member, and the Stony Gap Sandstone Member. Sandstone units are very fine to medium grained, quartz-rich, and conglomeratic, and range from 55 to 420 feet thick. The Little Stone Gap Member is a calcareous and fossil-bearing mudstone and clay shale up to 45 feet thick. The Middle Red Member is a yellowish-brown to reddish-brown sequence of siltstone and shale 165 to 370 feet thick. The Tallery Sandstone and Stony Gap Sandstone Members of the Hinton Formation were examined and sampled.

The Tallery Sandstone Member is the upper unit of the Hinton Formation. The sandstone unit is 55 to 125 feet thick. Three samples from the Tallery Sandstone Member were analyzed for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss ranged from 3.3 to 86.3 percent. Soundness loss of Grade A Stone ranged from 0.4 to 12.0 percent. One sample qualified for use as coarse aggregate in bituminous surface material. One sample was analyzed for potential use as glass sand. The disaggregated sand is very fine to medium grained. Silica content is 98.0 percent. Two samples were analyzed for potential use as metallurgical-grade material. Silica content of both samples is 98.0 percent.

The Stony Gap Sandstone Member is the lower unit of the Hinton Formation. The sandstone unit is 160 to 420 feet thick. Two samples from the Stony Gap Sandstone Member were analyzed for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss ranged from 33.4 to 42.7 percent. Soundness loss of Grade A Stone ranged from 0.7 to 14.9 percent. One sample qualified for use as bituminous surface material. One sample was analyzed for potential use as glass sand. The disaggregated sand is very fine to fine grained. Silica content is 98.0 percent. Four samples were analyzed for potential use as metallurgical-grade material. Silica content ranges from 95.0 to 98.0 percent.

PENNINGTON FORMATION

The Pennington Formation (Mississippian) is found in the southern portion of Scott county. It is stratigraphically equivalent to the Bluestone and Hinton Formations, but is not subdivided. The Pennington Formation is a sequence of shales, siltstones, and sandstones which is approximately 2,250 feet thick in the Early Grove area (Averitt, 1941). Sandstones are regionally discontinuous, light gray to red, fine to coarse grained, and locally interbedded with shale. Two samples from the Pennington Formation were analyzed for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss ranged from 21.9 to 23.6 percent. Soundness loss of Grade A Stone ranged from 0.7 to 5.2 percent. Two samples qualified for use as coarse aggregate in bituminous surface material.

FIDO SANDSTONE

The Fido Sandstone (Mississippian) is found in southeastern Scott County, where Averitt (1941) describes the unit as 35 to 50 feet thick from measured sections. Gas well data from the Early Grove area, however, show that formation is as much as 120 feet thick, with an average of 60 to 75 feet. The sandstone is grayish red to very dusky red, and fine to coarse grained, with fossil fragments, feldspar and mica. X-ray diffraction identified quartz, calcite, muscovite, plagioclase, chlorite, and microcline. X-ray fluorescence determined that the silica content ranges from 49.4 to 55.7 percent and the calcium carbonate content ranged from 30.7 to 34.6 percent (O. M. Fordham, personal communication, 1988). In thin section, the rock is very fine to coarse grained, with angular to subrounded quartz grains, fossil fragments, calcite, feldspar, mica, chlorite, and a fine matrix of silt and calcareous material. Three samples from the Fido Sandstone were analyzed for potential use as coarse aggregate in bituminous surface material. Test results of the samples were very good. Los Angeles abrasion loss ranged from 17.3 to 19.5 percent. Soundness loss of Grade A Stone ranged from 0.2 to 2.4 percent. All three samples may qualify for use as coarse aggregate in bituminous surface material.

BARITE

The Division of Mineral Resources is compiling data on mineral resources throughout Virginia for use in the Mineral Resources Data System (MRDS) in cooperation with the U. S. Geological Survey. Barite mines and prospects located in Smyth County were examined as part of this project.

Barite ($BaSO_4$) is the naturally occurring barium sulfate mineral, and contains 58.8 percent barium and 41.2 percent sulfate. When pure, it is stable and chemically inactive. Barite is relatively soft and non-abrasive, but is very heavy, with a specific gravity of 4.5. The mineral name was derived from the Greek word "barus", meaning heavy. Barite varies considerably in appearance, depending on impurities and surface coatings. It is opaque and forms tabular crystals to granular masses in assorted shades of white, red, brown, gray, and black.

Barite is primarily used as a weighting compound in rubber, plastics, paper, and oil and gas drilling. It is also used as an industrial filler, in color pigments, and for medical purposes and chemical manufacturing.

Barite is found in Grayson, Russell, Smyth, and Tazewell counties in southwest Virginia. It was first mined in Smyth County about 1875 and was worked until the early 1900's.

FIELD TRIP GUIDE

Stop 1. Coal beds in the middle siltstone unit of the Middlesboro Member, Lee Formation, along the Alleghany structural front, East Stone Gap 7.5-minute quadrangle, Scott County.

This stop is 1.5 miles north of Stanleytown, at an abandoned coal mine along Stinking Creek (Figure 3). The rocks at this locality are on the upright limb of the Stone Mountain syncline and have a gentle dip to the southeast. The structure is named for Stone Mountain, the prominent ridge to the southeast. The overturned synclinal axis has been traced across the road about 0.3 mile to the southeast of the stop. The overturned limb lies northwest of the Hunter Valley thrust, which marks the Alleghany structural front.

The Cove Creek coal bed mined at this locality lies near the base of the middle siltstone unit of the Middlesboro Member. The lower quartzarenite unit crops out in Cove Creek north of the stop and sandstone samples were collected from gently dipping beds on the upright limb of the syncline. The same sandstone unit forms riffles in the creek down-stream, where it dips steeply to the southwest on the overturned limb of the fold. The Cove Creek coal bed is actively mined beneath Good Spur Ridge by the Trinity Coal Company 0.9 mile to the northwest of Stop 1. The coal bed at the Trinity mine is more than 4 feet thick and has a hard sandstone roof at the portal. At this stop, the abandoned mine is closer to the structural front and the Cove Creek appears to be split into two benches, with portals on both. Examination of the coal exposed in the upper bench provides evidence of intense shearing across the coal between the the floor and roof of the portals. Classic duplex structures similar to these, were first described by Campbell (1893) from exposures to the northeast along strike.

<u>Stop 2.</u> Cliffs in the lower quartzarenite of the Middlesboro Member, Lee Formation, East Stone Gap 7.5-minute quadrangle, Scott County.

This stop is 0.5 mile northwest of Mabe, along State Road 825 (Figure 4). The massive sandstone ledges exposed here are on the upright, gently dipping limb of the Stone Mountain syncline. The same unit is exposed in steeply overturned beds southeast of the fold axis at Mabe, northwest of the Hunter Valley thrust fault. The dominant sedimentary structures in the lower quartzarenite at this locality are well-developed, planar-tabular cross-bed sets. Pebble lag material and fossil logs are commonly found near the base of the massive sandstone beds. Detailed mapping indicates that the lower quartzarenite unit was deposited as a series of coalescing tidal channels which were cut deeply into the underlying basal Pennsylvanian and Mississippian formations. Sandstone sequences as thick as 50 feet are characteristic of the lower quartzarenite unit in Scott County.

The quartzarenite at this location is well indurated, light gray and very pale gray, fine to coarse grained, locally conglomeratic, and medium to massive bedded, with flaggy to massive parting. Two samples were collected for physical and chemical testing. Sample 60C-1 was collected from the lower 50 feet of the outcrop and tested for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss is 51.2 percent, indicating that this sample does not meet the requirements as Grade A, B, or C stone. Sample 60C-5 was collected about 30 feet above the road in a very clean zone 10 feet thick and tested for potential use as metallurgical-grade material. Chemical analyses are shown in Table 1. Silica content is very good at 97.0 percent, although the alumina content of 2.9 percent is too high for use as metallurgical material.

Table 1. Chemical analyses for Sample 60C-5 from the lower quartzarenite of the Middlesboro Member of the Lee Formation.

CHEMICAL ANALYSES (Inductively Coupled Plasma Analysis, in percent)

SAMPLE	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	Cr_2O_3	CoO	LOI
60C-5	97.0	2.9	0.38	0.04	0.04	<0.03	0.28	0.27	0.005	<0.10	0.007	<0.001	1.04

[metallurgical-grade material — lower quartzarenite of the Middlesboro Member]

Stop 3. Ledges of the Tallery Sandstone Member of the Hinton Formation, Big Stone Gap 7.5-minute quadrangle, Scott County.

This stop is 1 mile north of Bowens Chapel, along State Road 655 (Figure 5). The sandstone ledges are on the gently dipping southeastern limb of the Powell Valley anticline, northwest of the Stone Mountain syncline. The Tallery Sandstone Member is the uppermost unit of the Hinton Formation. It is generally non-fossiliferous, but marine fossils are common in the overlying Bluestone Formation and in the Little Stone Gap Member of the Hinton Formation, which directly underlies the Tallery. Thick planar-tabular cross-bed sets, scour channels, and pebble lags similar to those in quartzarenite units of the Lee Formation are common.

The sandstone at this location is friable to well-indurated, very pale orange to grayish orange, fine to medium grained, locally conglomeratic, and thin to massive bedded. Two samples were collected for physical and chemical testing. Sample 61D-1 was collected from the friable upper 30 feet of the outcrop for potential use as glass sand. Sieve and chemical analyses are shown in Table 2. Silica content is 98.0 percent. Alumina content of 1.9 percent from the unbeneficiated sample is too high for use; washing and sizing of the sand would be required for use as glass sand.

Table 2. Sieve and chemical analyses for Sample 61D-1 from the Tallery Sandstone Member of the Hinton Formation.

SIEVE ANALYSES (percent retained)

	U.S. Standard Sieve Mesh Number								
Sample	**10**	**35**	**60**	**80**	**100**	**120**	**140**	**200**	**PAN**
61D-1	0.00	0.17	34.41	29.46	14.43	3.87	6.43	1.22	9.99

CHEMICAL ANALYSES (Inductively Coupled Plasma Analysis, in percent)

SAMPLE	SiO_2	AL_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	Cr_2O_3	CoO	LOI
61D-1	98.0	1.9	0.32	0.03	0.04	<0.03	<0.10	0.16	0.001	<0.10	0.012	<0.001	0.94

[glass sand — Tallery Sandstone Member]

Sample 61D-2 was collected from a clean, well-indurated, 15-foot-thick section near the base of the unit for potential use as metallurgical-grade material. Chemical analyses are shown in Table 3. Silica content is 98.0 percent, and alumina content of 2.2 percent is too high for use as metallurgical material.

Table 3. Chemical analyses for Sample 61D-2 from the Tallery Sandstone Member of the Hinton Formation.

CHEMICAL ANALYSES (Inductively Coupled Plasma Analysis, in percent)

SAMPLE	SiO_2	AL_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	Cr_2O_3	CoO	LOI
61D-2	98.0	2.2	0.47	<0.01	<0.03	<0.03	<0.10	0.20	0.003	<0.10	0.019	<0.001	0.93

[metallurgical-grade material — Tallery Sandstone Member]

Stop 4. Cliffs in the Stony Gap Sandstone Member of the Hinton Formation, Duffield 7.5-minute quadrangle, Scott County.

This stop is 2.3 miles northeast of Duffield, along State Road 655 (Figure 6). The large sandstone ledges east of the creek are very close to the axial trace of the Stone Mountain syncline and have a gentle dip to the northeast, reflecting the local plunge of the structure. The Stony Gap Sandstone Member is the basal unit of the Hinton Formation. In this part of Scott County, the unit is about 420 feet thick, although it thins markedly to the northeast.

The sandstone at this location is well-indurated, very pale orange to light gray, very fine to medium grained, thin to thick bedded, and has flaggy to blocky parting. Two samples were collected for physical and chemical testing. Sample 29A-2 was collected from the lower 70 feet of the unit for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss is 42.7 percent, qualifying this sample as Grade B stone. Sample 29A-1 was collected from a clean, 15-foot-thick section near the base of the unit for potential use as metallurgical-grade material. Chemical analyses are shown in Table 4. Silica, alumina, and iron content are very good, although calcium oxide content is too high for use as metallurgical-grade material.

Table 4. Chemical analyses for sample 29A-1 from the Stony Gap Sandstone Member of the Hinton Formation.

CHEMICAL ANALYSES (Inductively Coupled Plasma Analysis, in percent)

SAMPLE	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	Cr_2O_3	CoO	LOI
29A-1	97.0	1.5	0.74	0.07	1.70	0.04	<0.10	0.10	0.041	<0.10	<0.004	<0.001	2.10

[metallurgical-grade material — Stony Gap Sandstone Member]

Stop 5. Sandstone in the Pennington Formation, Indian Springs, Tennessee-Virginia 7.5-minute quadrangle, Scott County.

This stop is 3.1 miles northeast of Bloomingdale, Tennessee, along State Road 693 (Figure 7). The rocks are on the northwestern limb of the Vineyard Ridge syncline and have a moderate dip to the southeast. The syncline appears to postdate the emplacement of the Saltville thrust sheet, which is demonstrated by folding of the thrust plane along the synclinal axis to the east and west of the stop. The Pennington Formation has not been subdivided southeast of the Hunter Valley fault. This stop, near the axis of the syncline, is in the upper part of the Pennington Formation.

The sandstone at this location is well-indurated, dark gray to grayish red, slightly calcareous, fine grained, and thin to thick bedded, with flaggy to blocky parting. One sample was collected for physical testing.

Sample 27C-1 was collected from a 15-foot-thick section along the roadcut for potential use as coarse aggregate in bituminous surface material. Los Angeles abrasion loss is 23.6 percent, qualifying this sample as Grade A stone. As shown in Table 5, soundness loss ranges from 0.7 to 5.2 percent, qualifying this sample for use as coarse aggregate in bituminous surface material.

Table 5. Soundness loss for sample 27C-1 from the Pennington Formation.

SOUNDNESS LOSS (percent loss in magnesium sulphate--5 (cycles)			
Sample	**1 1/2 to 3/4 inch**	**3/4 to 3/8 inch**	**3/8 inch to #4**
27C-1	0.7	1.5	5.2

Stop 6. Exposures of the Fido Sandstone, Mendota 7.5-minute quadrangle, Scott County.

This stop is 5 miles southwest of Mendota, along U.S. Highway 58 (Figure 8). The sandstone is on the northwestern flank of the Early Grove anticline. The structure is a small anticline within the synclinal block between the Copper Creek and Saltville thrust faults.

The calcareous sandstone at this location is well-indurated, grayish red to very dusky red, fine to coarse grained with rock and fossil fragments, and thin to massive bedded. Three samples were collected for physical and chemical testing. Samples 27A-1, 27A-2, and 27A-3 were collected from 12- to 16-foot sections along U.S. Highway 58 and tested for potential use as coarse aggregate in bituminous surface material. Test results from all three samples were very good. As shown in Table 6, Los Angeles abrasion loss ranged from 17.3 to 19.5 percent, qualifying these samples as Grade A stone. As shown in Table 7, soundness loss ranged from 0.2 to 2.4 percent. These samples may qualify for use as coarse aggregate in bituminous surface material.

Table 6. Los Angeles abrasion loss for samples from the Fido Sandstone.

LOS ANGELES ABRASION LOSS (percent loss at 500 revolutions)

Sample	L.A. Grading	% loss at 500 Rev.	Use
27A-1	A	19.5	Grade A Stone
27A-2	A	19.4	Grade A Stone
27A-3	A	17.3	Grade A Stone

Table 7. Soundness loss for the samples of Grade A Stone from the Fido Sandstone.

SOUNDNESS LOSS (percent loss in magnesium sulphate--5 cycles)

Sample	1 1/2 to 3/4 inch	3/4 to 3/8 inch	3/8 inch to #4
27A-1	0.2	0.4	1.3
27A-2	0.2	0.6	1.2
27A-3	0.6	0.8	2.4

Stop 7. Myers - L. Copenhaver barite mine, Marion 7.5-minute quadrangle, Smyth County.

This stop is located 4.2 miles northwest of Marion, east of State Road 645 (Figure 9). The abandoned barite mine is on the western flank of the Marion dome and is one of the largest mines in the district. Surface and underground workings extend almost 0.25 miles in a S70^{o}E direction from the largest open cut east of Wassum Valley. Surface pits are as much as 300 feet long, 100 feet wide, and 50 feet deep. The mine was worked during the 1875 to 1885 period, and was prospected by core drilling in the late 1950's. Barite masses and clusters occur in fractures in the Beekmantown dolomite and limestone. In addition to barite, minor fluorite, sphalerite, and pyrite are found.

Stop 8. Henderlite barite mine, Atkins 7.5-minute quadrangle, Smyth County.

This stop is located 3.4 miles northeast of Marion, south of Interstate Highway 81 (Figure 10). The abandoned barite mine is 1400 feet north of the Seven Springs thrust fault. Surface and underground workings extend about 1500 feet in an east-west to N70°E direction. The mine was worked during the 1875 to 1885 period, and was prospected by core drilling in the late 1970's. As in other mines and prospects in Smyth County, the barite occurs as masses and clusters in fractures in the Beekmantown dolomite and limestone. Most of the surface workings are partially filled in and grown over, although the dumps contain very good mineral samples. Fluorite, calcite, chalcopyrite, pyrite, and malachite are found in addition to the barite.

REFERENCES

Averitt, Paul, 1941, The Early Grove gas field, Scott and Washington counties, Virginia: Virginia Geological Survey Bulletin 56, map, 50 p.

Campbell, M. R., 1893, Geology of the Big Stone Gap coal field of Virginia and Kentucky: United States Geological Survey Bulletin No. 111, 106 p.

FIELDTRIP ROADLOG

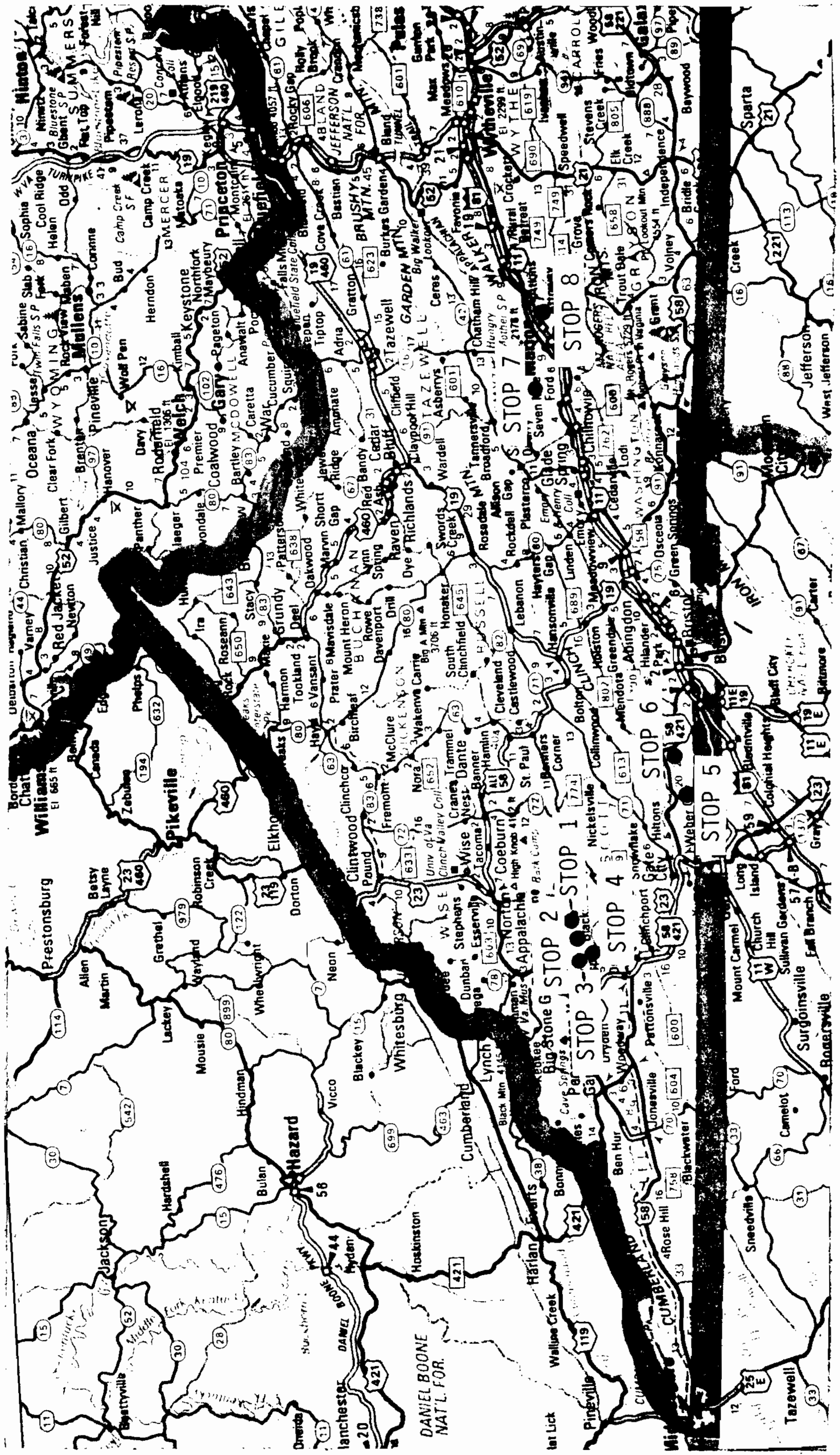
Prepared by W. S. Henika
April 20, 1988

	Interval Mileage	Cumulative Mileage
Field trip will start at Ramada Inn parking lot, Duffield, Virginia. Leave parking lot and turn left to head in a northeastward direction on U.S. Highway 58 East - 421 North.	0.0	0.0
Cross U.S. Highway 23-58 and continue in a northeastward direction along State Road 871.	0.3	0.3
Pass Foote Mineral Plant on left.	1.8	2.1
Cross Southern Railway tracks and then turn left at Sunbright onto State Road 653.	0.4	2.5
Follow State Road 653 6.2 miles to Stanleytown. Turn left at Texaco sign onto State Road 722 to head in a northwesterly direction along Cove Creek.	6.2	8.7
Follow State Road 722 1.7 miles and turn right into Sinking Creek Coal Company mine site for Field trip Stop 1.	1.7	10.4
Turn around to return to State Road 653 along State Road 722 to southeast. Turn right on State Road 653 at Stanleytown.	1.8	12.2
Continue along State Road 653 towards the southwest. Turn right on State Road 725 at Mabe.	2.5	14.7
Follow State Road 725 northwestward along Stock Creek to sandstone cliffs at Stop 2.	0.5	15.2
Continue along State Road 725 to turn around in area beyond "End State Maintenance" sign.	0.1	15.3
Return to intersection of State Road 725 with State Road 653 at Mabe and turn right on State Road 653.	0.6	15.9
Follow State Road 653 back to southwest for 3.3 miles and turn right on State Road 775.	3.3	19.2
Follow State Road 775 to intersection with State Road 654 and turn right on 654.	0.8	20.0

Follow State Road 654 to intersection with State Road 655 and turn right on 655.	0.1	20.1
Follow State Road 655 along Dry Creek, passing sandstone cliffs and cascades on right.	0.6	20.7
Continue along State Road 655 passing "Bowens Chapel" sign on right.	1.4	22.1
Pass intersection with Mill Hollow logging road that fords stream to right.	0.1	22.2
Take right fork at Y intersection.	0.3	22.5
Continue through clear-cut on forest road, stop in hairpin turn below Bowling Knob, above massive sandstone ledge at Stop 3.	0.6	23.1
Turn around and retrace route to State Road 655, descending into gorge of Dry Branch. At 2.4 miles below Stop 3 carefully park vehicles in driveway that ascends steeply to right, parallel to road. Because the road is very narrow and there are heavy trucks, walk carefully downhill along State Road 655 to a point where two pick-up trucks, a green Chevy and an orange Ford have been abandoned between the road and Dry Branch. Carefully descend the slope down to stream level at this point for Stop 4.	2.4	25.5
Return to vehicles and continue downhill along State Road 655 to intersection with State Road 654. At intersection turn right onto State Road 654.	0.5	26.0
Follow State Road 654 west along Dry Branch to intersect U.S. Highway 23 in Duffield. Turn left to follow U.S. Highway 23 south towards Gate City.	1.8	27.8
Follow U.S. Highway 23 south towards Gate City, cross U.S. Highway 58-23 Business to Gate City, Stay on U.S. Highway 23 By-pass.	15.5	43.3
At Weber City, turn left by Highway Shop onto U.S. Highway 58-421 East towards Bristol.	3.5	46.8
Turn right on State Road 701 to head south towards Tennessee.	0.4	47.2
Cross North Fork of Holston River, continue south on State Road 701.	1.5	48.7

Turn left at intersection onto State Road 704 to head east.	1.0	49.7
Turn left at intersection onto State Road 693 to head north.	3.6	53.3
Sharp curve to left, sandstone outcrops.	1.1	54.4
Continue along State Road 693 to Stop 5, which is at roadcut on right, 0.8 mile beyond sharp curve. Park along road at <u>Stop 5</u>.	0.8	55.2
Return to vehicle and continue along State Road 693 northeastward to intersection with State Road 696. Turn left on State Road 696.	1.1	56.3
Follow State Road 696 northwestward to intersection with U.S. Highway 58. Turn right on U. S. Highway 58 East towards Bristol.	1.9	58.2
Pass dumpsters in parking area to right, limestone outcrops on left side of road.	6.3	64.5
Pull onto grassy shoulder on right, across stream from Miller Chapel. <u>Stop 6</u>	0.1	64.6
Return to vehicles and continue eastward along U.S. Highway 58 to Bristol. At 9.5 miles from Stop 5 pass under Interstate Highway 81, turn left onto ramp and head north on I-81.	9.7	74.3
Follow I-81 north to Exit 14, which is second Chilhowee exit to U.S. Highway 11 and State Road 645. Turn left from ramp onto State Road 645. Follow 645 north across U.S. Highway 11.	24.3	98.6
Pass through narrow viaduct beneath Norfolk-Southern Railway.	0.5	99.1
Follow State Road 645 for three miles from railway viaduct to dirt road that descends steep bank on right. Park vehicles along road at this point and walk uphill approximately 300 feet to pit on left for <u>Stop 7</u>.	3.0	102.1
Return to vehicles and retrace route along State Road 645 to I-81 at Exit 14. Cross over I-81 and turn onto ramp to northbound lane.	3.3	105.4
Follow I-81 north to second Marion exit and turn onto ramp to U.S. Highway 11.	8.5	113.9
Turn left onto access road.	0.2	114.1

Pass beneath I-81 and turn right at stop sign onto U.S. Highway 11.	0.1	114.2
Follow U.S. Highway 11 north to intersection with State Road 689 and turn right.	0.8	115.0
Follow State Road 689 to southeast passing beneath I-81.	0.3	115.3
Follow State Road 689 for 0.3 miles beyond I-81 and turn sharply left onto old section of paved road.	0.3	115.6
Follow old road back towards I-81 to quarry on right. Park in quarry to keep drive clear. <u>Stop 8</u>	0.2	115.8
Return to vehicles and retrace route to U.S. Highway 11. Turn left from State Road 689 onto U.S. Highway 11 south towards Marion.	0.8	116.6
Follow Highway 11 south to I-81 access road, turn left to northbound lane, continue straight ahead to southbound lane or turn right to follow Highway 11 approximately 1 mile to Holiday Inn. End of road log.	1.0	117.6


STOP 1
STOP 2
STOP 3
STOP 4
STOP 5
STOP 6
STOP 7
STOP 8
Pikeville
Hazard
Harlan
Whitesburg
Prestonsburg
Jackson
Princeton
Tazewell
Abingdon
Wytheville
Chilhowie
Richlands
Grundy
Welch
Big Stone Gap
Norton
Coeburn
Wise
Appalachia
Lebanon
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Bluefield
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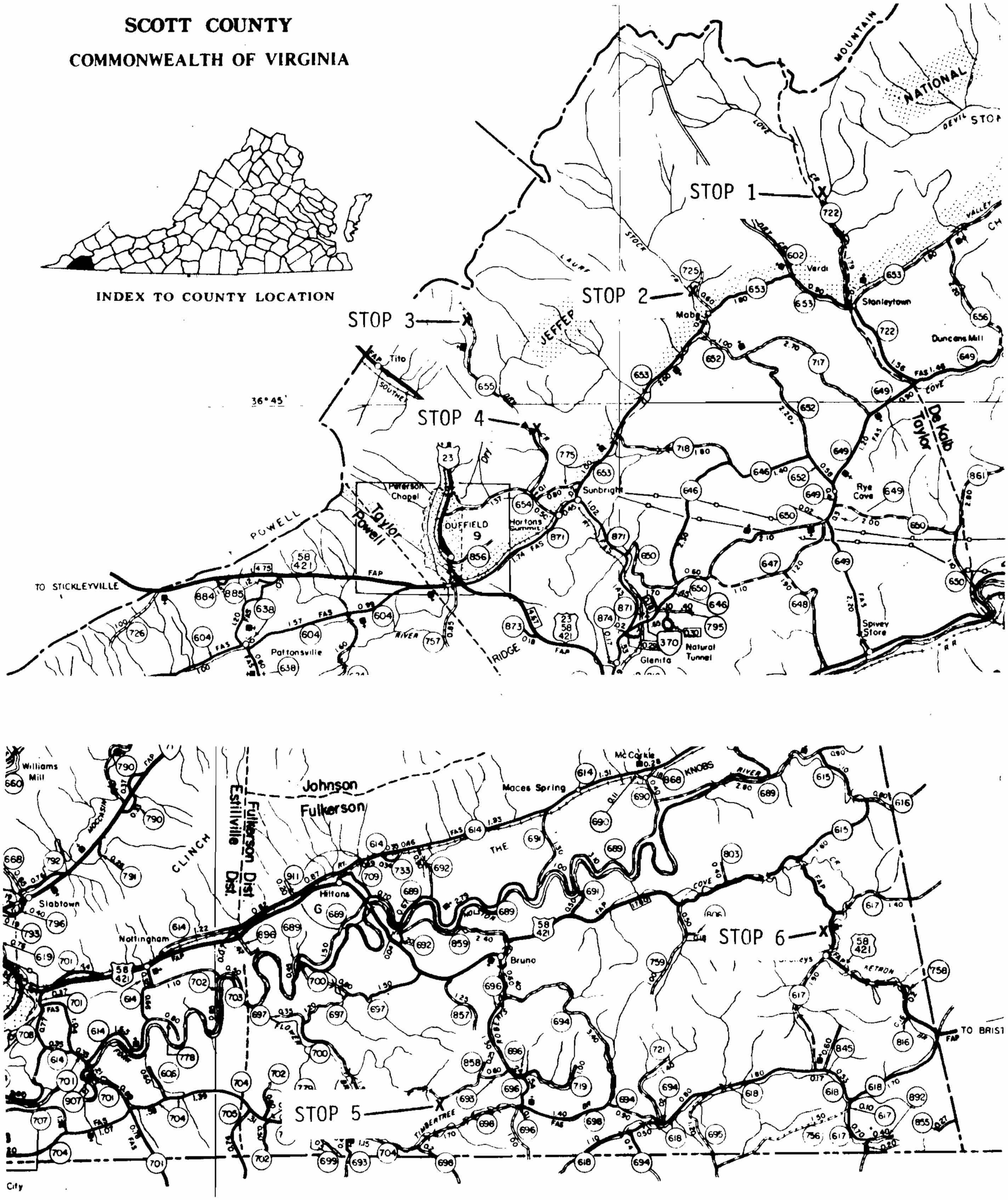

Figure 1. Location map of field trip stops in Scott County, Virginia.

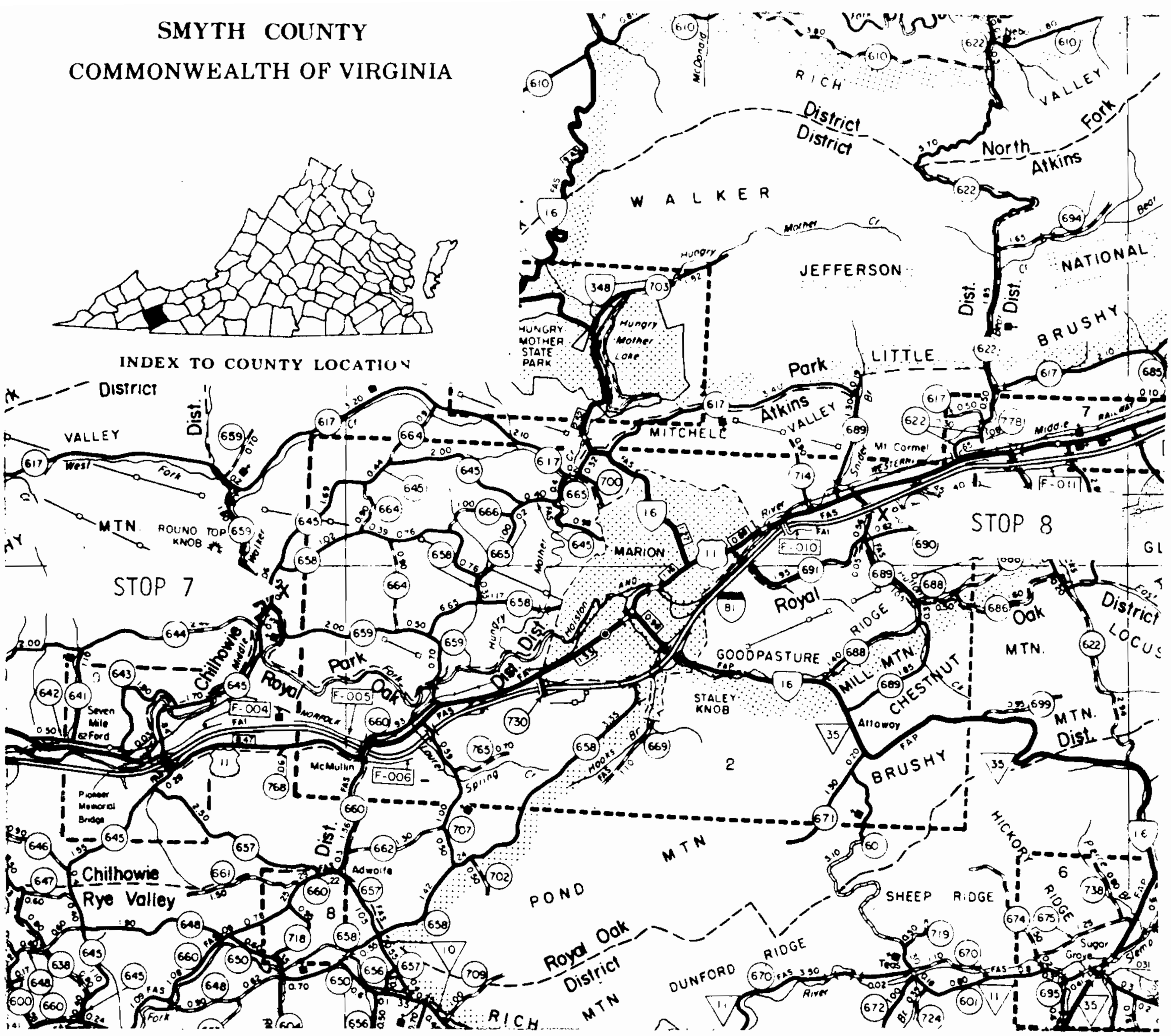

Figure 2. Location map of field trip stops in Smyth County, Virginia.

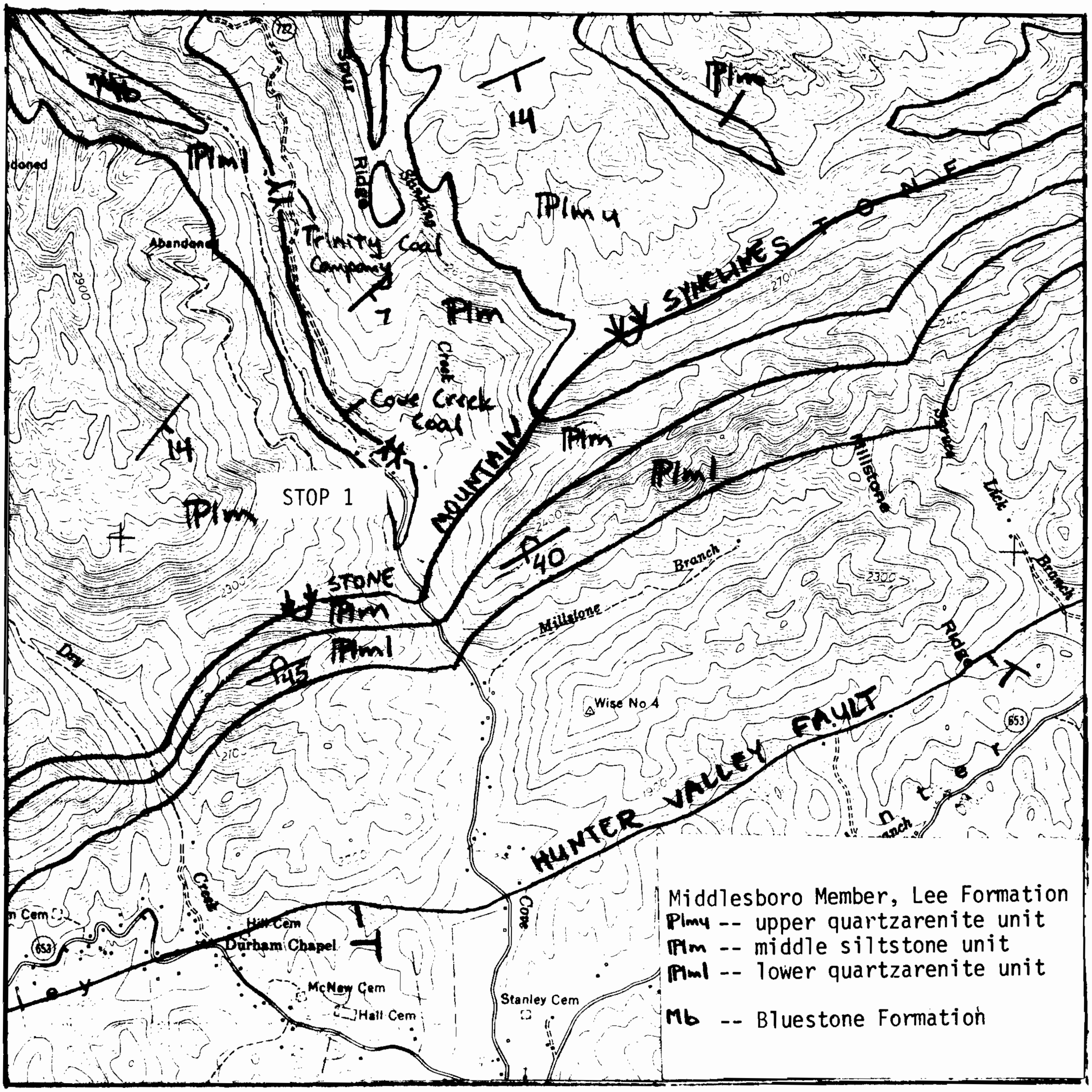

Figure 3. Stop 1, coal beds in the middle siltstone unit of the Middlesboro Member, Lee Formation, East Stone Gap 7.5-minute quadrangle, Scott County.

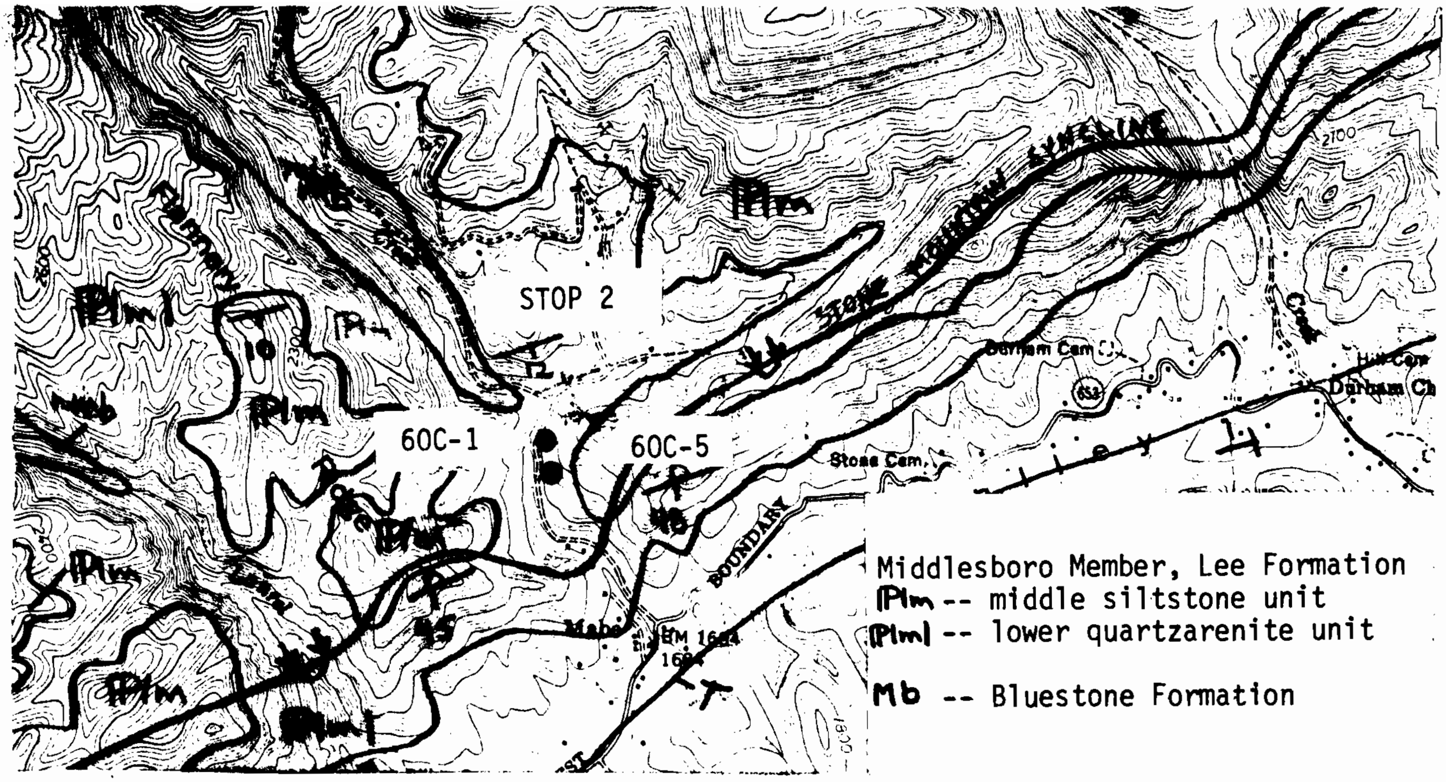

Figure 4. Stop 2, lower quartzarenite of the Middlesboro Member, Lee Formation, East Stone Gap 7.5-minute quadrangle, Scott County.

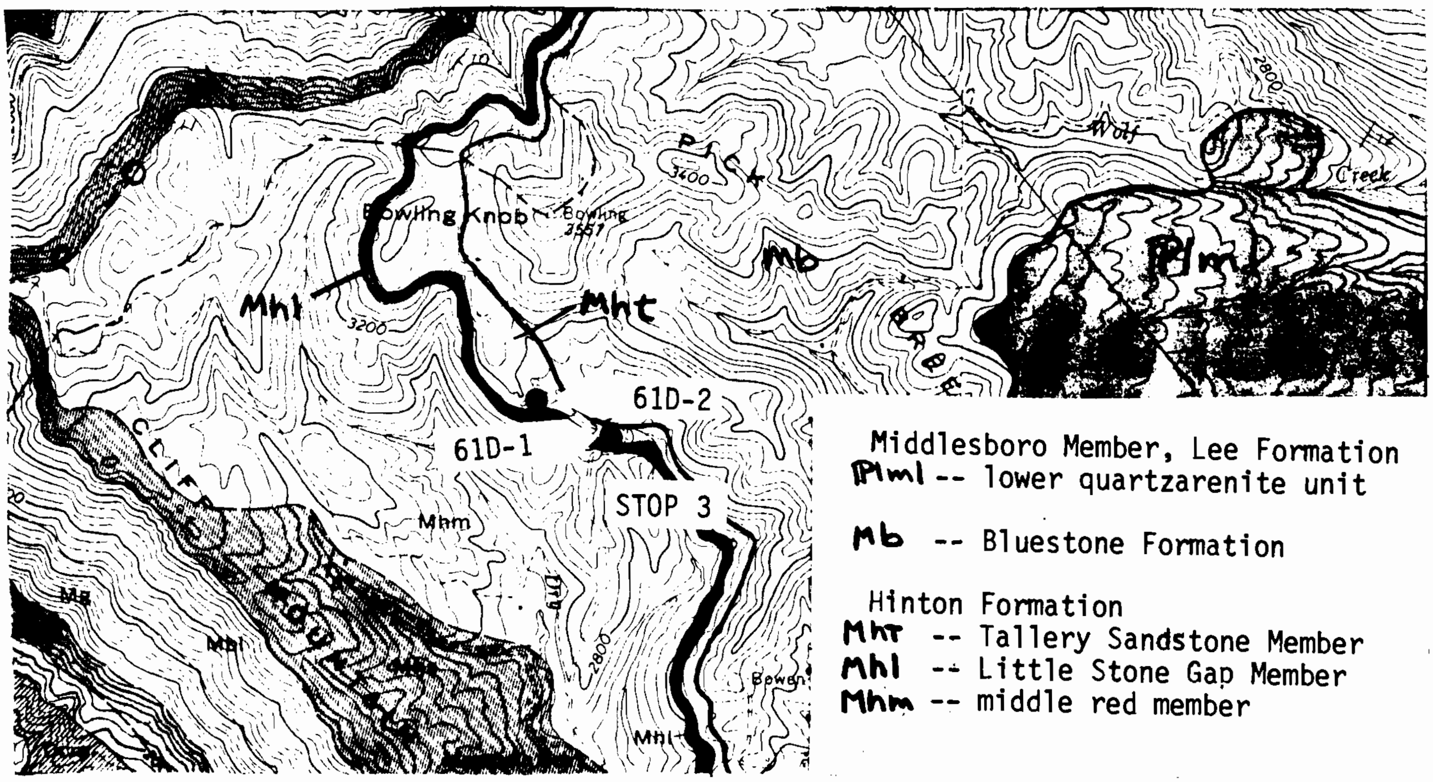

Figure 5. Stop 3, Tallery Sandstone Member of the Hinton Formation, Big Stone Gap 7.5-minute quadrangle, Scott County.

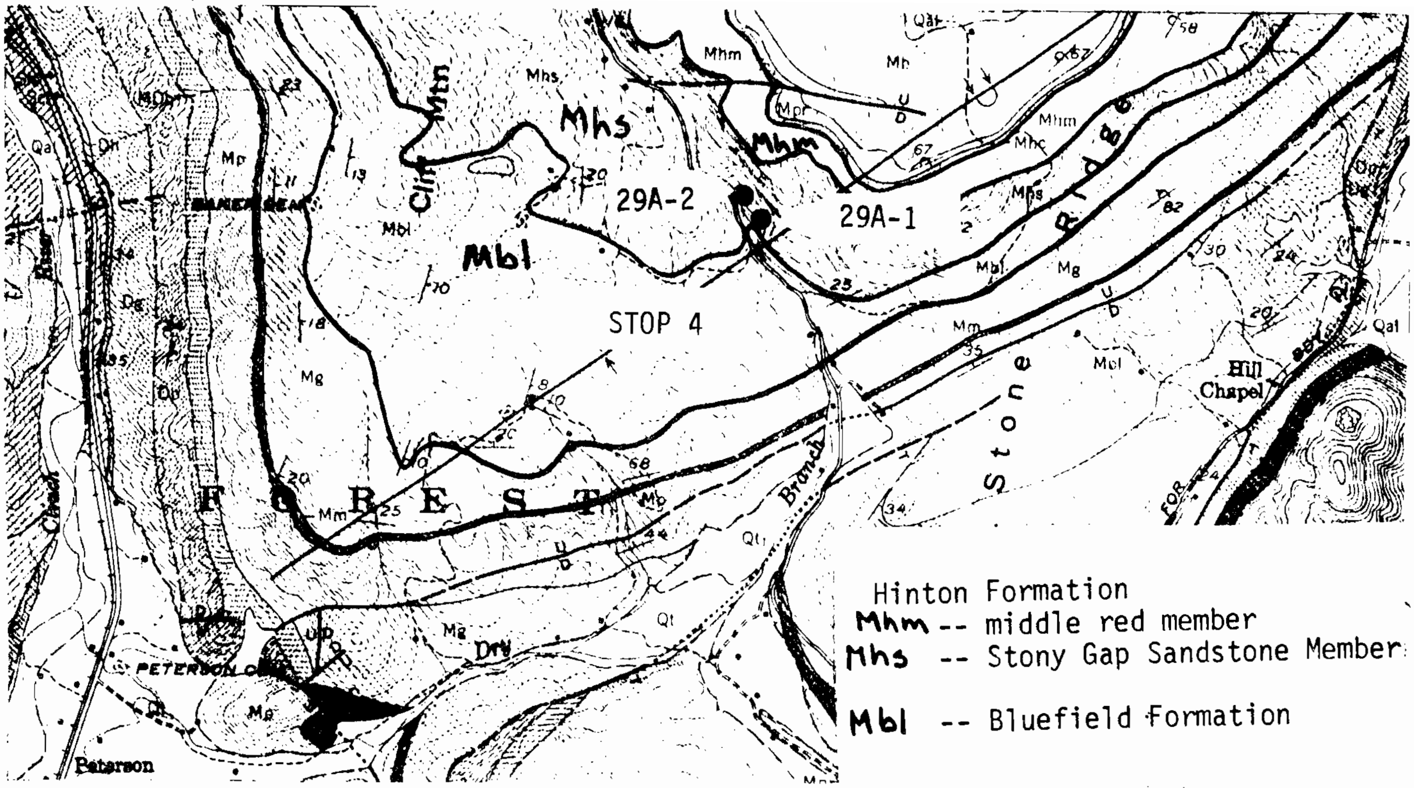

Figure 6. Stop 4, Stony Gap Sandstone Member of the Hinton Formation, Duffield 7.5-minute quadrangle, Scott County.

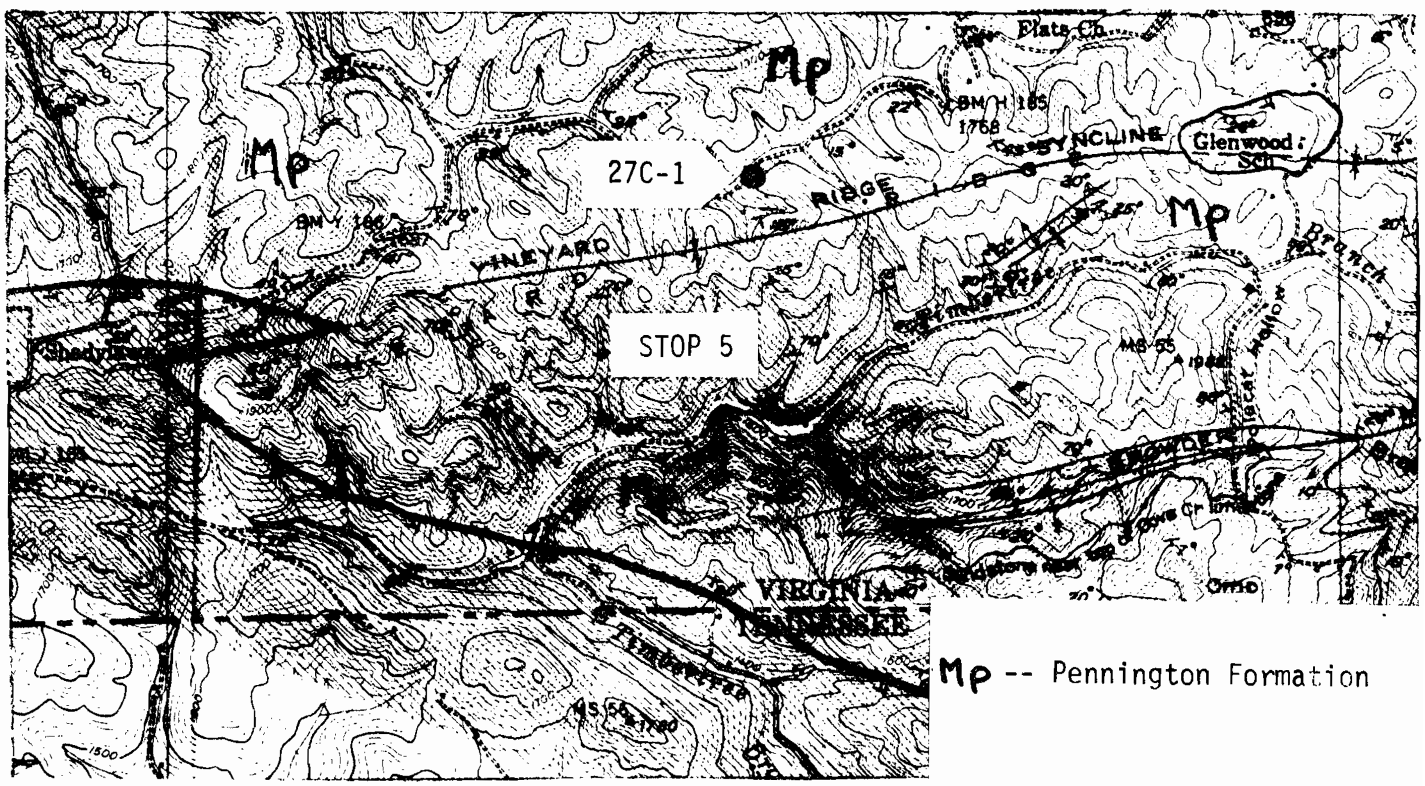

Figure 7. Stop 5, sandstone unit in the Pennington Formation, Indian Springs, Tennessee-Virginia 7.5-minute quadrangle, Scott County.

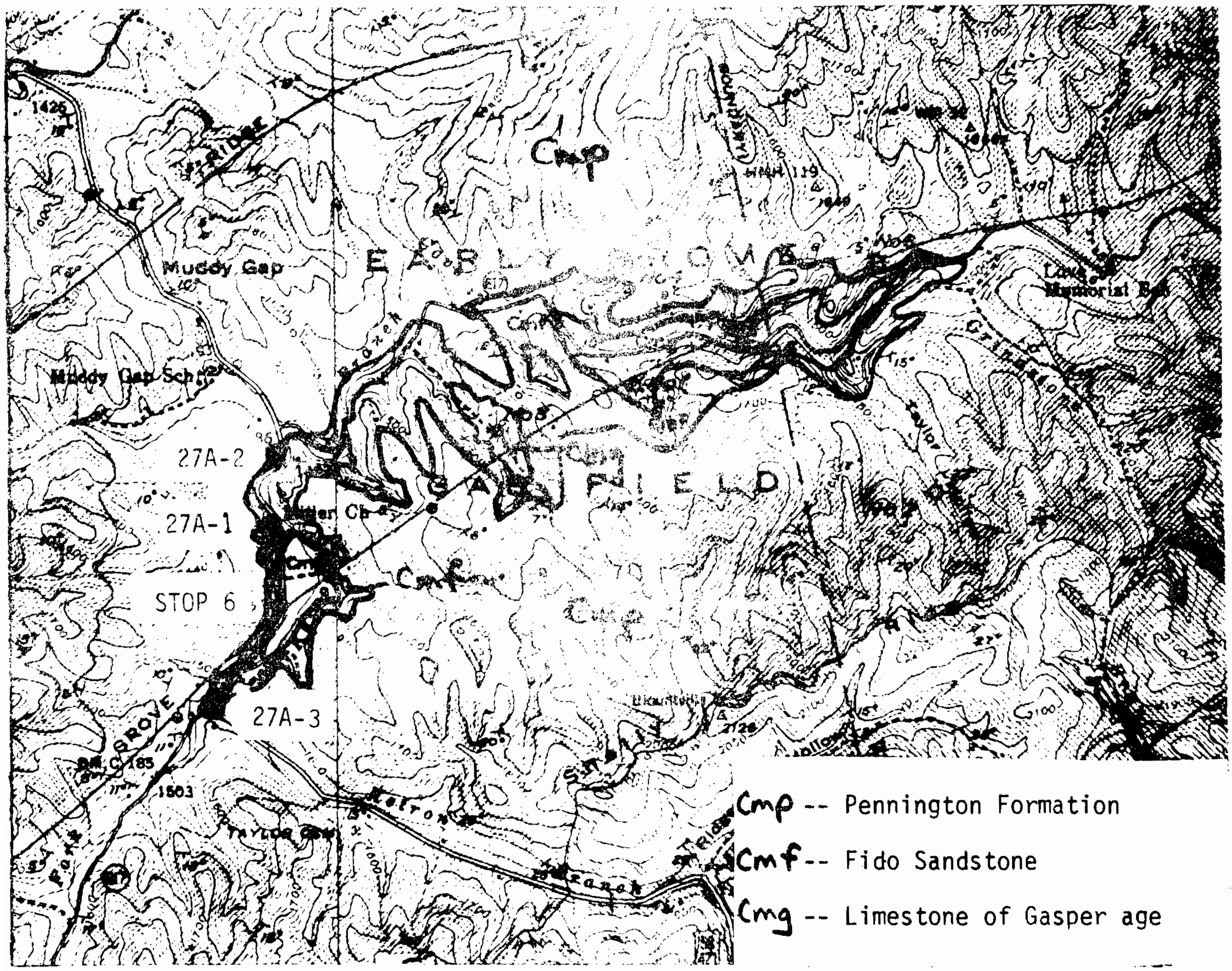

Figure 8. Stop 6, Fido Sandstone. Mendota 7.5-minute quadrangle, Scott County.

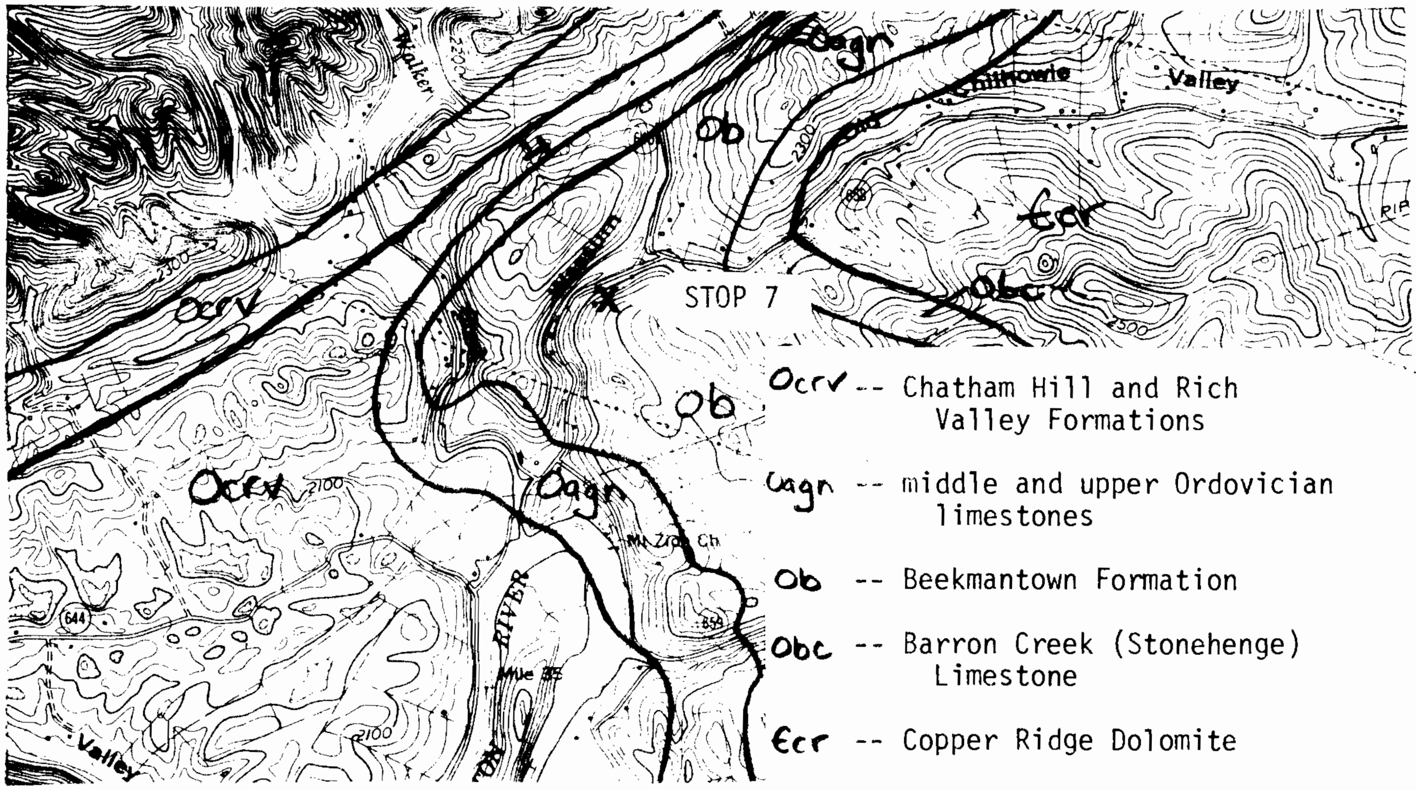

Figure 9. Stop 7, Myers - L. Copenhaver barite mine, Marion 7.5-minute quadrangle, Smyth County.

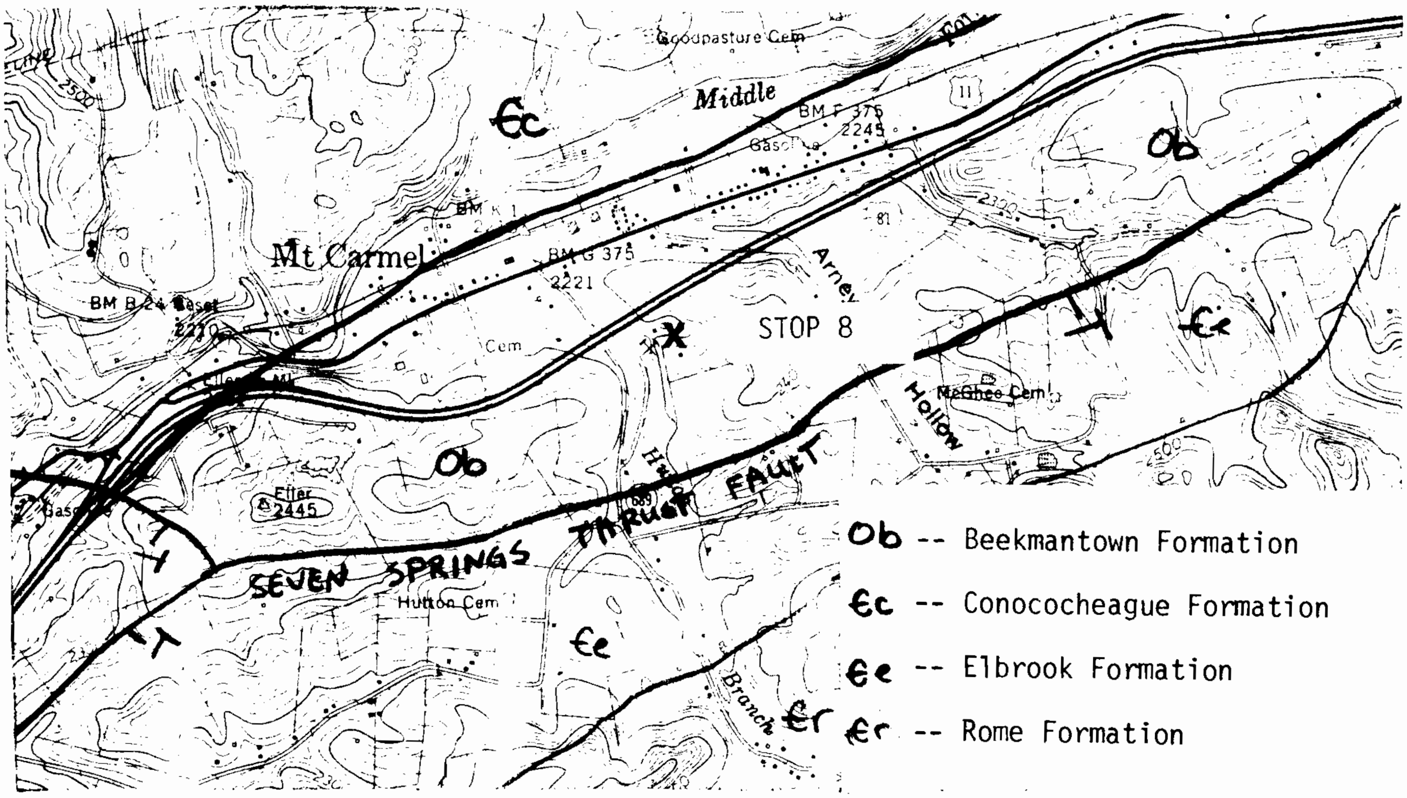

Figure 10. Stop 8, Henderlite barite mine, Atkins 7.5-minute quadrangle, Smyth County.