HYDROGEOLOGIC EVALUATION FOR UNDERGROUND INJECTION CONTROL IN NORTH GEORGIA

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HYDROGEOLOGIC EVALUATION FOR UNDERGROUND INJECTION CONTROL IN NORTH GEORGIA

INTRODUCTION

J. A. KELLAM AND R. ARORA

The area investigated includes the Piedmont, Blue Ridge, Valley and Ridge, and Cumberland Plateau Provinces of Georgia, covering about 23,500 square miles, 40 percent of the State. The Piedmont and Blue Ridge Provinces consist of several northeast to southwest trending belts of crystalline rock ranging in age from Precambrian to Triassic. The Valley and Ridge Province consists of folded and faulted sedimentary rocks of Cambrian to early Pennsylvanian age. The Cumberland Plateau Province is a sequence of relatively undeformed Paleozoic-aged sedimentary rocks.

The hydrogeologic analyses were based on the study of remote sensing data, oil and gas information, and water well data, with extensive use made of previous geologic and hydrologic studies. Eleven maps and five cross sections have been constructed for north Georgia in this hydrologic atlas. Well yields and specific capacity maps were constructed for the entire north Georgia area. In the primarily crystalline terranes of the Blue Ridge and Piedmont Provinces, maps were constructed to delineate the size and location of homogeneous, competent granite and gneiss bodies. Additionally, a map was constructed to define areas where tectonic activity such as faulting (i.e., brittle deformation) has resulted in porosity-enhancing fractures. Similarly, a lineament map was prepared, as such features may be indicative of enhanced weathering along fractures. Cumberland Plateau and Valley and Ridge aquifers (Knox Group, Armuchee Chert and Fort Payne Chert) were examined according to the following criteria: 1) water quality, 2) relation of aquifers and confining units, and 3) thickness of aquifers.

GEOLOGY

Blue Ridge and Piedmont Provinces

The Blue Ridge and Piedmont Provinces comprise approximately 20,450 square miles, an area characterized as a complex terrane of igneous and metamorphic rocks of Precambrian to Triassic age. Structurally, these provinces are divided into a series of northeast to southwest trending belts separated by major faults and/or shear zones. Lithologies consist of deeply weathered and extensively folded, faulted, and fractured igneous, metaigneous, and metasedimentary rocks. The principal episodes of metamorphism occurred during Precambrian and middle Paleozoic times.

Valley and Ridge and Cumberland Plateau Provinces

Encompassing a total area of about 3050 square miles, these two provinces are located in northwest Georgia. They are separated from the rest of Georgia by the Cartersville and/or Great Smoky Fault system to the east and south. The regional structural trend here is northeast to southwest. The Valley and Ridge is a province of complexly folded and faulted sedimentary rocks, whereas the structure of the Cumberland Plateau Province is more subtle with rare thrust faulting and more gently folded strata.

The lithologies consist of sedimentary formations ranging from Cambrian to Early Pennsylvanian in age. Compositional and thickness variations in the strata reflect changing environments of deposition in the generally marine environment during this span of time, as well as nearby tectonism which periodically occurred.

HYDROGEOLOGY

The primary porosities and permeabilities are small in unfractured metamorphic and igneous rocks. The quantity of water available in these rocks depends upon the development of secondary permeability in the form of joints, fractures, and their interconnection. The size of openings and degree of interconnection of joints and fractures depend upon the nature of the rock, depth below land surface, and geologic and tectonic environment. According to Cressler and others (1983), joints and other openings in soft rocks such as phyllite tend to be tight and poorly connected. The well yield in these rocks is small. On the other hand, openings in more brittle rocks such as quartzite and graywacke tend to be larger and better connected. Wells in these rocks normally supply greater yields. Carbonate rocks commonly contain large interconnected solution openings and transmit large quantities of water.

This atlas contains three plates (2-4) displaying the locations of water wells in northern Georgia which are characterized by yields less than or equal to 35 gal/min, between 36 gal/min and 74 gal/min, and greater than or equal to 75 gal/min. No significant correlation of yield with lithology or depth is apparent. Approximately two-thirds of the plotted wells have specific capacity values within the range of 0.1 to 1.0 gal/min/ft (Plate 5).

Cressler and others (1983, p. 10) associate high-yielding wells with certain structural and stratigraphic features which include: 1) contact zones between rock units of contrasting character; 2) contact zones within multilayered rock units; 3) fault zones; 4) stress relief fractures; 5) zones of fracture concentration; 6) small-scale structures including joints, foliation planes, and fold axes, that localize drainage development; 7) folds that produce concentrated jointing; and 8) shear zones.

Other factors, such as topographic setting, drainage style, rock type, depth of weathering, thickness of soil cover, and the pervasiveness and orientation of foliation can interact to increase or decrease the availability of ground water.

MAP AND CROSS SECTION PLATES

A total of eleven maps and five cross sections were produced for this study. Seven maps covering the entire study area were constructed for the following parameters: 1) well yields (three maps) indicating pumping rates (in gallons per minute) which, over an indefinite time period did not lower the water level below the pump intake; 2) specific capacity, showing productivity of the wells, defined as the ratio of pumping rate to measured drawdown (gallons/minute/foot drawdown); 3) hydrographs of selected wells illustrating annual changes in water levels; 4) brittle structures illustrating current interpretations regarding the locations of major fault and cataclastic zones in the study area; and 5) lineaments representing linear features seen on National Aeronautics and Space Administration ERTS imagery checked by comparison with U.S. Geological Survey topographic maps. For the Piedmont and Blue Ridge Provinces, a map of granitic plutons and gneissic bodies was constructed to delineate the size and location of the bodies. Three maps and five cross sections were constructed for the Valley and Ridge and Cumberland Plateau Provinces. These include: 1) structural contours of the tops of the Knox Group and the Fort Payne Chert and Armuchee Chert intervals; 2) isopachs of the Fort Payne Chert and Armuchee Chert; 3) total dissolved solids concentrations of selected wells in northwest Georgia, and their relationship to several hydrogeologic units in the area; 4) cross sections (five) of the Paleozoic rocks of northwest Georgia, using well data and measured sections to determine the relationship of aquifers to confining units.

Data

Data for this project came primarily from published and unpublished material on file at the U.S. Geological Survey, the Georgia Geologic Survey and other branches of the Environmental Protection Division of the State of Georgia. Also, persons involved in current relevant studies were consulted.

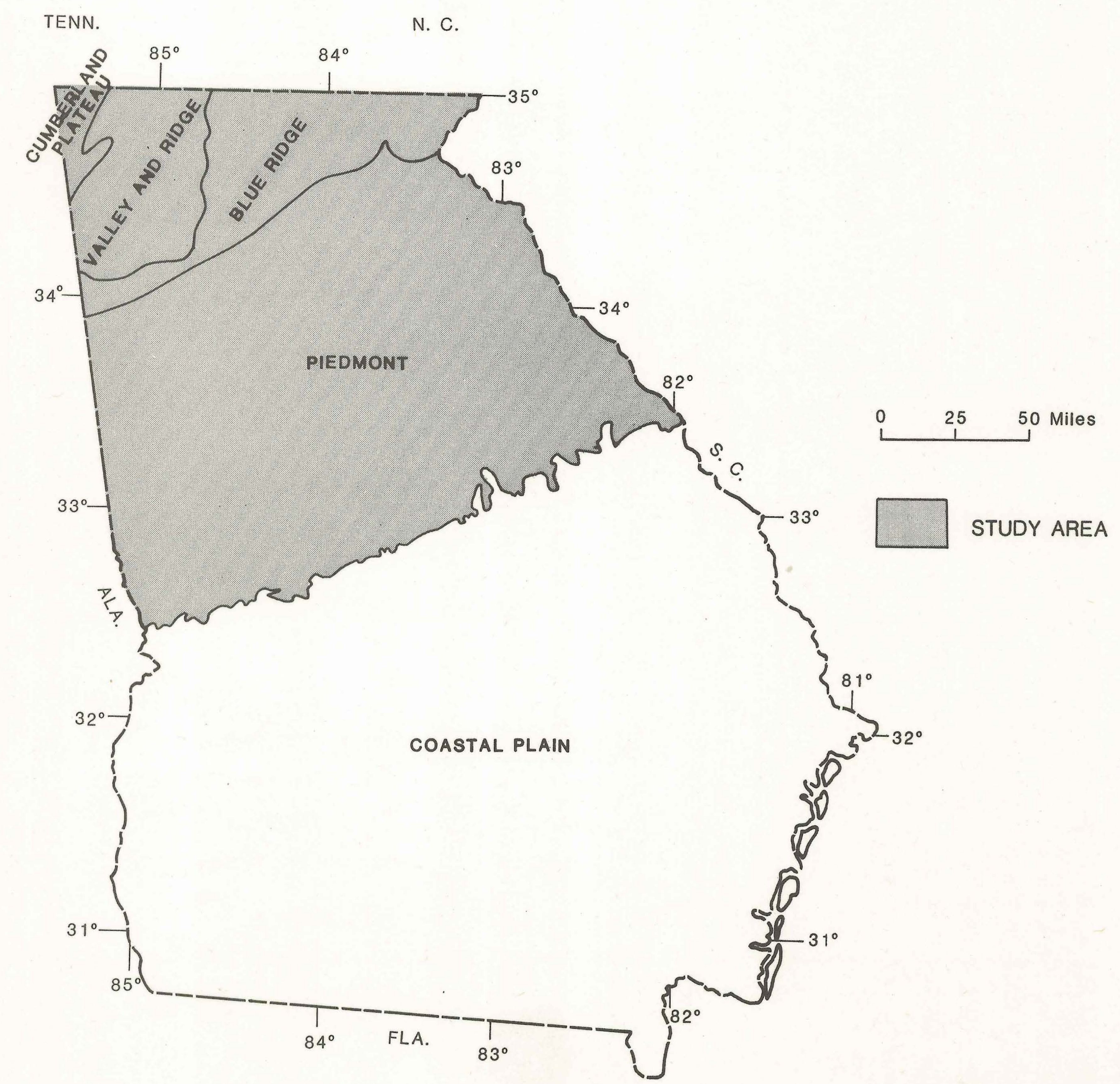
Map Scale

Map scales in this study are generally 1:1,000,000. Exceptions are the 1:500,000 scale used for the total dissolved solids map of northwest Georgia, and the structural contour of the Knox Group and Fort Payne Chert-Armuchee Chert intervals. Contour intervals are dependent on the number of data points available and the range of variability of the data. Location of contour lines are approximate and extrapolation is based on assumed continuous trends between points.

Vertical exaggeration on the cross sections is 1:1. Vertical and horizontal scales are 1' = 5,000.

Funding

Funding for this project has been provided by the U.S. Environmental Protection Agency (E.P.A.) and the State of Georgia Department of Natural Resources, Environmental Protection Division.



Underground Injection Control Project
Coastal Plain of Georgia

The Georgia Geologic Survey also has prepared a series of maps and cross sections of the Coastal Plain of Georgia, entitled "Hydrogeologic Evaluation for Underground Injection Control in the Coastal Plain of Georgia: Georgia Geologic Survey Hydrologic Atlas 10." To obtain a copy, direct requests to:

Georgia Geologic Survey
Room 400
19 Martin Luther King, Jr. Dr., S.W.
Atlanta, Georgia, 30334

REFERENCE

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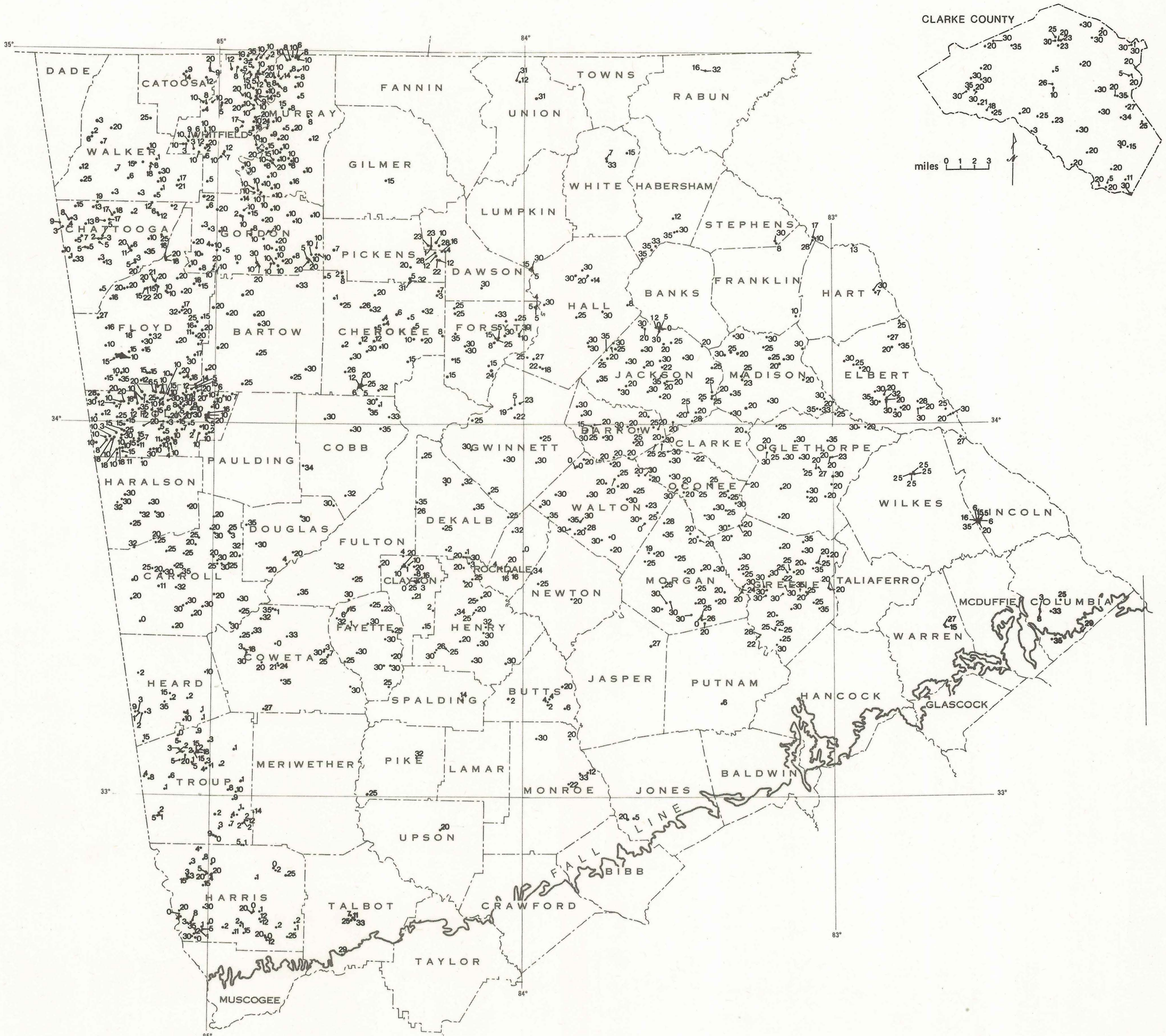
PLATE 2

YIELDS OF SELECTED WELLS IN NORTHERN GEORGIA
MAP 1 OF 3

A. L. STIEVE

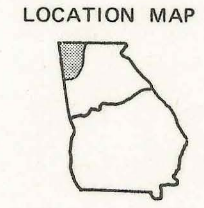
This map displays the locations of water wells in northern Georgia which are characterized by yields of less than or equal to 35 gal/min. The locations are derived from various data sources listed in the following list of sources. The locations have not been field checked.

Freeze and Cherry (1979) define well yield as the maximum rate of extraction that can be maintained without lowering the water level below the pump intake. As used in relation to this map, the term is more ambiguous. Most wells shown here were constructed by private drilling firms which generally omitted important drawdown and pumping time data from their records. Yields reported for most of the mapped wells are pumping rates which, over an indefinite time period, did not lower the water level below the pump intake. In the absence of reliable drawdown data, the reported yields should be regarded as minimum values.



EXPLANATION

•30 WELL - Number is yield in gallons per minute.



0 10 20 MILES

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Croft, M.G., 1964, Geology and ground water resources of Dade County, Georgia: Georgia Geol. Survey Inf. Circ. 26, 17 p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater, Englewood Cliffs, N.J., Prentice Hall, 305 p.

Unpublished data on file at the Georgia Geologic Survey, Atlanta.

Unpublished data on file at the U.S. Geological Survey, Doraville, Ga.

PLATE 3

YIELDS OF SELECTED WELLS IN NORTHERN GEORGIA
MAP 2 OF 3

A. L. STIEVE AND N. M. COLEMAN

This map displays the locations of water wells in northern Georgia which are characterized by yields of between 36 gal/min and 74 gal/min. The locations are derived from various data sources listed in the following list of sources. The locations have not been field checked.

Freeze and Cherry (1979) define well yield as the maximum rate of extraction that can be maintained without lowering the water level below the pump intake. As used in relation to this map, the term is more ambiguous. Most wells shown here were constructed by private drilling firms which generally omitted important drawdown and pumping time data from their records. Yields reported for most of the mapped wells are pumping rates which, over an indefinite time period, did not lower the water level below the pump intake. In the absence of reliable drawdown data, the reported yields should be regarded as minimum values.

SOURCES

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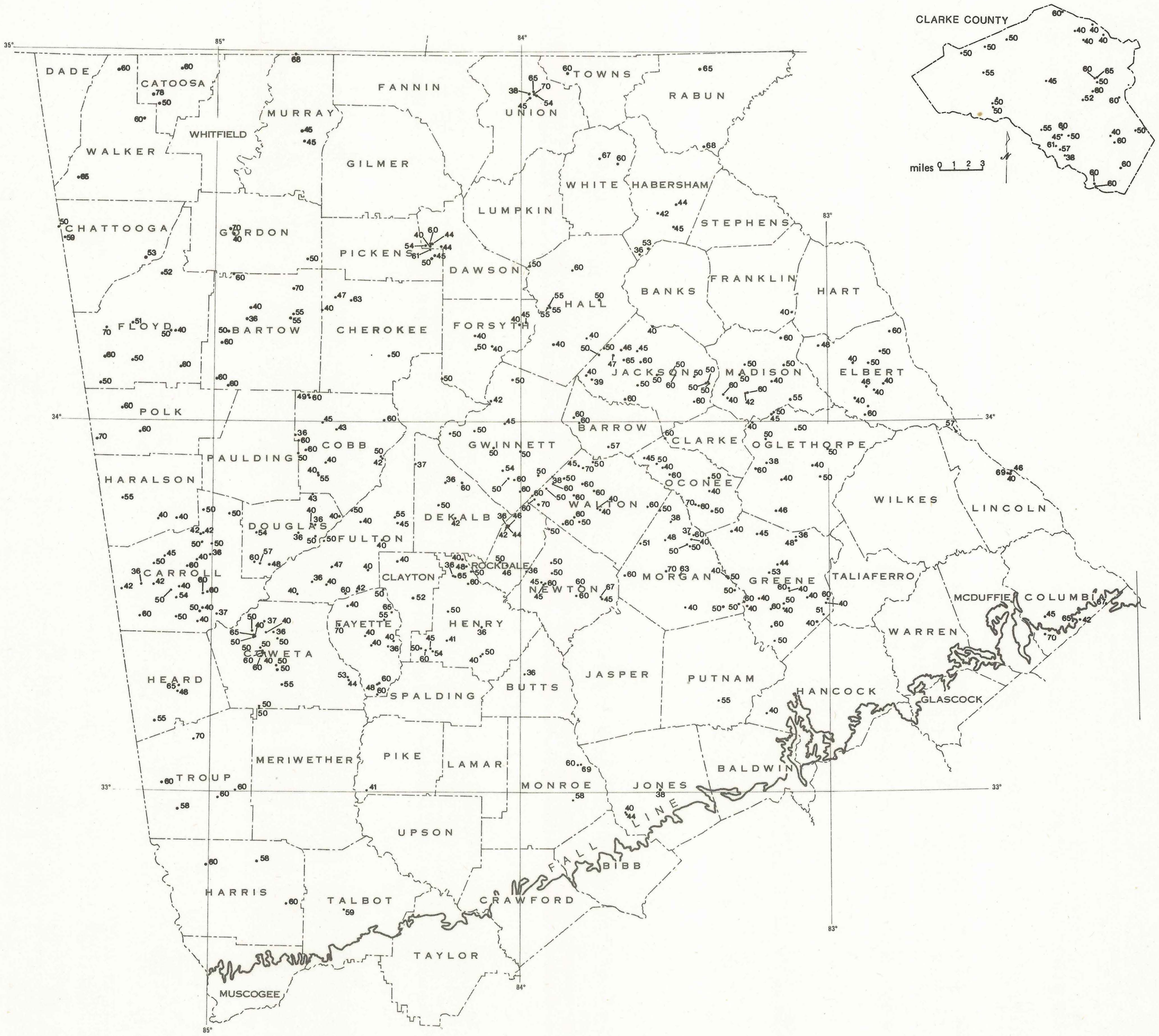


EXPLANATION

•40 WELL - Number is yield in gallons per minute.

LOCATION MAP

0 10 20 MILES

YIELDS OF SELECTED WELLS IN NORTHERN GEORGIA

MAP 3 OF 3

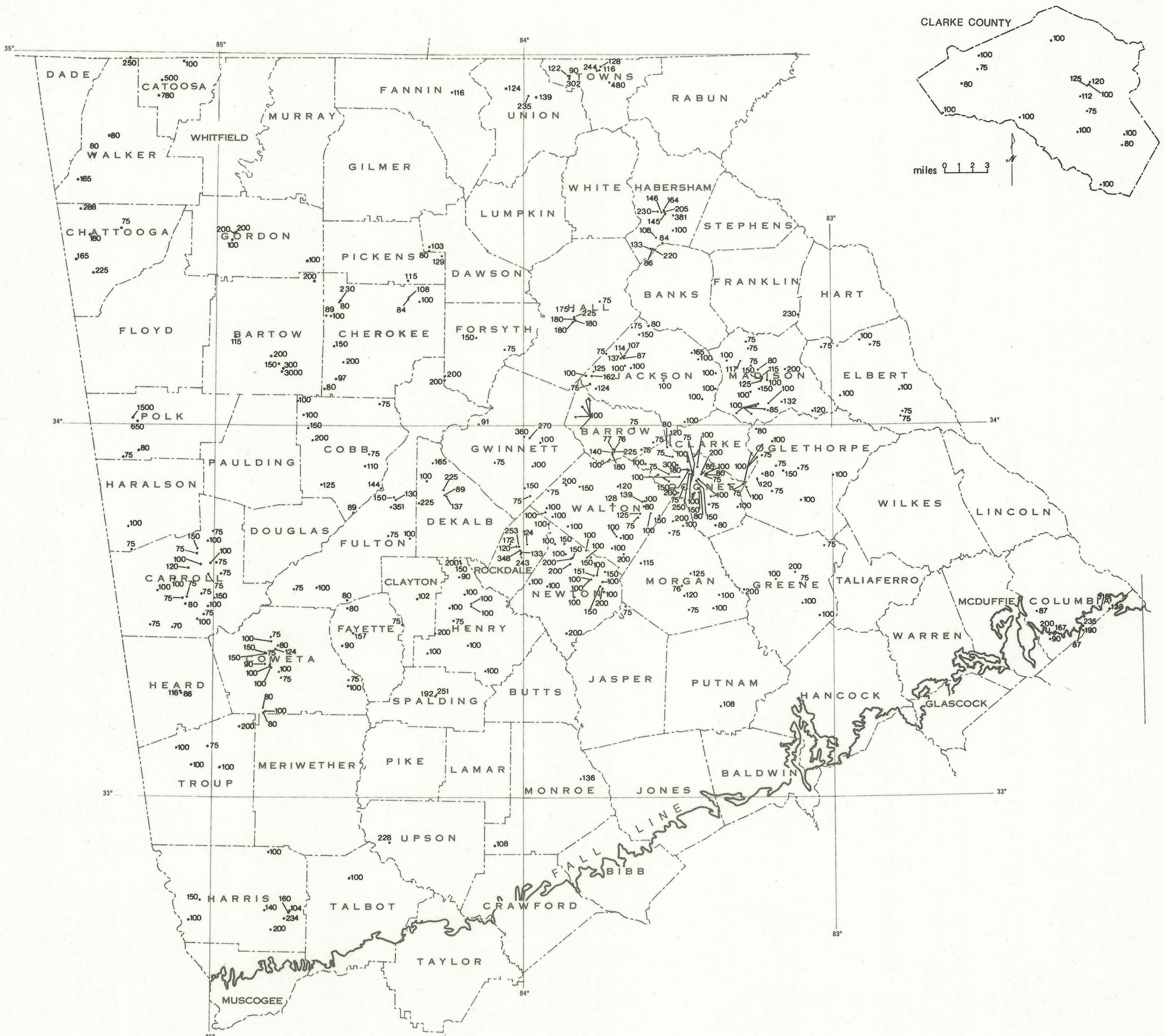
A. L. STIEVE AND N. M. COLEMAN

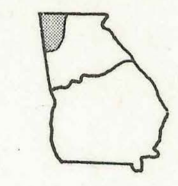
EXPLANATION

•120 WELL - Number is yield in gallons per minute.

This map displays the locations of water wells in northern Georgia which are characterized by yields of greater than or equal to 75 gal/min. The locations are derived from various data sources listed in the following list of sources. The locations have not been field checked.

Freeze and Cherry (1979) define well yield as the maximum rate of extraction that can be maintained without lowering the water level below the pump intake. As used in relation to this map, the term is more ambiguous. Most wells shown here were constructed by private drilling firms which generally omitted important drawdown and pumping time data from their records. Yields reported for most of the mapped wells are pumping rates which, over an indefinite time period, did not lower the water level below the pump intake. In the absence of reliable drawdown data, the reported yields should be regarded as minimum values.





0 10 20 MILES

SOURCES

Cressler, C.W., 1963, Geology and ground-water resources of Catoosa County, Georgia: Georgia Geol. Survey Inf. Circ. 28, 19 p.

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__________, 1970, Geology and ground-water resources of Floyd and Polk Counties, Georgia: Georgia Geol. Survey Inf. Circ. 39, 95 p.

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Freeze, R.A. and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, N.J., Prentice Hall, 305 p.

Unpublished data on file at the Georgia Geologic Survey, Atlanta.

Unpublished data on file at the U.S. Geological Survey, Doraville, Ga.

SPECIFIC CAPACITIES OF SELECTED WELLS IN NORTHERN GEORGIA

N. M. COLEMAN AND A. L. STIEVE

The productivity of a well is generally expressed by the term "specific capacity", which is defined as the ratio of the pumping rate to the measured drawdown. This map depicts calculated specific capacity values (gal/min/ft) for selected wells in northern Georgia.

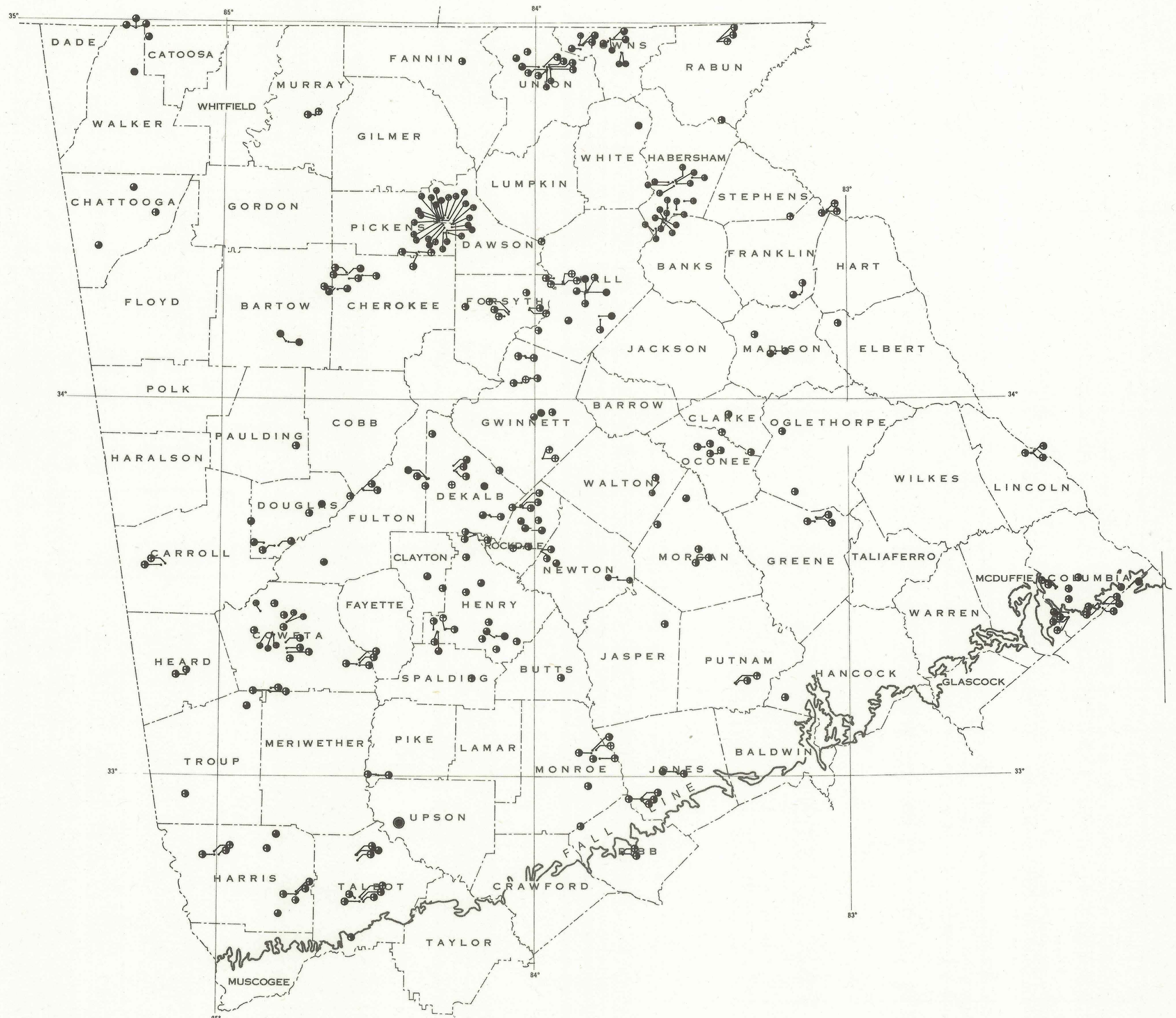
The wells are subdivided into six categories illustrating the logarithmic variation of well productivity. As illustrated by the bar graph in the explanation, the population of specific capacity values generally conforms to a log-normal distribution. Approximately two-thirds of the plotted wells have specific capacity values within the range of 0.1 to 1.0 gal/min/ft.

Locations of most of the wells on this map have not been field checked, nor have specific capacity values been standardized regarding variables such as well diameter, pumping time, and uncased well depth.

As an ancillary study, a correlation matrix (not shown) was generated to examine the association of well construction methods with reported specific capacity values. No significant correlations could be identified relating productivity to the following variables: total depth of the well, casing depth, uncased well depth, and well diameter. Correlation matrices were based on a population of 191 wells in the Piedmont and Blue Ridge Provinces.

SOURCES

Unpublished data on file at the Georgia Geologic Survey, Atlanta.



EXPLANATION

• WELL LOCATION

SPECIFIC CAPACITY = Gallons/minute/foot drawdown

.001 ≤ specific capacity < .01

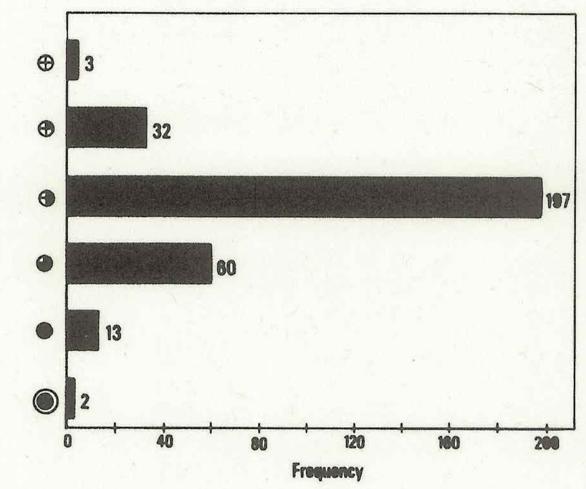
.01 ≤ specific capacity < 0.1

0.1 ≤ specific capacity < 1.0

1.0 ≤ specific capacity < 10

10 ≤ specific capacity < 100

100 ≤ specific capacity < 1000



LOCATION MAP

PLATE 6

WATER-LEVEL TRENDS IN SELECTED WELLS IN NORTHERN GEORGIA

N. M. COLEMAN AND J. A. KELLAM

EXPLANATION

HYDROGRAPH - Shows water-level fluctuations and trends from 1973 to 1982. Name refers to well identification.

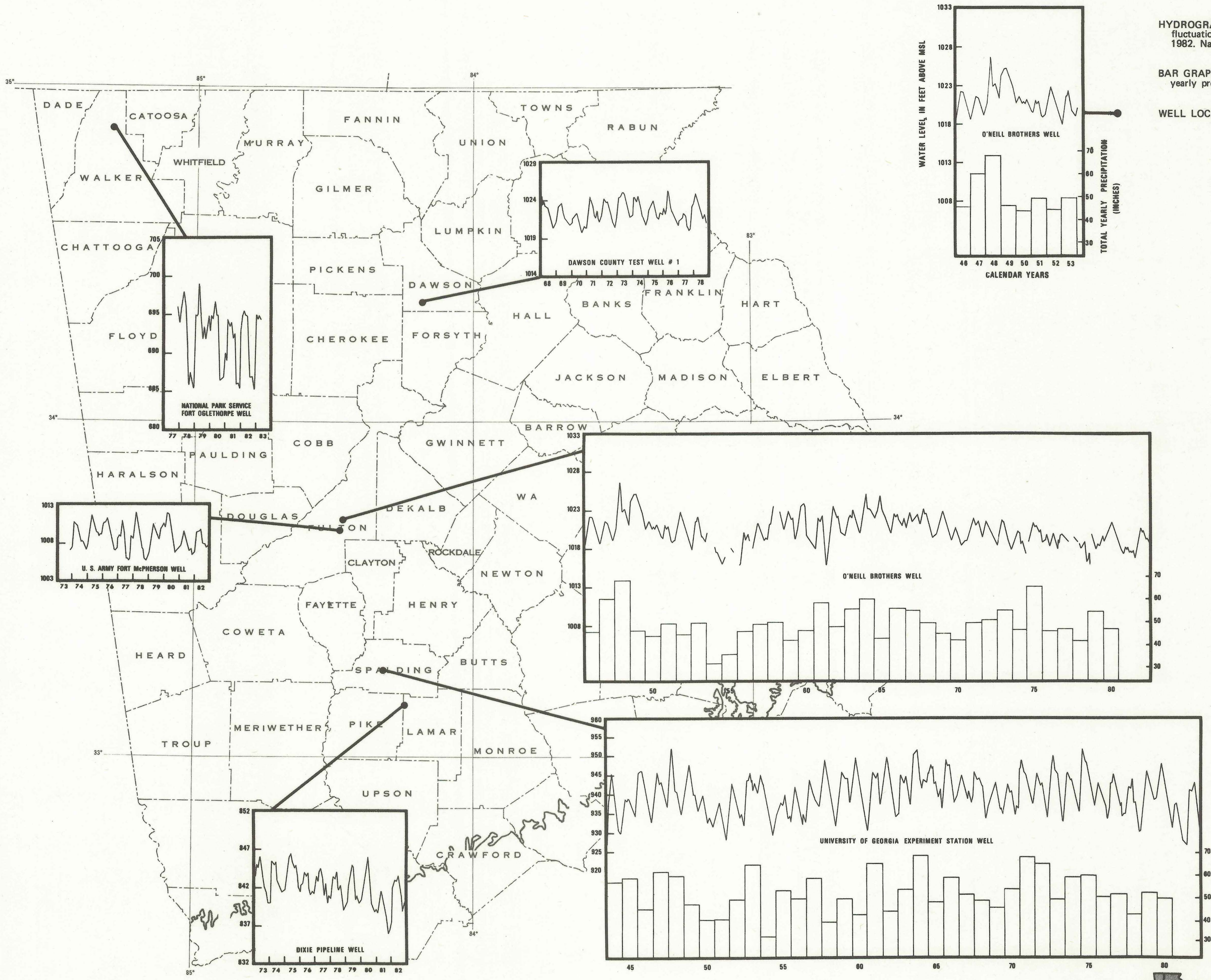
BAR GRAPH - Depicts amounts of total yearly precipitation in inches.

WELL LOCATION

These hydrographs present information about seasonal and long-term variations in ground water levels at selected sites in northern Georgia. Locations of six established hydrograph stations are shown with graphs of all available data. The Fort Oglethorpe well is located in the Valley and Ridge Province and the Dawson County well is located in the Blue Ridge Province. The other four hydrograph stations are within the Piedmont Province.

All of the wells except the Fort Oglethorpe well, which monitors water levels in fractured limestones of the Chickamauga Group, are located in metamorphic terranes. The hydrographs show the response of essentially unconfined fracture-network flow systems to variable conditions of recharge and discharge. The seasonal pattern of diminished summer and autumn aquifer recharge is clearly reflected in the continuous hydrograph data.

Long-term precipitation data are available from rain gauge stations located near the hydrographs in Fulton and Spalding Counties. For the purpose of comparison, bar graphs depicting amounts of total yearly precipitation have been plotted beneath the two long period hydrographs.



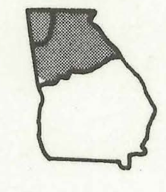


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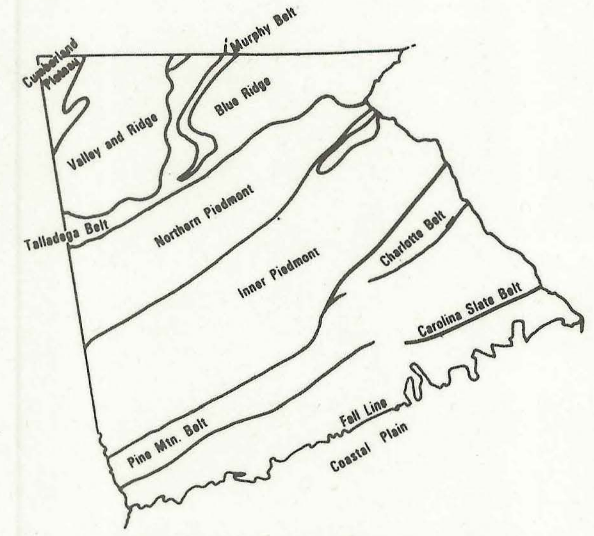
PLATE 7

BRITTLE STRUCTURES OF NORTHERN GEORGIA

J. A. KELLAM

(MODIFIED FROM GEOLOGIC MAP OF GEORGIA, 1976)



Provinces of north Georgia, with bounding faults and major belts.

The brittle structure map shows the current interpretations regarding the location of major fault and cataclastic zones in the Piedmont, Blue Ridge, Valley and Ridge, and Cumberland Plateau Provinces of Georgia. Fracturing and shearing, which accompanied faulting and brittle deformation overprinted on ductile shear zones, result in increased potential for improved water-bearing capabilities. Most previous investigators, including LeGrand (1967), suggest that fractures are useful as conduits for ground water only to depths of 150 to 200 feet below land surface. At this depth, pinching out of the fractures had been believed to negate their usefulness. Contrary to this are cases of productive fractures at 500 feet below land surface, as documented by Stewart (1962).

The Piedmont and Blue Ridge Provinces of Georgia consist of several juxtaposed and rifted continental and island-arc fragments of Precambrian to Triassic age. These fragments are composed principally of sedimentary and igneous rocks which were metamorphosed in Precambrian and Middle Paleozoic time. These metamorphic rocks are divided into a series of northeast to southwest trending belts separated by major faults and/or shear zones.

The Valley and Ridge Province consists of sedimentary rocks of Cambrian to Early Pennsylvanian age. Both folding and faulting occurred contemporaneously with Late Paleozoic deformation in the Cumberland Plateau and in the Blue Ridge and Piedmont Provinces.

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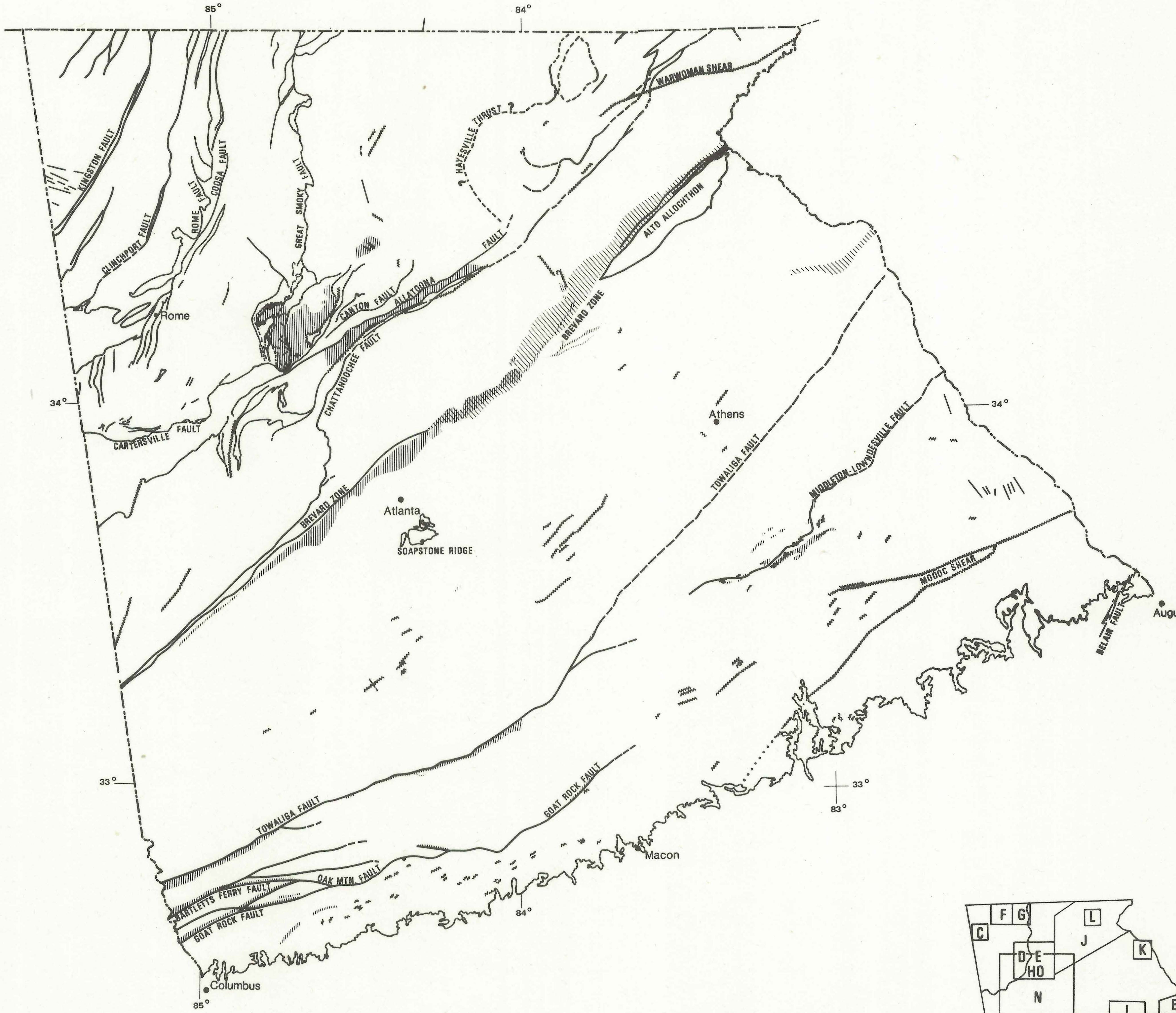

EXPLANATION

- FAULT
- IMPLIED FAULT
- POSSIBLE SHEAR
- SHEAR ZONES
- CATACLASTIC ROCKS (IMPLIED BRITTLE STRUCTURE)

DATA SOURCES CONT'D.

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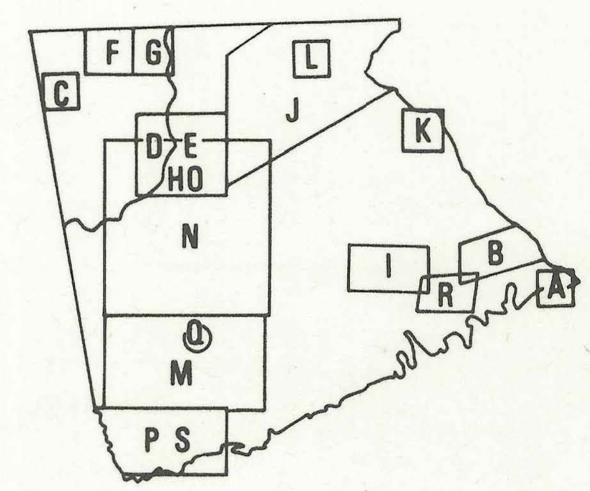
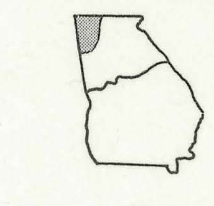


Index to data sources.

LOCATION MAP

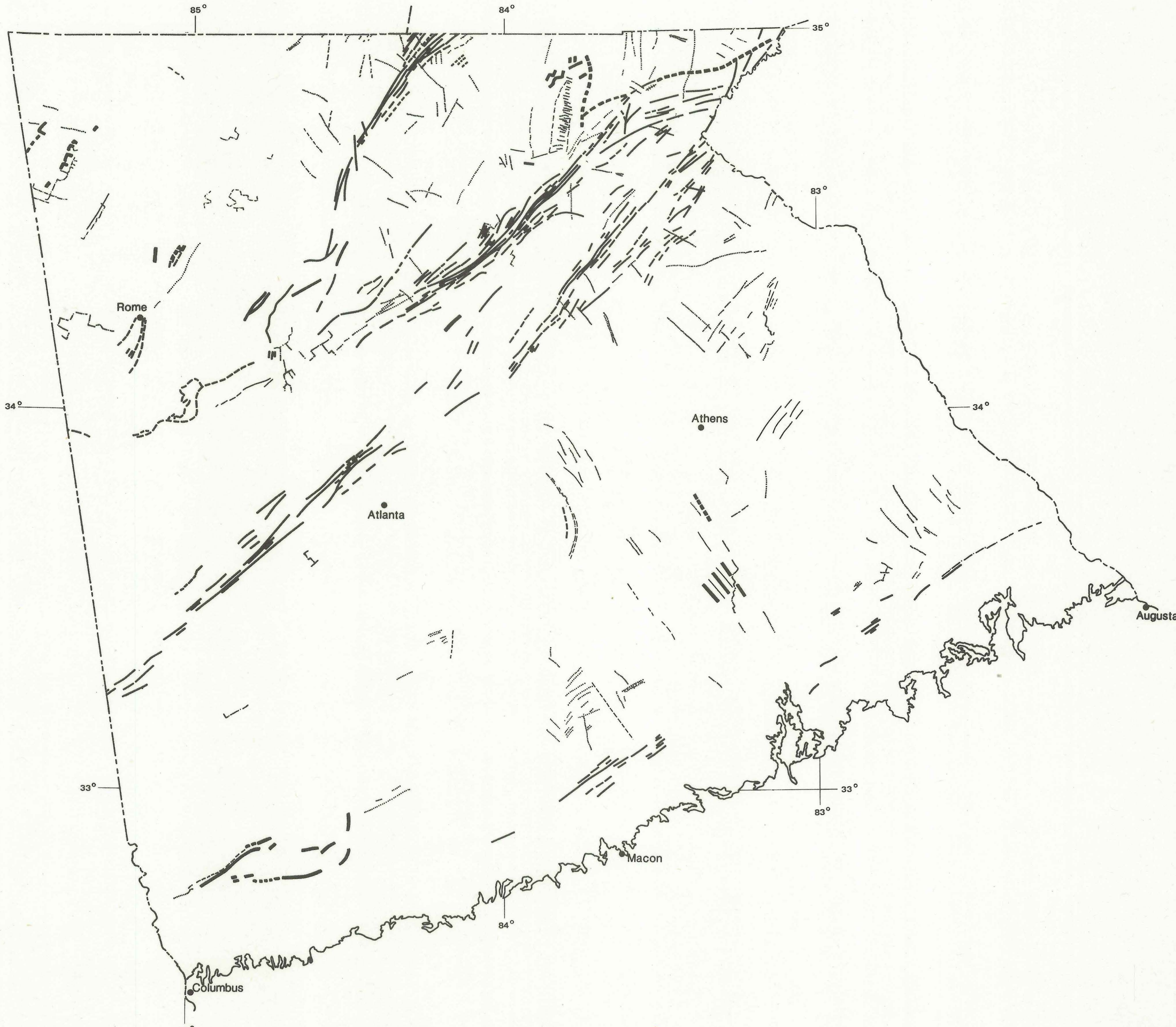


0 10 20 MILES

LINEAMENTS OF NORTHERN GEORGIA

J. A. KELLAM

(MODIFIED FROM GEOLOGIC MAP OF GEORGIA, 1976)



The lineament map represents lineaments seen on N.A.S.A. ERTS imagery, which were examined on a 1:250,000 scale. Subsequent to interpretation, these features were checked by comparison with the appropriate 1:250,000 topographic maps. Relationships of linear features to geomorphology are indicated on this map. These include features related to topographic highs and lows, and those related to surface water such as streams, rivers, and lakes. Also depicted are linear features probably related to major fault and shear systems.

A lineament is defined as "...a linear topographic feature of regional extent that is believed to reflect crustal structure. Examples are fault lines, ...and straight stream courses." (Bates and Jackson, 1980). Physiographic lineaments generally are surface expressions of intrusives such as dikes or sill, and more often, traces of faults, shears, and joints. The association of lineaments with the latter, coupled with their high potential for good permeability and ground-water transmission, causes them to be of interest in the study.

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Georgia Department of Natural Resources, 1977, Blue Ridge Mountains, N.A.S.A. ERTS MSS 7 image, scale 1:250,000.

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________________, 1970, Atlanta topographic map, scale 1:250,000.

________________, 1972, Phenix City topographic map, scale 1:250,000.

________________, 1972, Rome topographic map, scale 1:250,000.

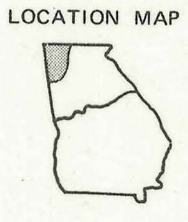
EXPLANATION

- ASSOCIATED WITH TOPOGRAPHIC LOWS.
- ASSOCIATED WITH MAJOR FAULT AND SHEAR TRENDS.
- ASSOCIATED WITH TOPOGRAPHIC HIGHS
- NOT ASSOCIATED WITH ANY OBVIOUS TOPOGRAPHIC FEATURES
- ASSOCIATED WITH SURFACE WATER FEATURES (STREAMS, RIVERS, AND LAKES).

Solid lines represent lineaments readily apparent on ERTS imagery.

Dashed lines represent indistinct or vague lineaments.

LOCATION MAP



0 10 20 MILES

PLATE 9

GRANITIC PLUTONS AND GNEISSIC BODIES IN THE BLUE RIDGE AND PIEDMONT PROVINCES, GEORGIA

J. A. KELLAM

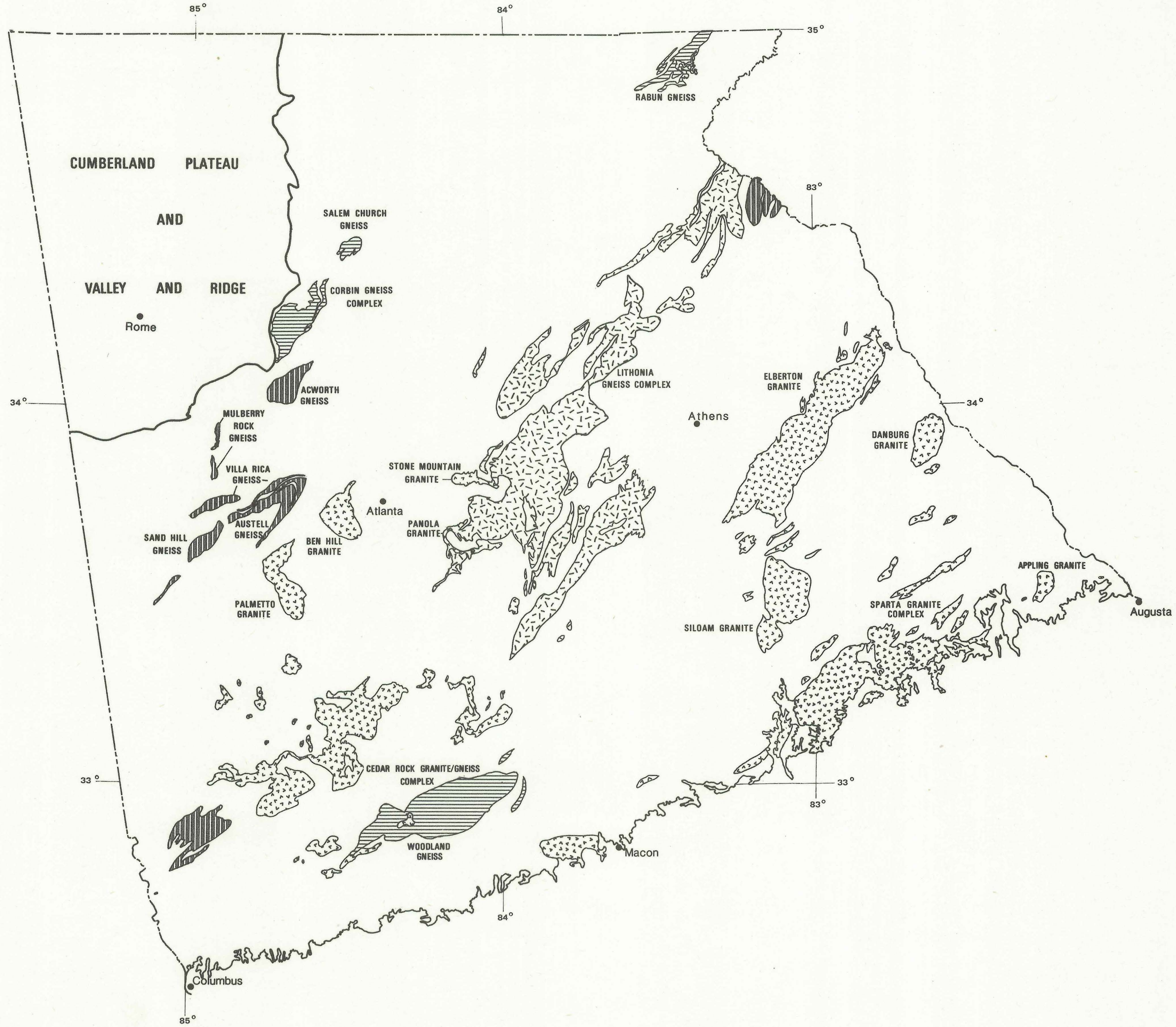
(MODIFIED FROM GEOLOGIC MAP OF GEORGIA, 1976)

EXPLANATION

- HETEROGENEOUS GRANITIC GNEISSIC "COMPLEX"
- GRANITIC INTRUSIVES
- DISCRETE GNEISSIC BODIES
- BASEMENT GNEISS "COMPLEX" of Precambrian age.

Unlabeled rock bodies are unnamed.

This map shows the location of granitic plutons and gneissic bodies in the Blue Ridge and Piedmont Provinces of Georgia. Detailed studies of these plutons in the Piedmont have shown that several, notably the Elberton and Danburg Granites, are relatively homogeneous (Stormer and Whitney, 1980; Whitney, 1983). This is not the case for others, such as the Siloam Granite (Vincent, in press), and the Sparta Complex (Roberts-Henry, 1983), where several lithologies coexist in a single body. The Lithonia Gneiss Complex is a classic example of the complex history and heterogeneous composition of a so-called discrete gneissic body (Grant and others, 1980). Also, data have been gathered which show moderate well yields in several of the crystalline bodies in the Piedmont (Stewart, 1962; LeGrand, 1967). Locations of wells which were drilled in the outcrop areas of these bodies, and reported yields, are plotted on the well yield maps in this atlas (plates 2-4).



SOURCES

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LOCATION MAP

0 10 20 MILES

PLATE 10

ISOPACH MAPS OF THE FORT PAYNE CHERT AND ARMUCHEE CHERT

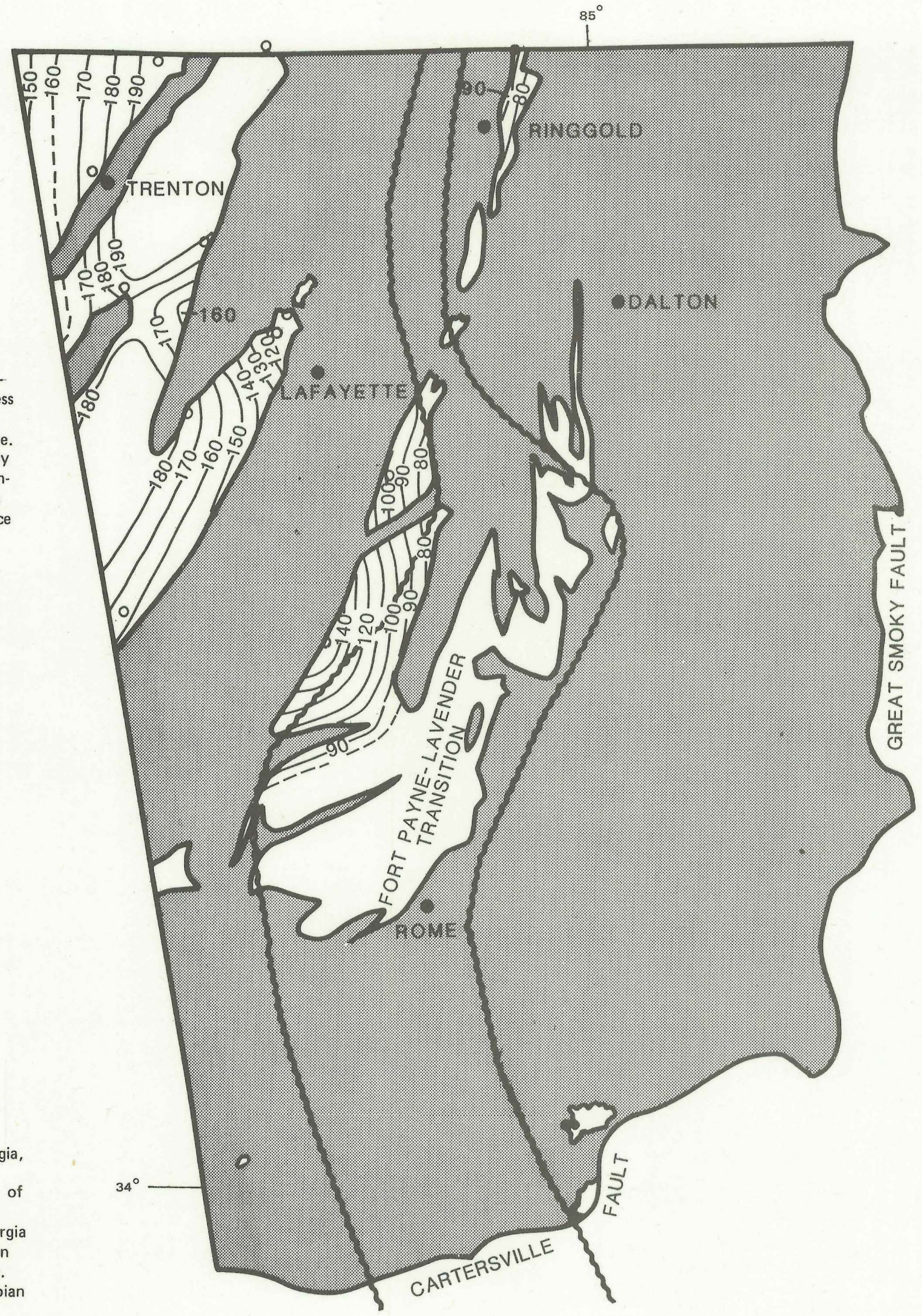
K.R. DAVIS AND A.L. STIEVE

(MODIFIED FROM GEOLOGIC MAP OF GEORGIA, 1976)

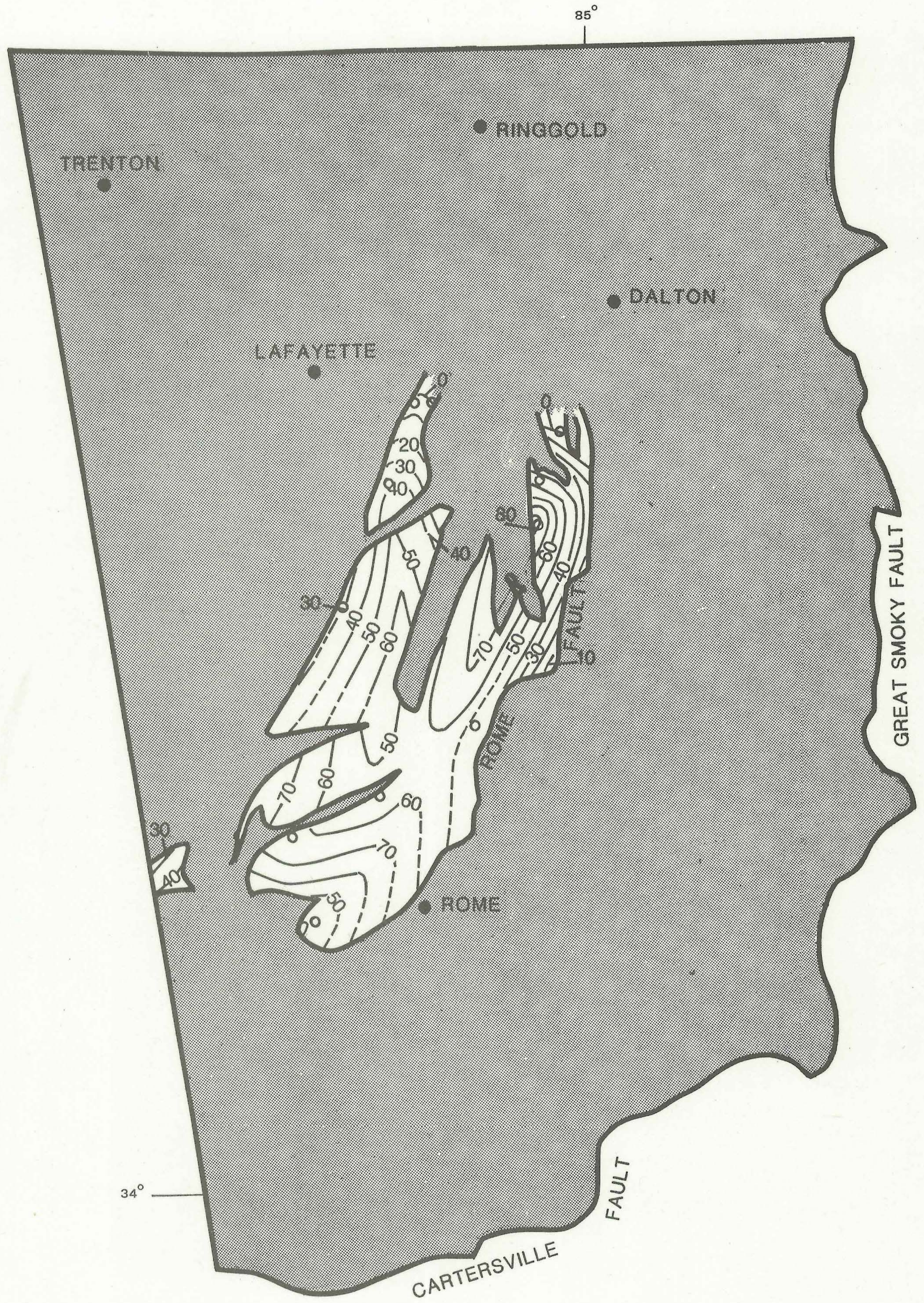
These maps show the thickness of an important aquifer system in northwest Georgia, the Fort Payne–Armuchee Chert–interval. In Georgia, the Mississippian-age Fort Payne Chert ranges up to 200 feet in thickness ness. It consists of chert, which is the weathering product of carbonate rock, and of dolostone and limestone. The Armuchee Chert, of Devonian age, is predominantly composed of interbedded sandstone and chert. It is generally less than 100 feet in total thickness. These units are separated by the Chattanooga Shale, a thin sequence of Devonian shale.

An important facies transition in the Fort Payne Chert occurs in the Rome area. A predominantly carbonate lithology to the northwest gives way to an increasing shale content to the southeast (the Lavender Shale Member). Where this intertonguing occurs, the shale represents a potentially good confining unit while limiting the aquifer potential further to the east and south.

The Armuchee Chert is exposed in synclinal valleys immediately south and west of Rome. Thickness variations and lithologies distribution suggest these synclines were actively developing during the deposition of the Armuchee Chert.



ISOPACH OF THE FORT PAYNE CHERT



ISOPACH OF THE ARMUCHEE CHERT

EXPLANATION

AREA WHERE NO FORT PAYNE CHERT OR ARMUCHEE CHERT IS KNOWN TO OCCUR - The presence or absence of these units beneath the thrust sheets is speculative.

—50— — — LINE OF EQUAL THICKNESS - Shows thickness in feet. Contour interval is 10 feet. Dashed where approximately located.

BOUNDARY OF OCCURRENCE OF FORT PAYNE CHERT OR ARMUCHEE CHERT

AREA OF FACIES TRANSITION

o LOCATION OF WELL OR MEASURED SECTION

SOURCES

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LOCATION MAP

0 10 20 MILES

STRUCTURE-CONTOUR MAPS OF TWO PALEOZOIC AQUIFER SYSTEMS OF NORTHWEST GEORGIA

K. R. DAVIS

These structure-contour maps illustrate the elevations of the tops of two prolific aquifer systems in northwest Georgia: the Knox Group and the Fort Payne–Lavender Shale–Armuchee Chert interval. Changes in the elevations of these aquifer systems are largely the result of past folding and faulting events, and the influence of the present erosional surface (see Plates 14-18).

Permeability in both aquifers is greatly enhanced where joints, fractures, and solution features have developed. These water conduits are most often found in association with faults and in areas of tight folding. Therefore, areas indicated on the maps as being fault traces and areas of closely spaced contours should be considered to have the best potential for ground-water development.

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__________, 1970, Geology and ground-water resources of Floyd and Polk Counties, Georgia: Georgia Geol. Survey Inf. Circ. 39, 95 p.

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__________, 1981, Geology and ground-water resources of Walker County, Georgia: Georgia Geol. Survey Inf. Circ. 29, 15 p. (2nd edition).

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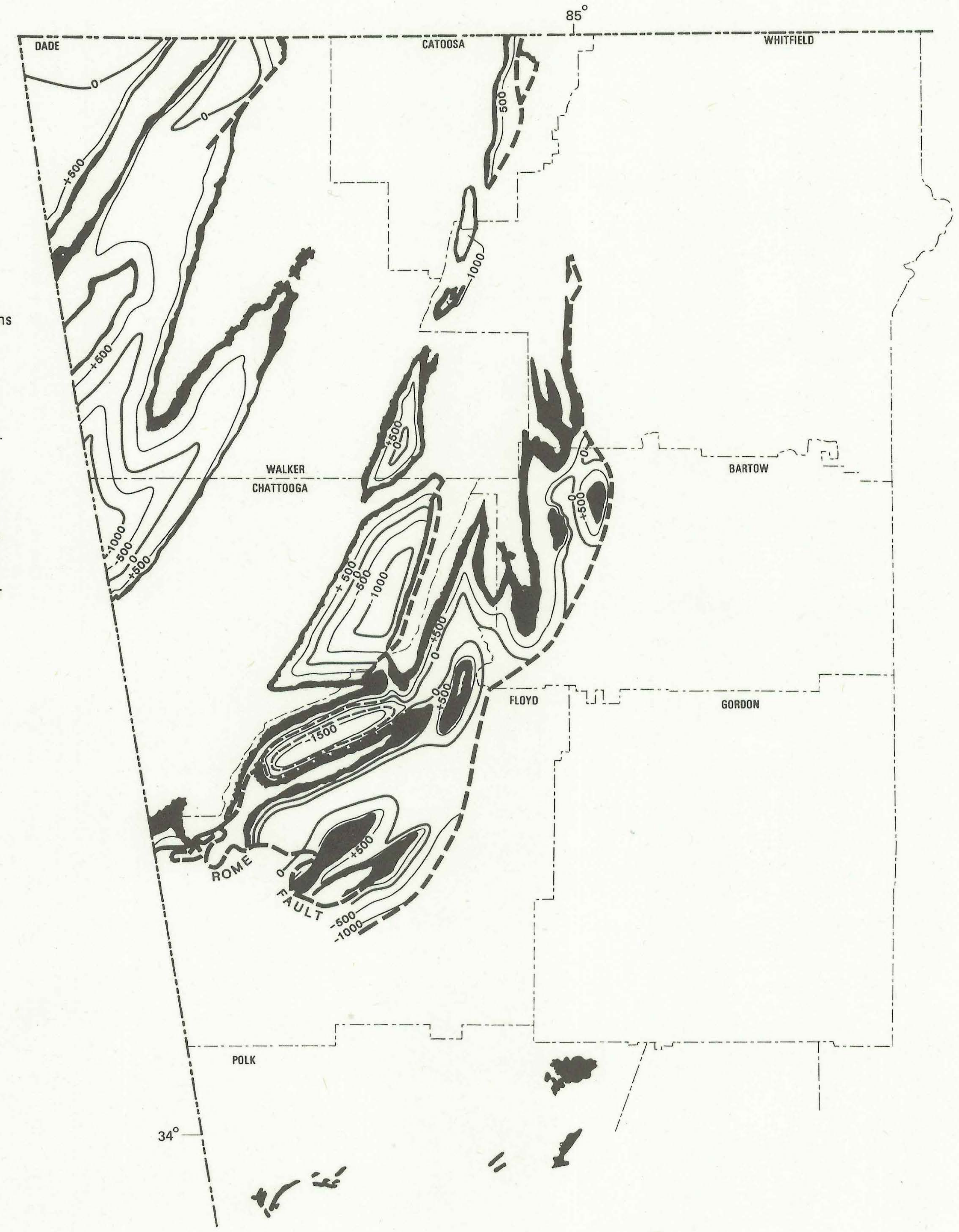
Croft, M.G., 1964, Geology and ground-water resources of Dade County, Georgia: Georgia Geol. Survey Inf. Circ. 26, 17 p.

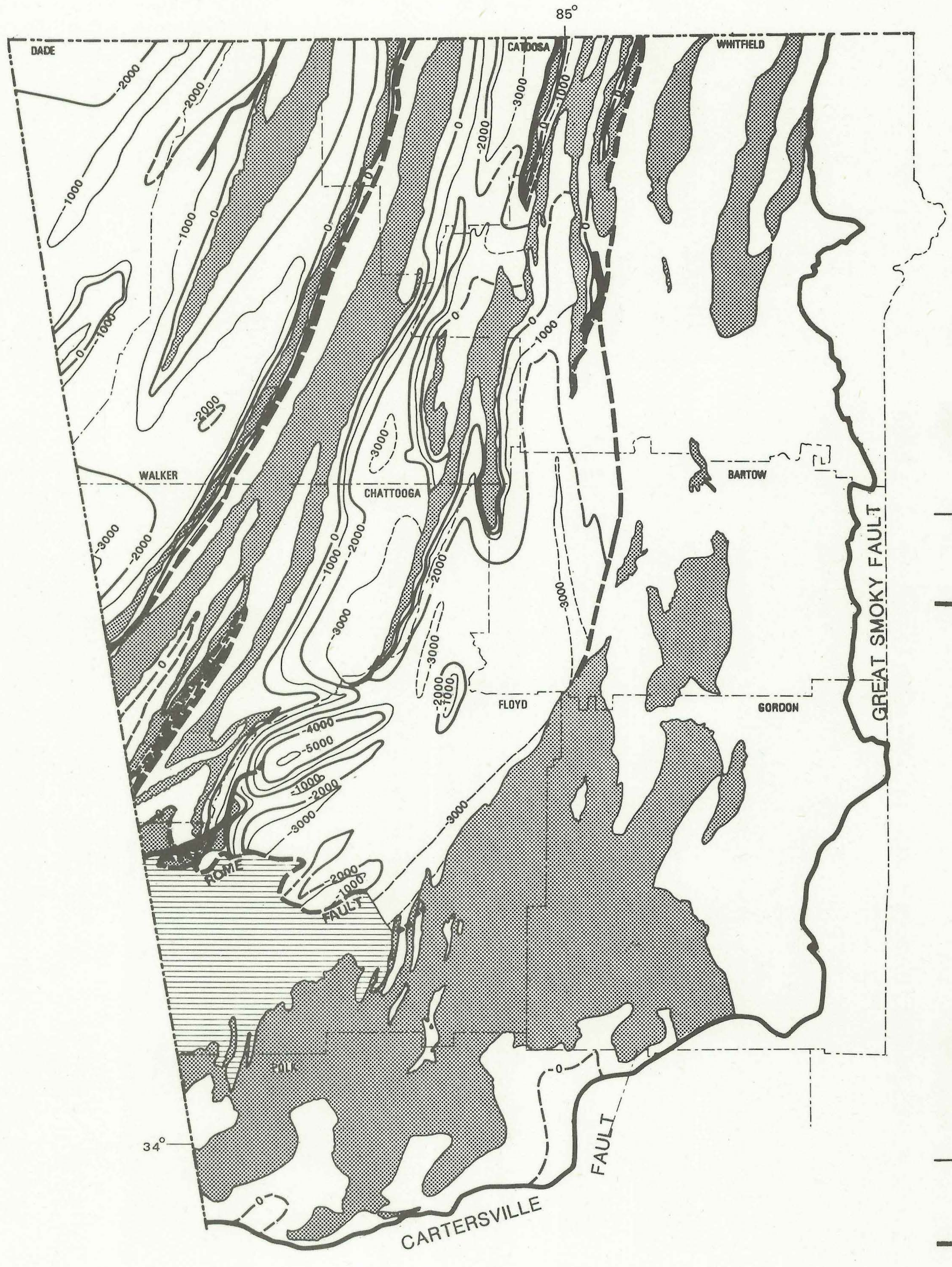
Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, N.J., Prentice Hall, 305 p.

Unpublished data on file at the Georgia Geologic Survey, Atlanta.

Unpublished data on file at the U.S. Geological Survey, Water Resources Div., Doraville, Ga.



MAP A – STRUCTURE CONTOUR MAP OF THE TOP OF THE FORT PAYNE CHERT – LAVENDER SHALE – ARMUCHEE CHERT INTERVAL



MAP B – STRUCTURE CONTOUR MAP OF THE TOP OF THE KNOX GROUP

EXPLANATION

MAP A – FORT PAYNE CHERT–LAVENDER SHALE– ARMUCHEE CHERT INTERVAL

OUTCROP OF FORT PAYNE CHERT–LAVENDER SHALE–ARMUCHEE CHERT

STRUCTURE CONTOUR - Contour interval is 500 feet. Datum is mean sea level. Dashed where approximately located.

FAULT - Dashed where implied.

EXPLANATION

MAP B – KNOX GROUP

OUTCROP OF THE KNOX GROUP

SUBSURFACE OCCURRENCE OF KNOX GROUP IS POORLY UNDERSTOOD

STRUCTURE CONTOUR - Contour interval is 1000 feet. Datum is mean sea level. Dashed where approximately located

FAULT - Dashed where implied.

LOCATION MAP

0 10 20 MILES

TOTAL DISSOLVED SOLIDS OF SELECTED WELLS IN NORTHWEST GEORGIA

K. R. DAVIS AND A. L. STIEVE

This map displays total dissolved solids (TDS) values from wells and springs in northwest Georgia. The numerical values on the map indicate the total dissolved solids (in parts per million) upon evaporation of a water sample at 180°C. TDS values for northwest Georgia range from 26 ppm to 630 ppm. The U.S. Public Health Service recommends that TDS values of water for domestic and municipal supplies not exceed 500 ppm.

Based on the available data, TDS values appear to be related to the lithologies from which samples were taken. To indicate the expected areal distribution of TDS values, outcrop patterns of the generalized geology have been included on the map. Most hydrogeologic groups displayed consist of several geologic formations which yield similar TDS values. These formations are not necessarily grouped as time-successive units. Seven hydrogeologic groups are recognized.

Group 'A' is comprised of the Pennsylvanian-Upper Mississippian clastic section, the Mississippian age Bangor–Monteagle–Tuscumbia limestone sequence, and the Mississippian Fort Payne Chert. These formations generally crop out on the top and along the sides of mountains and/or plateaus. The very low average TDS values of the upper clastic section (78 ppm) and the Mississippian carbonate section (105 ppm) may reflect the topography-induced isolation of this group. (See note below.)

Group 'B' includes the Mississippian Floyd Shale, the Hartselle Sandstone, and the Lavender Shale, and the Cambrian Upper Conasauga limestone-shale unit. This group occurs in broad valleys and yields a moderately high average TDS value (185 ppm) for the area.

Group 'C' consists of the Devonian Armuchee Chert and Frog Mountain Sandstone and the Silurian Red Mountain Formation. These lithologies form resistant ridges in northwest Georgia. The generally high average TDS value of the group (194 ppm) may indicate iron and hydrogen sulfide from the Devonian Chattanooga Shale and the high iron content of the Silurian Red Mountain Formation.

Group 'D' is comprised of the Chickamauga Group, a section of interbedded limestones and shales which occur in valleys and along the sides of ridges. The average TDS value for the group is very high (369 ppm), and may reflect the high sulfate content of some water-bearing horizons.

Group 'E' consists of the Ordovician Newala Limestone and the Cambro-Ordovician Knox Group. This thick section of dolomitic limestone and dolomite, which crops out in broad areas of northwest Georgia, is one of the most important aquifers in the region. The average TDS value for Group 'E' (132 ppm) is moderately low.

Group 'F' is comprised of the Cambrian middle and lower units of the Conasauga Group, the Rome Formation, and the Chilhowee Formation. These formations of interbedded clastic and carbonate rocks generally occupy broad, low lying areas and have a moderate average TDS value (143 ppm).

Group 'G' consists of the Cambrian Shady Dolomite, Shady Dolomite outcrop is restricted to the Cartersville area and has a moderately high average TDS value (160 ppm).

Note: The actual causes of TDS levels are varied. Interpretation regarding causes, as represented on this map, reflect the authors' experience with the hydrogeology of the area.

SOURCES

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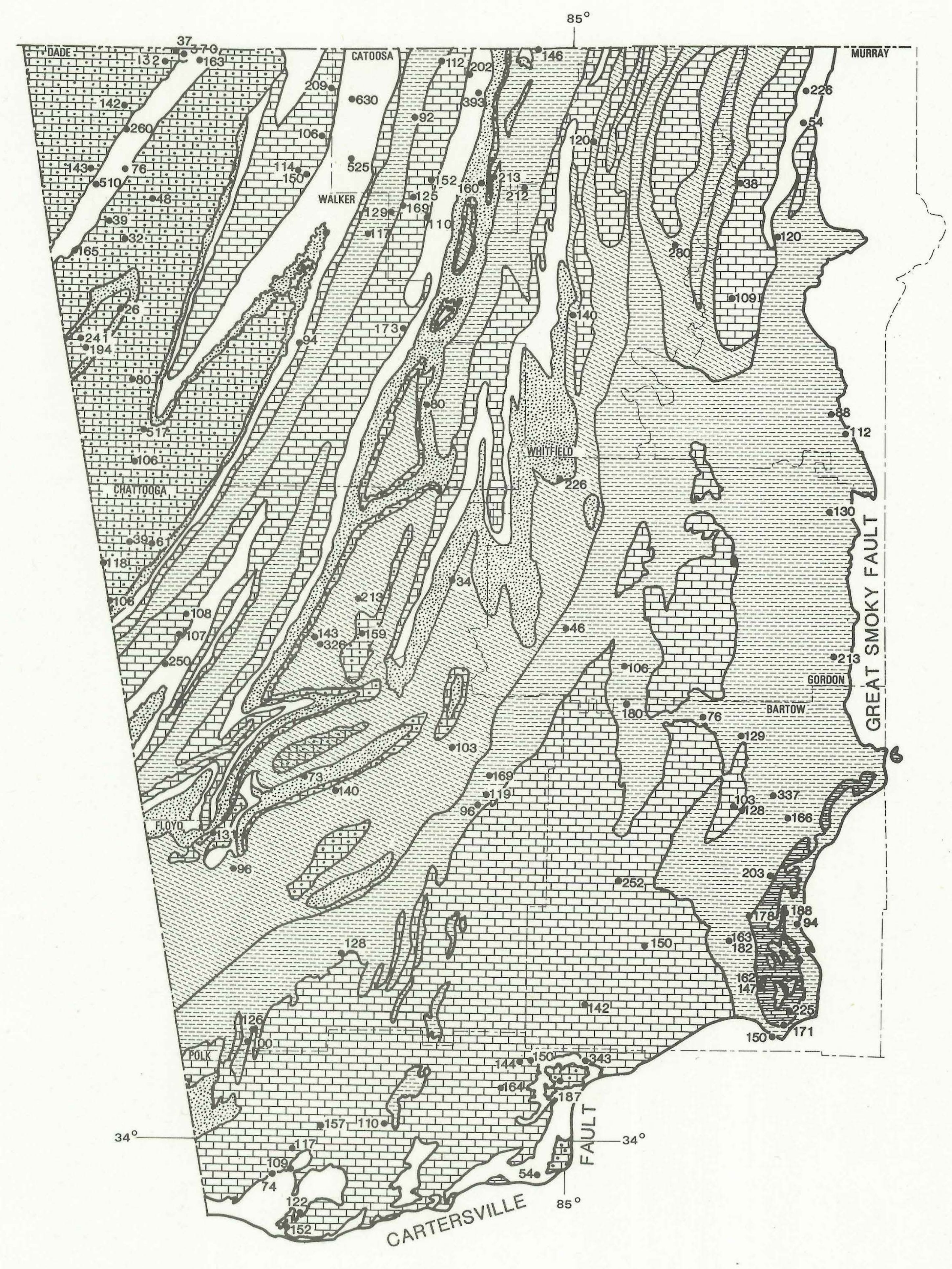
Croft, M.G., 1964, Geology and ground-water resources of Dade County, Georgia: Georgia Geol. Survey Inf. Circ. 26, 17 p.

Unpublished data on file at the Georgia Geologic Survey, Atlanta.

Unpublished data on file at the U.S. Geological Survey, Water Resources Div., Doraville, Ga.



EXPLANATION

- GROUP A
- GROUP B
- GROUP C
- GROUP D
- GROUP E
- GROUP F
- GROUP G
- •54 WELL OR SPRING LOCATION - Number is total dissolved solids value.

LOCATION MAP

0 10 20 MILES

SCHEMATIC CROSS SECTIONS OF THE PALEOZOIC ROCKS OF NORTHWEST GEORGIA
INTRODUCTION

K. R. DAVIS

Two physiographic provinces, the Cumberland Plateau and the Valley and Ridge, occur in northwest Georgia. These provinces are isolated from the remainder of Georgia by two large thrust faults. The Great Smoky Fault, to the east, separates northwest Georgia from the Blue Ridge Province. To the south, the Cartersville Fault separates northwest Georgia from the Talladega Belt. These two faults apparently merge in the vicinity of the city of Cartersville. Both provinces of northwest Georgia are underlain by sedimentary formations which range in age from Early Cambrian to Early Pennsylvanian. Lithology and thickness variations in the rocks reflect changing environments of deposition as well as periods of uplift and erosion in the nearshore and offshore areas that once covered Georgia.

In northwest Georgia, the general structural strike is in a northeast-southwest direction. The extreme northwest corner, including Sand, Lookout, and Pigeon Mountains, is in the Cumberland Plateau Province. The Cumberland Plateau geology is characterized by gently folded strata and infrequent occurrences of thrust faulting. The area to the east and south of Lookout and Pigeon Mountains is included in the Valley and Ridge Province. More tightly folded structures and more frequent occurrences of thrust faulting characterize the Valley and Ridge Province.

Three major thrust faults in the Valley and Ridge Province (the Rome, Kingston, and Clinchport Faults) have recognized horizontal displacements of greater than five miles. The oldest of these, the Rome Fault, has been folded and faulted by subsequent events. Other faults, notably the Coosa Fault, may have significant horizontal displacement, but are not adequately understood at present.

The following five geologic sections present a possible orientation of the geologic structure at depth (Plates 14-18). Many of the geologic units displayed on the sections also represent hydrostratigraphic units. In general, the most productive aquifers are the Knox Group, the Newala Limestone, the Shady Dolomite, and the Fort Payne Chert-Armuchee Chert interval.

Techniques outlined in Dennison (1968) provided guidelines for the construction of geologic sections. Many sources of information were used. Topography of the sections is based on the 1:250,000 Rome topographic map. County geology and ground-water resource studies by Cressler (1963, 1964, 1970, 1974, and 1981) and by Croft (1964) were the main sources of surface geology. Each of the sections is generally oriented normal to the regional structural strike and is spaced to take advantage of the limited petroleum exploration and deeper water wells which exist in northwest Georgia.

The placement and altitude of décollements follow the style developed by Milici (1969,1980). Available evidence suggests that the thrust sheets pass horizontally through shale sequences of Cambrian age (the Rome Formation and the Conasauga Formation) until cutting upward along a thrust sheet prow. No Late Precambrian-aged rocks are known to crop out in northwest Georgia. Therefore, it is assumed that no Precambrian-aged rocks are present above the basal thrust sheet. For this reason, a basal thrust sheet is shown at depth. Apparent metamorphic rocks were encountered in the Brown no. 1 well in Dade County. In this area metamorphic rocks are shown to underlie the Paleozoic sedimentary rocks.

SOURCES

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__________, 1974, Geology and ground-water resources of Gordon, Whitfield, and Murray Counties, Georgia: Georgia Geol. Survey Inf. Circ. 47, 55 p.

__________, 1981, Geology and ground-water resources of Walker County, Georgia: Georgia Geol. Survey Inf. Circ. 29, 15 p.

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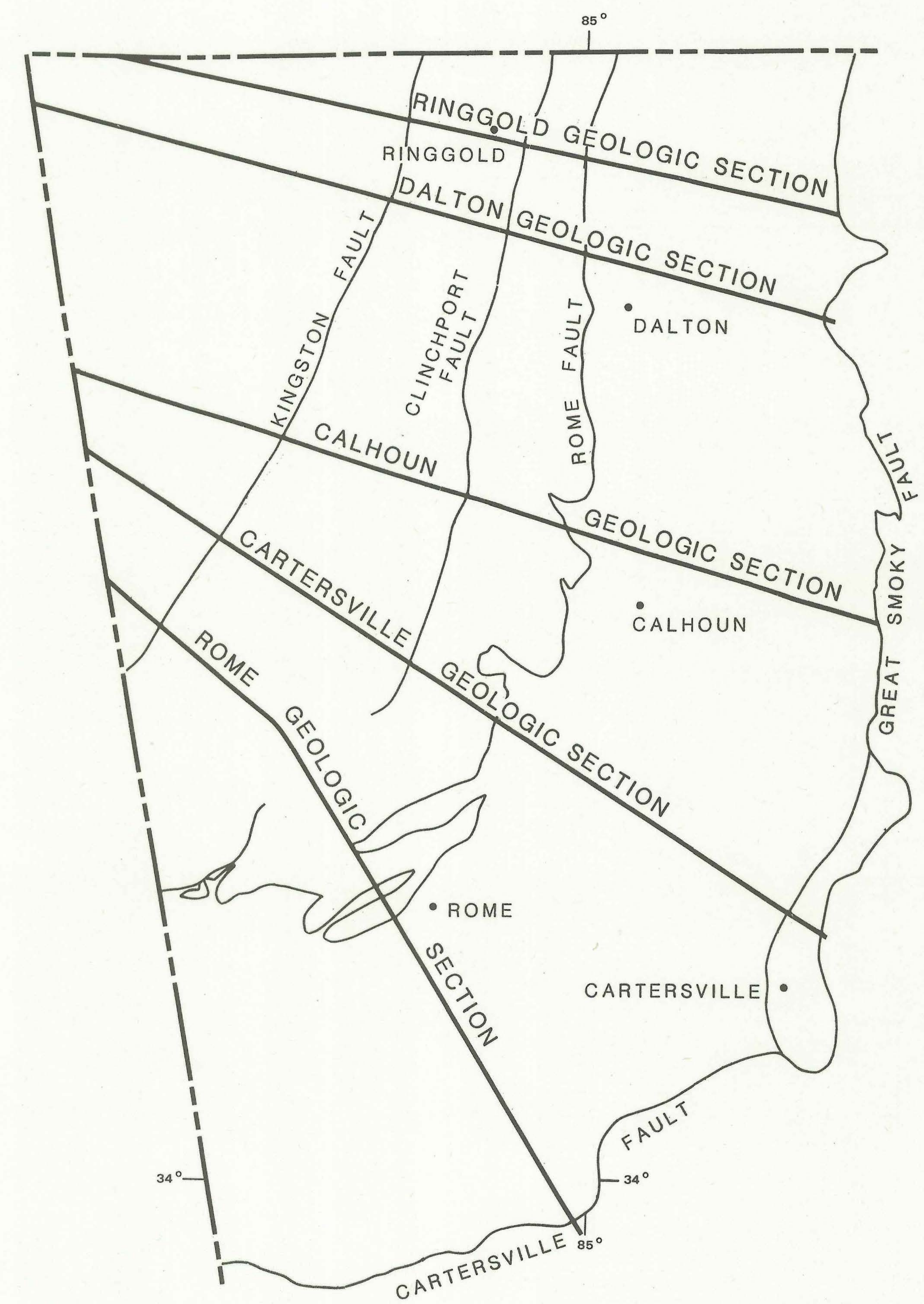


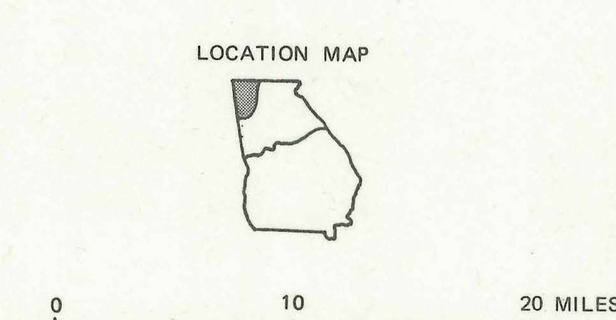
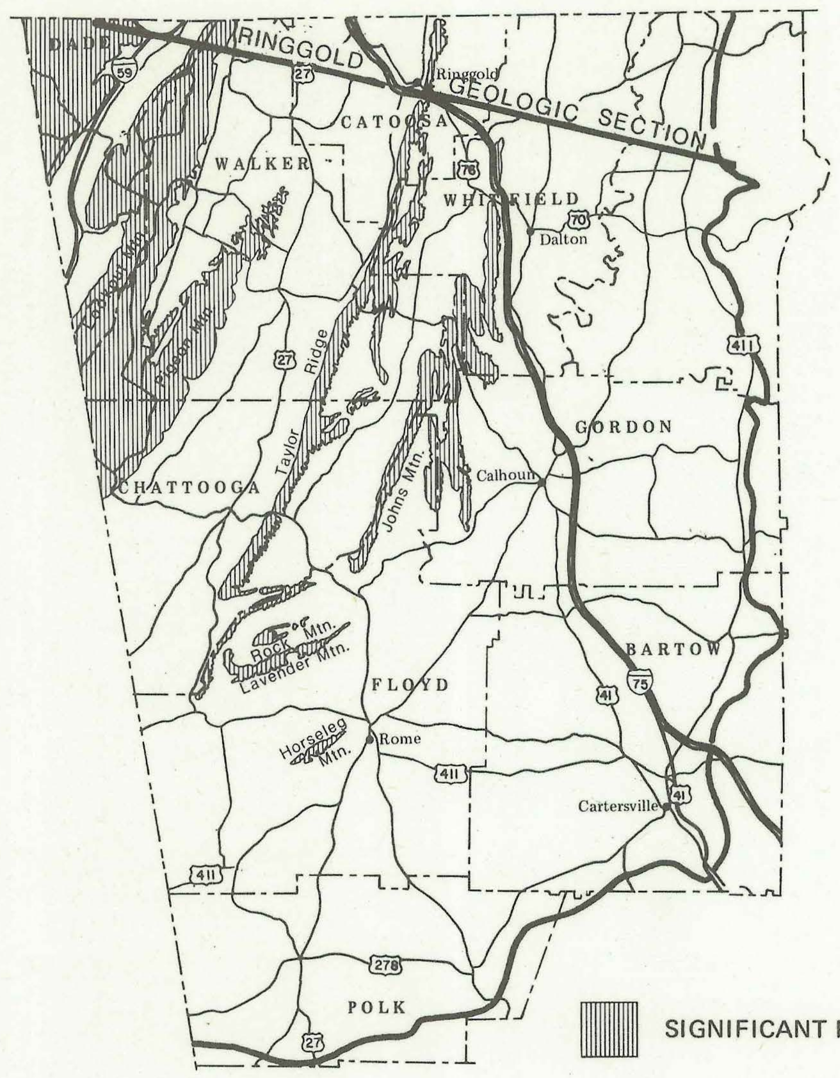


PLATE 14

RINGGOLD GEOLOGIC SECTION

SCHEMATIC CROSS SECTION

K. R. DAVIS



SIGNIFICANT RIDGES

The Late Cambrian and Ordovician formations on the Ringgold Geologic Section reflect deposition during active basin development in north Georgia. Drastic changes in thicknesses of the Knox Group indicate areas affected by Ordovician tectonic and erosional events. Facies changes in the Middle and Late Ordovician sediments reflect deposition during these events.

Interbedded limestones and shales of the offshore facies of the Ordovician Chickamauga Supergroup occur to the west of the Clinchport Fault. To the east, at least two basins receiving clastic sediments were present (Bays Formation and Athens Shale). These were separated by a carbonate facies (Holston Limestone).

FORMATIONAL CONTACT

THRUST FAULT

SEA LEVEL

SHALE (POSSIBLE CONFINING UNIT)

STRATIGRAPHIC SECTION

MISSISSIPPIAN–PENNSYLVANIAN

M–IPu — INCLUDES RACCOON MOUNTAIN AND YOUNGER 'PENNSYLVANIAN' CLASTIC SEQUENCES

Mu — INCLUDES THE PENNINGTON SHALE AND BANGOR–MONTEAGLE–TUSCUMBIA LIMESTONE SEQUENCE

Mfs — FLOYD SHALE

Mfp — FORT PAYNE CHERT, MAURY SHALE

Mls — LAVENDER SHALE

SILURIAN

Srm — RED MOUNTAIN FORMATION

ORDOVICIAN

Oc — CHICKAMAUGA SUPERGROUP (Oa ATHENS SHALE)

Ob — BAYS FORMATION

Oh — HOLSTON LIMESTONE

On — NEWALA LIMESTONE

CAMBRIAN–ORDOVICIAN

O€k — KNOX GROUP

CAMBRIAN

CONASAUGA FORMATION

€cm — UPPER LIMESTONE UNIT, 'MAYNARDVILLE'

€cl — LIMESTONE UNIT

€c — INTERBEDDED SHALE AND LIMESTONE UNITS

€cls — MAINLY LIMESTONE, INCLUDES SHALE LAYERS

€csl — MAINLY SHALE, INCLUDES LIMESTONE LAYERS

€cs — MAINLY SHALE, INCLUDES SOME SILTSTONE

€r — ROME FORMATION

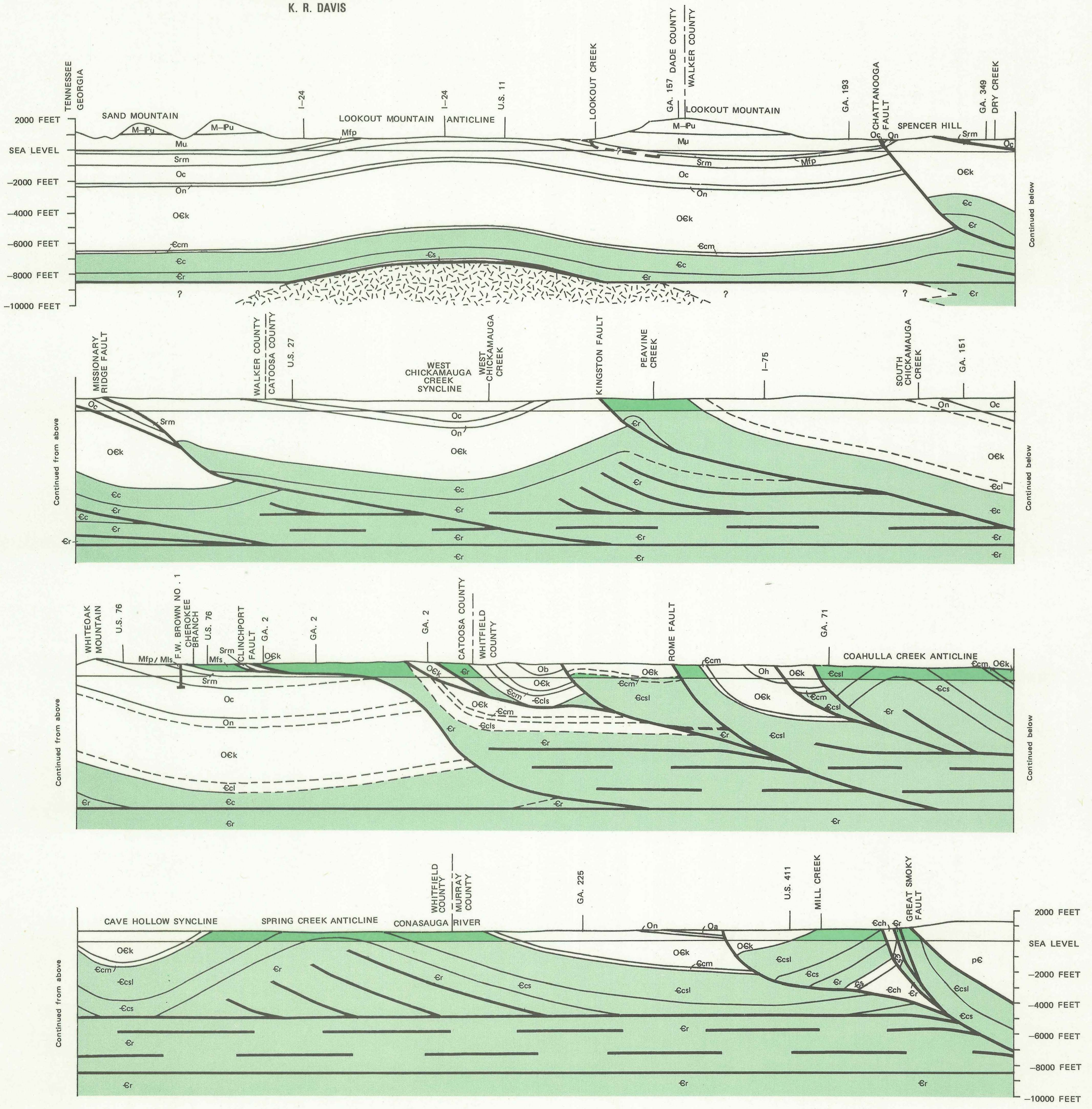
€s — SHADY DOLOMITE

€ch — CHILHOWEE GROUP

PRECAMBRIAN

p€ — LATE PRECAMBRIAN

METAMORPHIC ROCK OF UNKNOWN AGE



Note: Thrust faults/décollements at depth are speculative.

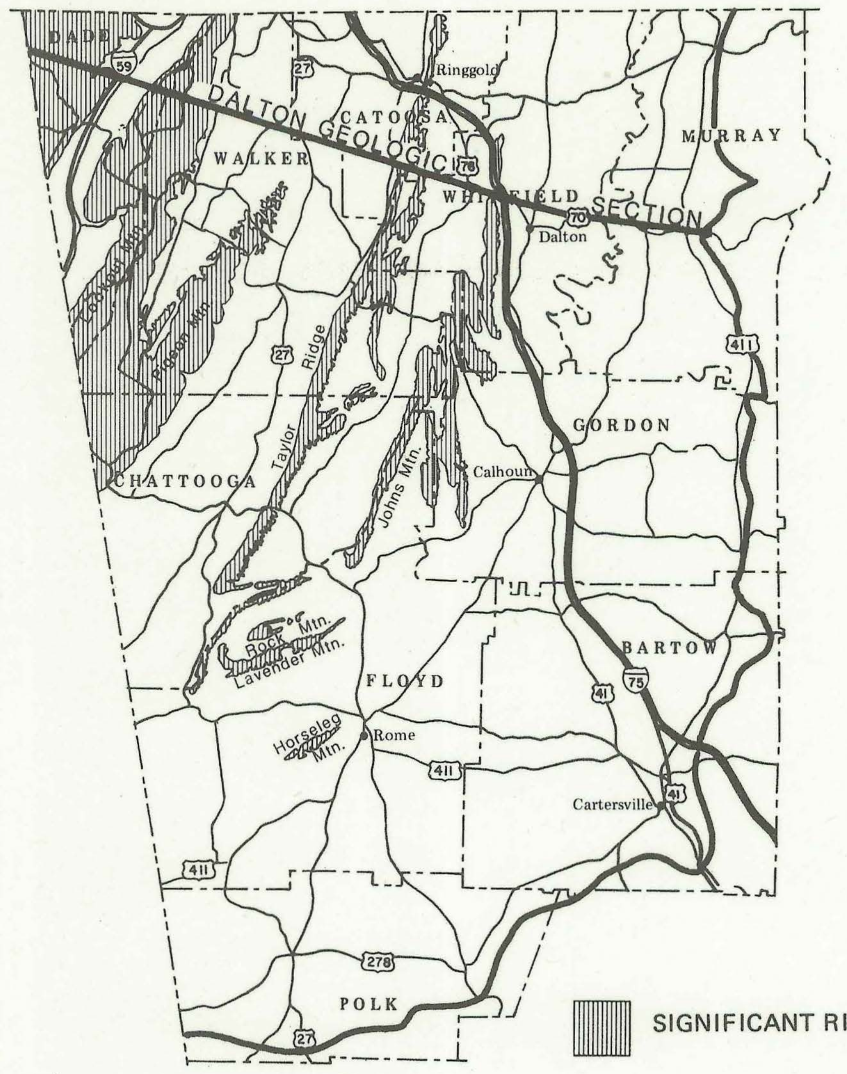
2000 0 2000 4000 FEET

NO VERTICAL EXAGGERATION

DALTON GEOLOGIC SECTION

SCHEMATIC CROSS SECTION

K. R. DAVIS



Three distinct facies of the Conasauga Formation occur on the Dalton Geologic Section. Northwest of the Clinchport Fault, the Conasauga Formation is a thick sequence of interbedded limestones and shales. In the area between the Clinchport and Rome Faults, the Conasauga Formation is a much thinner, mainly carbonate formation. East of the Rome Fault, the formation grades into a predominantly clastic sequence.

FORMATIONAL CONTACT

THRUST FAULT

SEA LEVEL — SHALE (POSSIBLE CONFINING UNIT)

STRATIGRAPHIC SECTION

MISSISSIPPIAN–PENNSYLVANIAN

M–Pu — INCLUDES RACCOON MOUNTAIN AND YOUNGER 'PENNSYLVANIAN' CLASTIC SEQUENCES

MISSISSIPPIAN

Mu — INCLUDES THE PENNINGTON SHALE AND BANGOR–MONTEAGLE–TUSCUMBIA LIMESTONE SEQUENCE

Mfs — FLOYD SHALE

Mfp — FORT PAYNE CHERT, MAURY SHALE, AND THE DEVONIAN CHATTANOOGA SHALE

SILURIAN

Srm — RED MOUNTAIN FORMATION

ORDOVICIAN

Oc — CHICKAMAUGA SUPERGROUP

Ob — BAYS FORMATION

On — NEWALA LIMESTONE

CAMBRIAN–ORDOVICIAN

O€k — KNOX GROUP

CAMBRIAN

CONASAUGA FORMATION

€cm — UPPER LIMESTONE UNIT, 'MAYNARDVILLE'

€cl — LIMESTONE UNIT

€c — INTERBEDDED SHALE AND LIMESTONE UNITS

€cls — MAINLY LIMESTONE, INCLUDES SHALE LAYERS

€csl — MAINLY SHALE, INCLUDES LIMESTONE LAYERS

€cs — MAINLY SHALE, INCLUDES SOME SILTSTONE

€r — ROME FORMATION

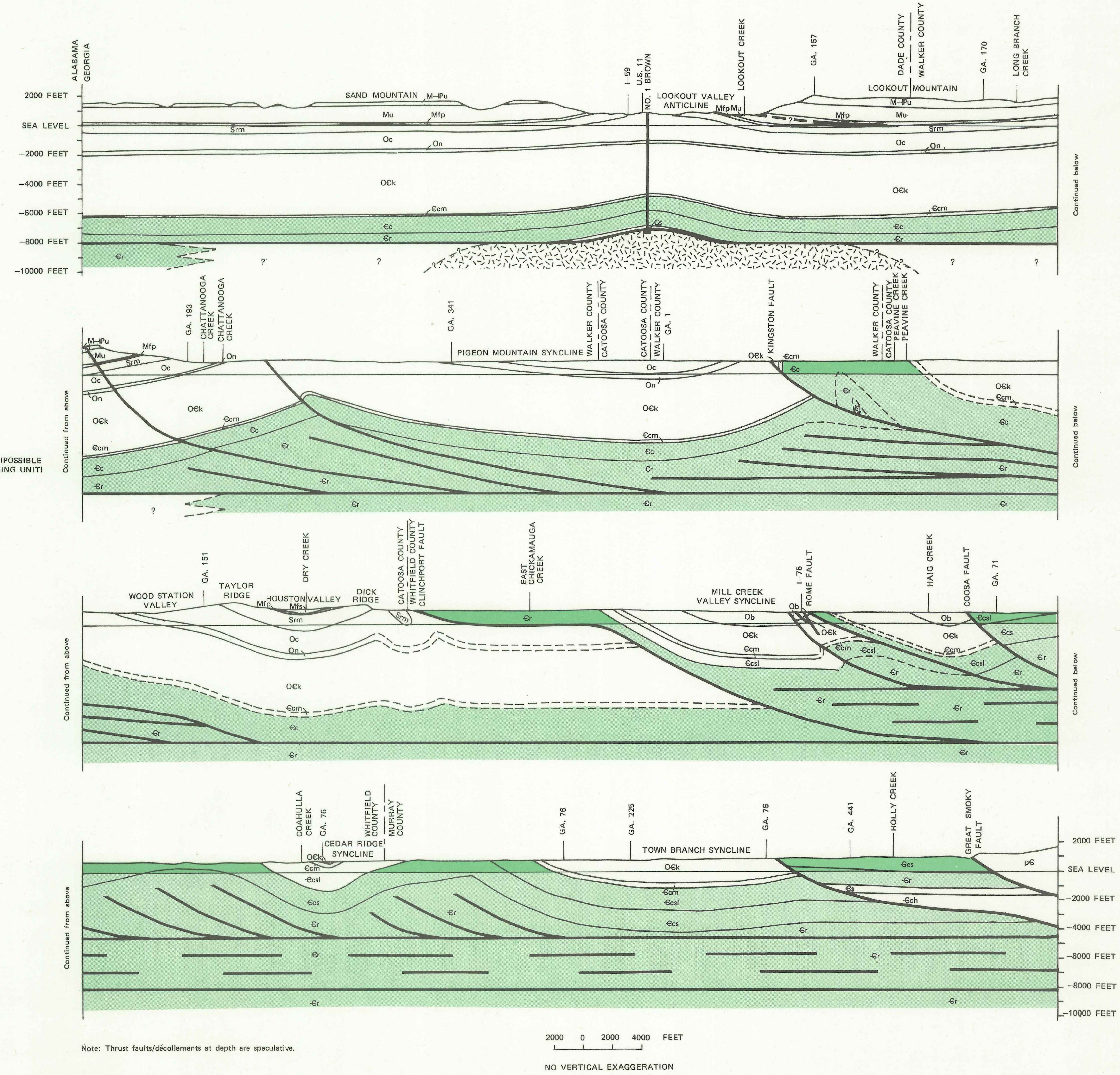
€s — SHADY DOLOMITE

€ch — CHILHOWEE GROUP

PRECAMBRIAN

p€ — LATE PRECAMBRIAN SEDIMENTS

METAMORPHIC ROCKS OF UNKNOWN AGE



Note: Thrust faults/décollements at depth are speculative.

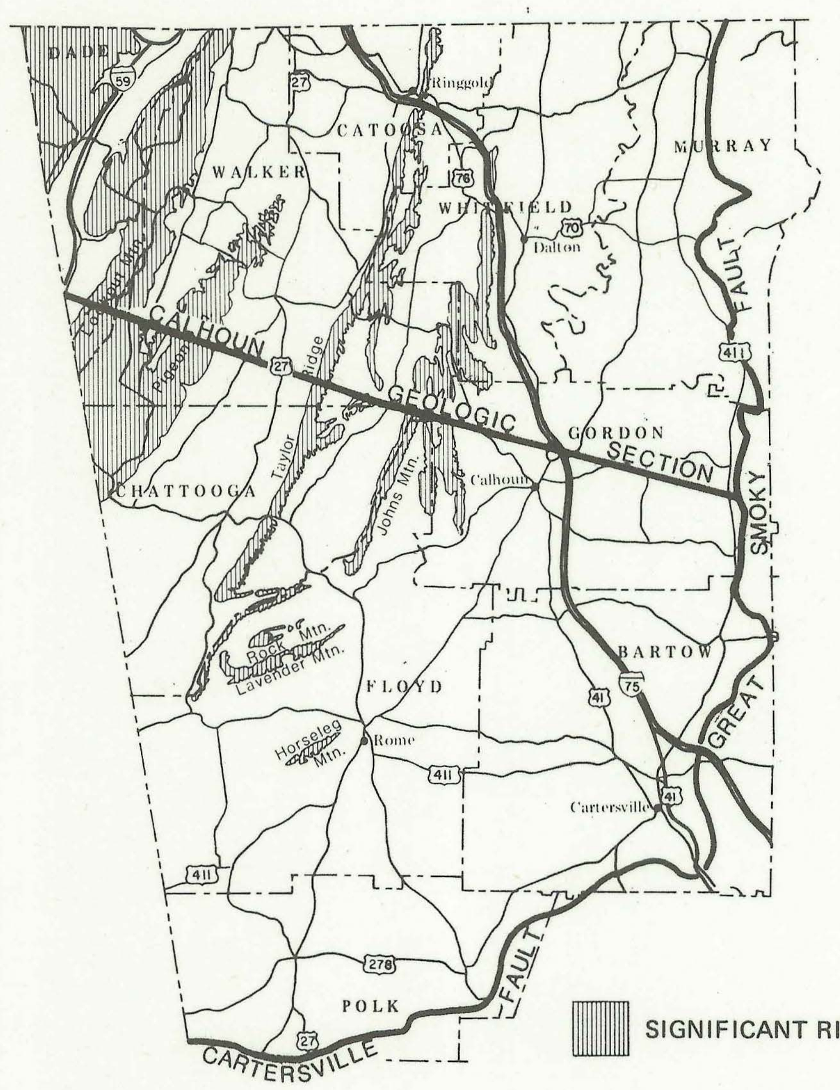
2000 0 2000 4000 FEET

NO VERTICAL EXAGGERATION

CALHOUN GEOLOGIC SECTION

SCHEMATIC CROSS SECTION

K. R. DAVIS



Along most of the Calhoun Geologic Section, the constant thickness and consistent lithologic nature of the Knox Group and Newala Limestone (Late Cambrian-Early Ordovician) suggest a stable basin of deposition. Greatly increased thickness of the Knox Group immediately to the northwest of the Kingston Fault suggests that substantial movement has occurred along the fault.

FORMATIONAL CONTACT

THRUST FAULT

SEA LEVEL — SHALE (POSSIBLE CONFINING UNIT)

STRATIGRAPHIC SECTION

MISSISSIPPIAN – PENNSYLVANIAN

M–IPu — INCLUDES RACCOON MOUNTAIN AND YOUNGER PENNSYLVANIAN CLASTIC SEQUENCES

MISSISSIPPIAN

Mu — INCLUDES THE PENNINGTON SHALE AND BANGOR MONTEAGLE–TUSCUMBIA LIMESTONE SEQUENCE

Mfs — FLOYD SHALE

Mfp — INCLUDES FORT PAYNE CHERT, MAURY SHALE, AND THE DEVONIAN CHATTANOOGA SHALE

DEVONIAN – MISSISSIPPIAN

MDc — INCLUDES Mfp AND ARMUCHEE CHERT

SILURIAN

Srm — RED MOUNTAIN FORMATION

ORDOVICIAN

Oc — CHICKAMAUGA SUPERGROUP

On — NEWALA LIMESTONE

CAMBRIAN – ORDOVICIAN

O€k — KNOX GROUP

CAMBRIAN

CONASAUGA FORMATION

€cm — UPPER LIMESTONE UNIT, 'MAYNARDVILLE'

€c — INTERBEDDED SHALE AND LIMESTONE UNITS

€cls — MAINLY LIMESTONE, INCLUDES SHALE LAYERS

€csl — MAINLY SHALE, INCLUDES LIMESTONE LAYERS

€cs — MAINLY SHALE, INCLUDES SOME SILTSTONE

€cl — LIMESTONE UNIT

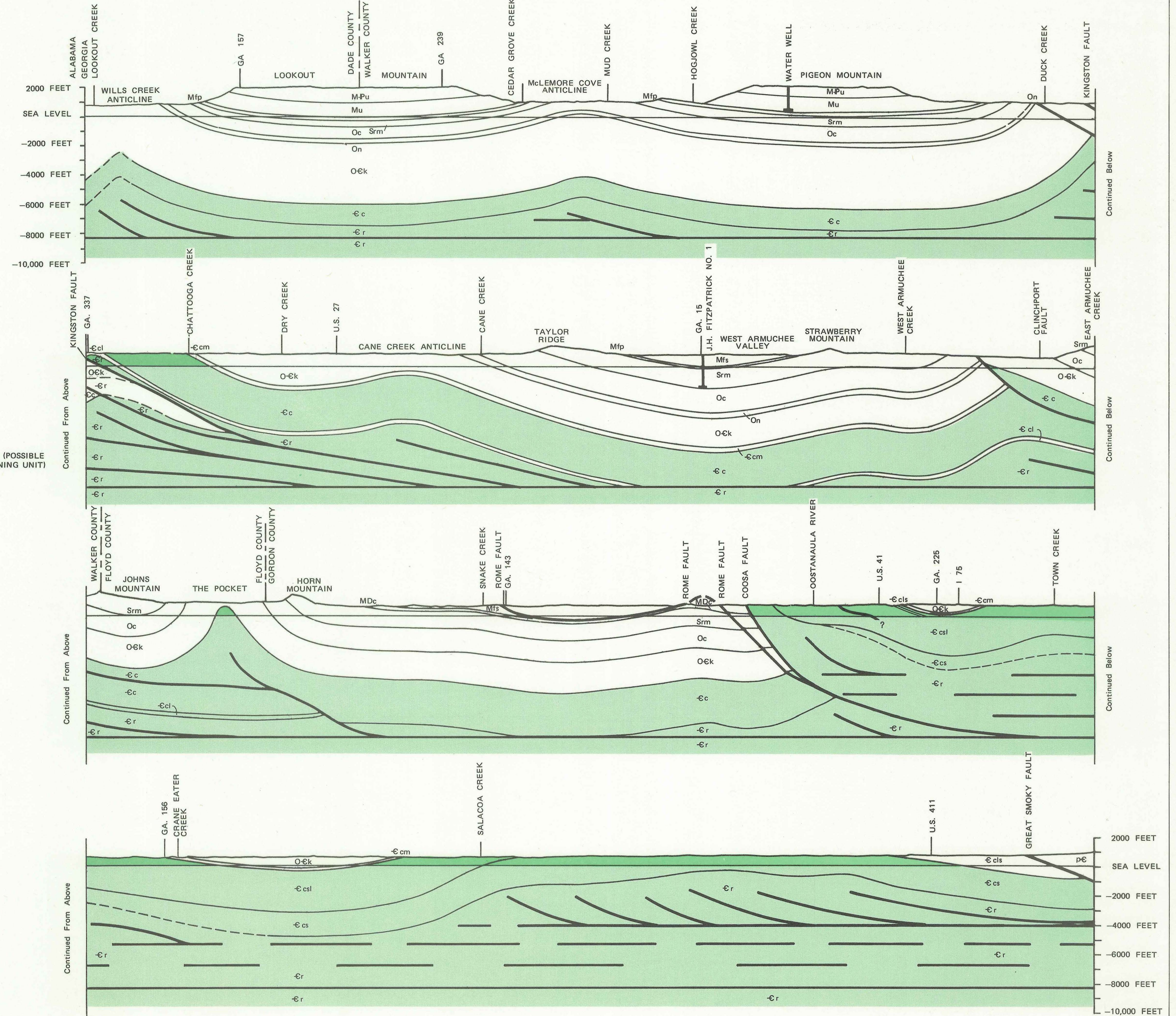
€r — ROME FORMATION

€s — SHADY DOLOMITE

€ch — CHILHOWEE GROUP

PRECAMBRIAN

p€ — LATE PRECAMBRIAN



Note: Thrust faults/décollements at depth are speculative.

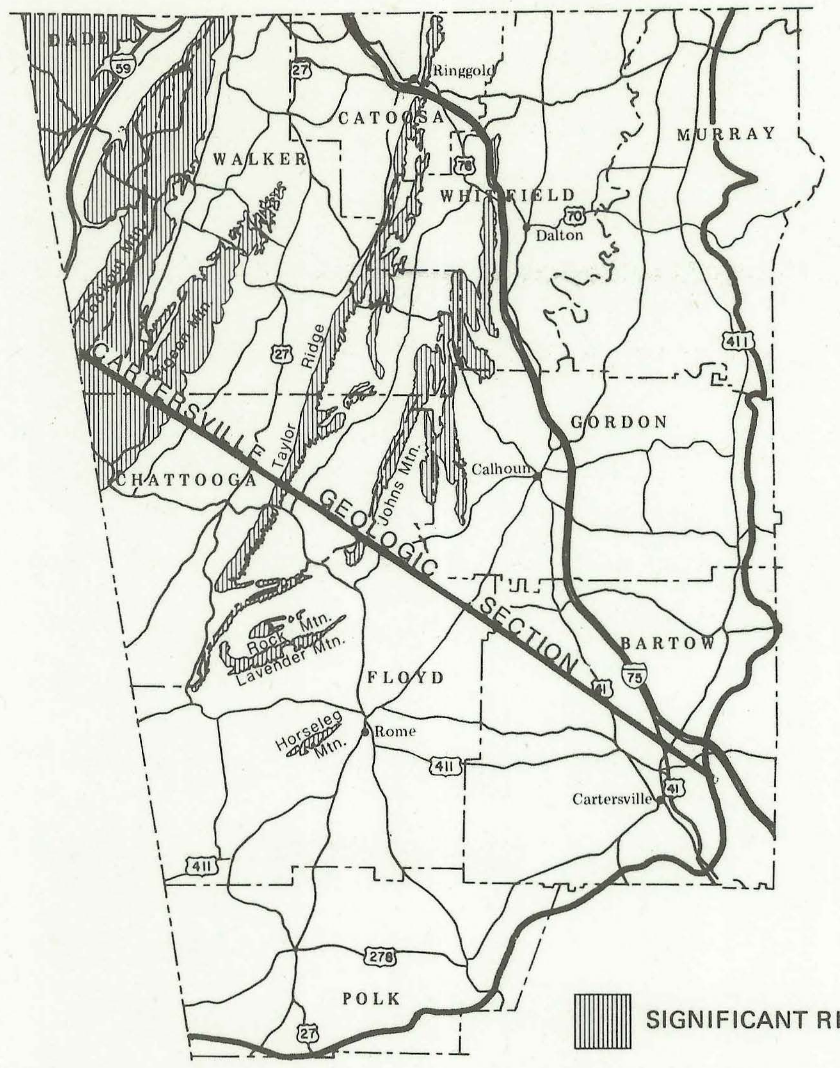
2000 0 2000 4000 FEET

NO VERTICAL EXAGGERATION

CARTERSVILLE GEOLOGIC SECTION

SCHEMATIC CROSS SECTION

K. R. DAVIS



Mississippian facies trends on the Cartersville Geologic Section parallel trends on the Rome Geologic Section. Little Sand Mountain appears to be an area of converging carbonate and clastic environments in the Mississippian period.

Red Mountain (Silurian) sandstone and shale and Chickamauga (Middle and Upper Ordovician) limestone and shale generally thicken to the east. Thickness trends in both sequences reflect nearer shore sedimentation to the east.

At Turkey Mountain, thickness relationships demonstrate the effect of Ordovician topography on Silurian sedimentation. A line through Turkey Mountain and Beech Creek Anticline to the southwest may reflect an abrupt transition from nearshore to offshore sedimentation.

FORMATIONAL CONTACT

THRUST FAULT

SEA LEVEL

SHALE (POSSIBLE CONFINING UNIT)

STRATIGRAPHIC SECTION

MISSISSIPPIAN — PENNSYLVANIAN

M–IPu	INCLUDES RACCOON MOUNTAIN AND YOUNGER 'PENNSYLVANIAN' CLASTIC SEQUENCES
Mu / Mfs / Mfp / Mfp Mls	Mu INCLUDES THE PENNINGTON SHALE AND BANGOR–MONTEAGLE–TUSCUMBIA LIMESTONE SEQUENCE Mfs FLOYD SHALE Mfp INCLUDES FORT PAYNE CHERT, MAURY SHALE, AND THE DEVONIAN CHATTANOOGA SHALE Mls LAVENDER SHALE

DEVONIAN– MISSISSIPPIAN

MDc	INCLUDES Mfp, Mls, AND ARMUCHEE CHERT

DEVONIAN

Da	ARMUCHEE CHERT

SILURIAN

Srm	RED MOUNTAIN FORMATION

ORDOVICIAN

Oc	CHICKAMAUGA SUPERGROUP

CAMBRIAN–ORDOVICIAN

O€k	KNOX GROUP

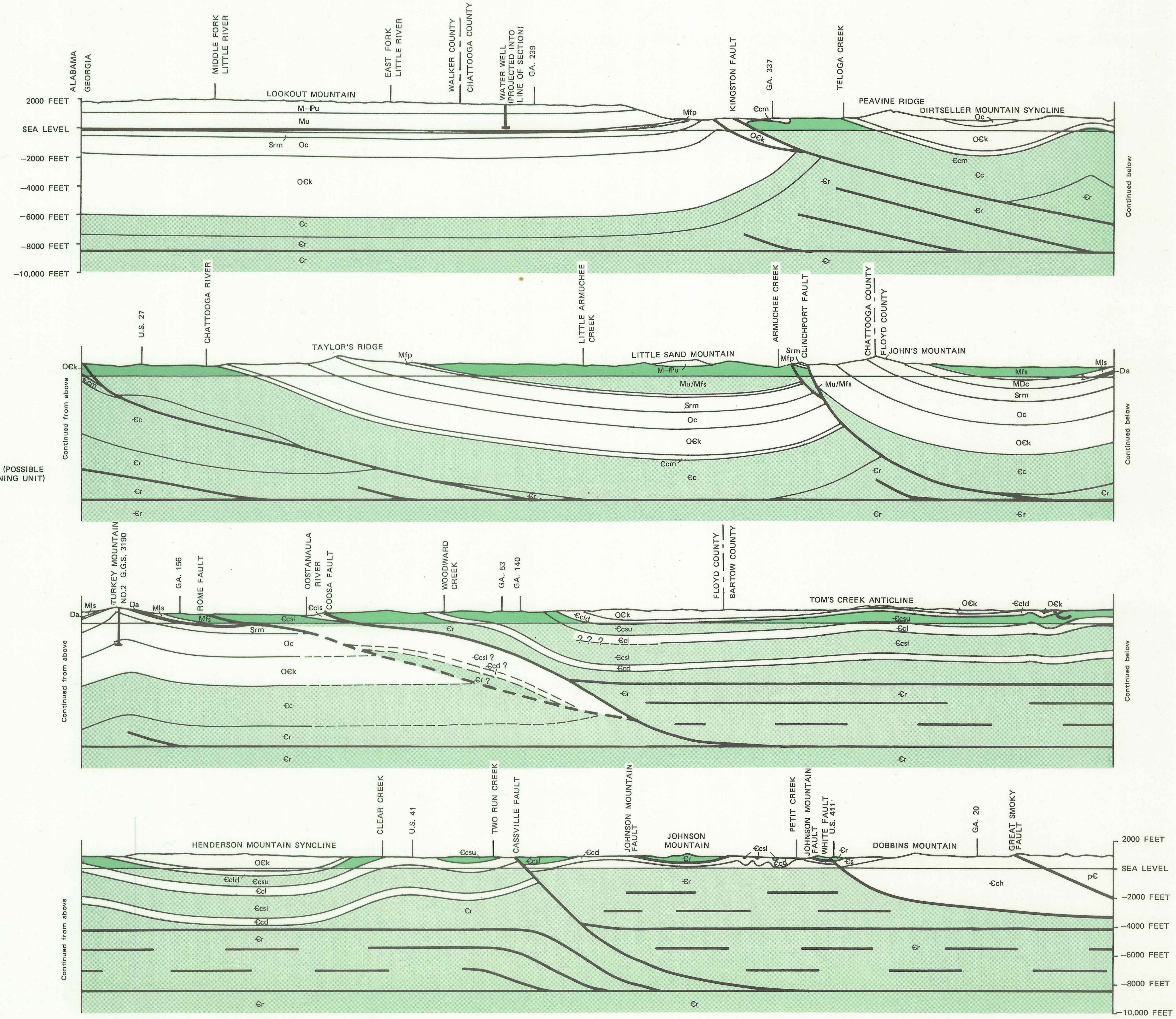
CAMBRIAN

CONASAUGA FORMATION

€cm €cls €cld €c €csl €csu €cl €csl €cls €cd	€cm UPPER LIMESTONE UNIT, 'MAYNARDVILLE' €cls MAINLY LIMESTONE, INCLUDES SHALE LAYERS €cld UPPER DOLOMITE €c INTERBEDDED SHALE AND LIMESTONE UNITS €csl MAINLY SHALE, INCLUDES LIMESTONE LAYERS €csu UPPER SHALE UNIT €cl LIMESTONE UNIT €cd LOWER DOLOMITE UNIT
€r	ROME FORMATION
€s	SHADY DOLOMITE
€ch	CHILHOWEE GROUP

PRECAMBRIAN

p€	LATE PRECAMBRAIN



Note: Thrust faults/décollements at depth are speculative.

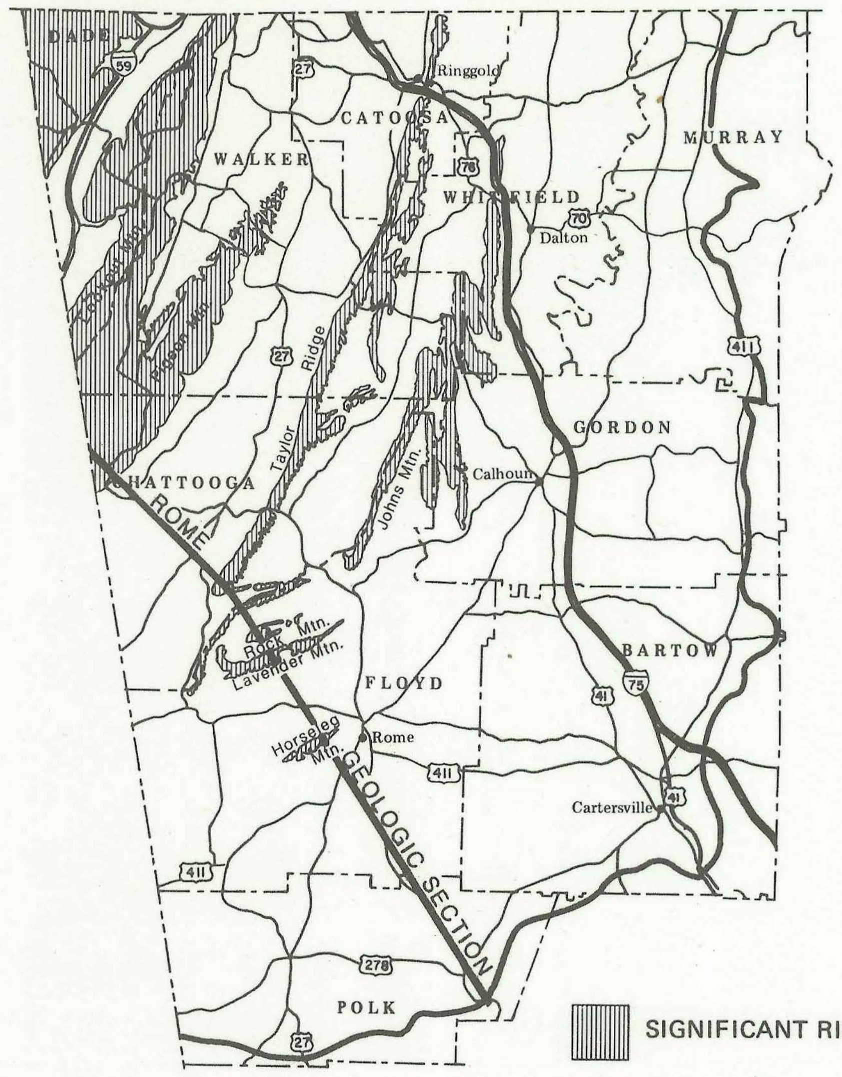
2000 0 2000 4000 FEET

NO VERTICAL EXAGGERATION

ROME GEOLOGIC SECTION

SCHEMATIC CROSS SECTION

K. R. DAVIS



The Rome Geologic Section provides the best demonstration of Mississippian facies transitions. Predominantly carbonate lithologies at Lookout Mountain give way to clastic lithologies to the southeast. Rock Mountain, with its expanded section of both carbonate and clastic rocks, is an area influenced by both environments of deposition.

Little is known of the continuation of the Clinchport Fault through the Rock Mountain area. Outcrop patterns suggest the fault may continue through the area unmappable in the Floyd Shale. The Rome Geologic Section shows a possible structural interpretation if the fault 'dies out' to the immediate north of the Rock Mountain area.

FORMATIONAL CONTACT

THRUST FAULT

SEA LEVEL

SHALE (POSSIBLE CONFINING UNIT)

STRATIGRAPHIC SECTION

MISSISSIPPIAN – PENNSYLVANIAN

M–IPu INCLUDES RACCOON MOUNTAIN AND YOUNGER 'PENNSYLVANIAN' CLASTIC SEQUENCES

MISSISSIPPIAN

- Mu INCLUDES THE PENNINGTON SHALE AND BANGOR–MONTEAGLE–TUSCUMBIA LIMESTONE SEQUENCE
- Mh UPPER 'HARTSELLE' SANDSTONE MEMBER OF THE FLOYD SHALE
- Mfs INCLUDES MIDDLE AND LOWER SHALE MEMBERS OF THE FLOYD SHALE
- Mfp INCLUDES FORT PAYNE CHERT, MAURY SHALE, AND THE DEVONIAN CHATTANOOGA SHALE
- Mls LAVENDER SHALE

DEVONIAN – MISSISSIPPIAN

MDc INCLUDES Mfp, Mls, AND ARMUCHEE CHERT

DEVONIAN

Da ARMUCHEE CHERT

SILURIAN

Srm RED MOUNTAIN FORMATION

ORDOVICIAN

- Oc CHICKAMAUGA SUPERGROUP
- Or ROCKMART SLATE, SLATE OR SILTSTONE
- Ors ROCKMART SLATE, UPPER PART, SAND, CONGLOMERATE, OR SLATE
- On NEWALA LIMESTONE

CAMBRIAN – ORDOVICIAN

O€k KNOX GROUP

CAMBRIAN

CONASAUGA FORMATION

- €cm UPPER LIMESTONE UNIT, "MAYNARDVILLE"
- €csl MOSTLY SHALE AND SOME LIMESTONE
- €cls MOSTLY LIMESTONE AND SOME SHALE
- €c INTERBEDDED SHALE AND LIMESTONE UNITS

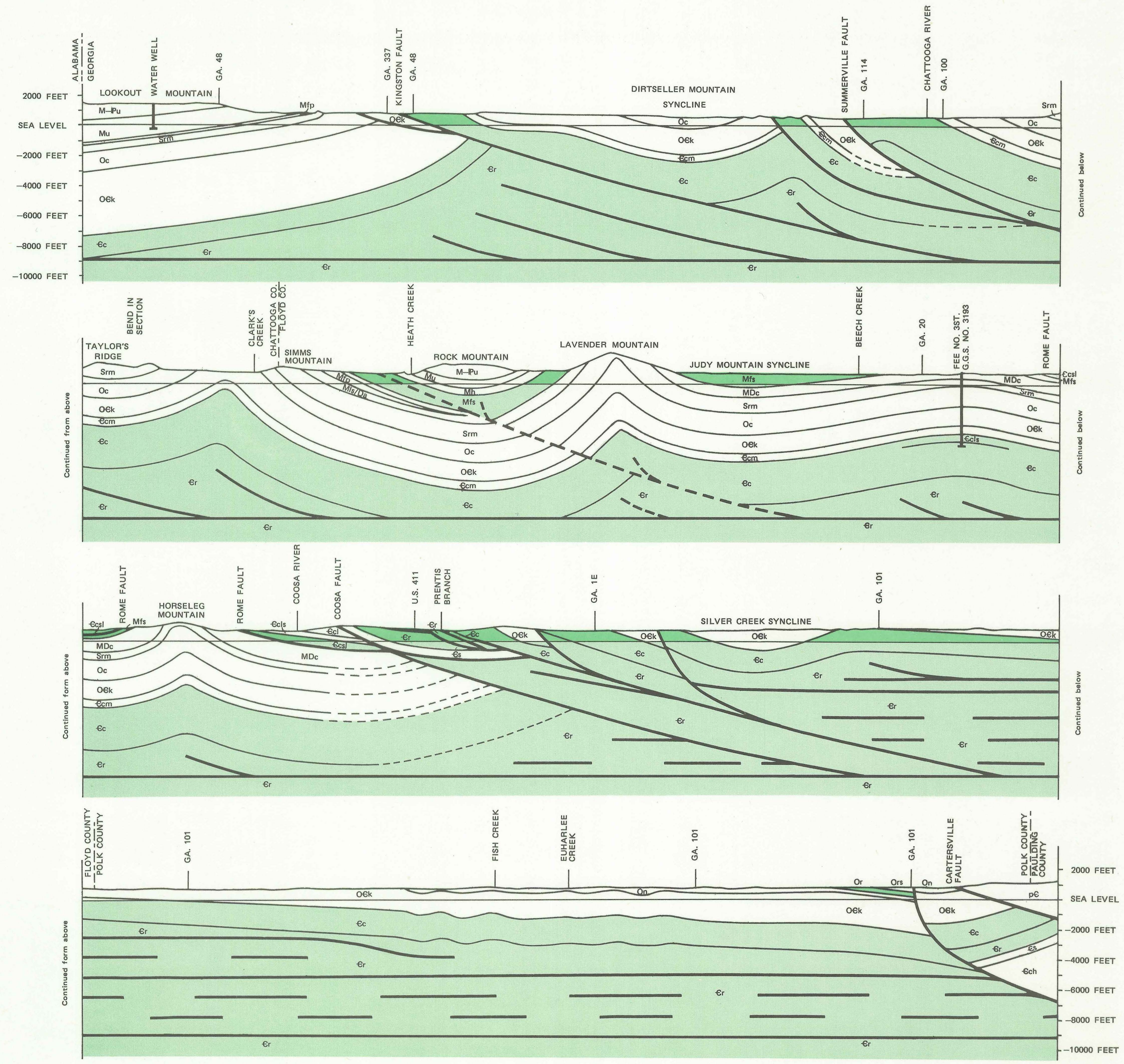
€r ROME FORMATION

€s SHADY DOLOMITE

€ch CHILHOWEE GROUP

PRECAMBRIAN

p€ LATE PRECAMBRIAN



Note: Thrust faults/décollements at depth are speculative.

2000 0 2000 4000 FEET

NO VERTICAL EXAGGERATION