1982

Barite Deposits of Kentucky

Warren H. Anderson
University of Kentucky, wanderson@uky.edu

Robert D. Trace
University of Kentucky

Preston McGrain
University of Kentucky

KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY, LEXINGTON
Donald C. Haney, Director and State Geologist

BARITE DEPOSITS

OF KENTUCKY

**Warren H. Anderson, Robert D. Trace,
and Preston McGrain**

BULLETIN 1	SERIES XI, 1982

https://doi.org/10.13023/kgs.b01.11

ISSN 0075-5559

KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY, LEXINGTON SERIES XI, 1982
Donald C. Haney, Director and State Geologist

BARITE DEPOSITS OF KENTUCKY

Warren H. Anderson
Robert D. Trace
Preston McGrain

BULLETIN 1
https://doi.org/10.13023/kgs.b01.11

UNIVERSITY OF KENTUCKY

Otis A. Singletary, President
Art Gallaher, Jr., Vice President for Academic Affairs
Wimberly C. Royster, Dean of Graduate School and Coordinator of Research
James Y. McDonald, Executive Director, University of Kentucky Research Foundation

KENTUCKY GEOLOGICAL SURVEY ADVISORY BOARD

David A. Zegeer, Chairman, Lexington
Phil M. Miles, Vice Chairman, Lexington
David E. Bayer, Lexington
John G. Donan, Sr., Madisonville
Wallace W. Hagan, Lexington
Nicholas C. Kieffer, Jr., Louisville
Harold G. Mays, Frankfort
J. Edward Parker, Lexington
W. J. Reynolds, Allen
Henry A. Spalding, Hazard
Ralph N. Thomas, Owensboro
George H. Warren, Jr., Owensboro

KENTUCKY GEOLOGICAL SURVEY

Donald C. Haney, Director and State Geologist
Preston McGrain, Assistant State Geologist, Water, Minerals, and Maps
John D. Kiefer, Assistant State Geologist, Energy

ADMINISTRATIVE DIVISION

Personnel and Finance Section:
James Hamilton, Administrative Staff Officer II
Margaret Fernandez, Administrative Accounts Clerk

Clerical Section:
Brenda L. Hayden, Administrative Secretary
Anna L. Hopkins, Administrative Secretary
Sherry A. McKune, Administrative Secretary
Norma J. Reynolds, Administrative Secretary
Jean Kelly, Secretary
Juanita G. Smith, Secretary, Henderson Office

Publications Section:
Donald W. Hutcheson, Head
Margaret K. Luther, Assistant Editor
Roger B. Potts, Chief Cartographic Illustrator
Lynn D. Guindon, Principal Drafting Technician
Freda M. Harris, Drafting Technician
William A. Briscoe, III, Sales Supervisor
Lemuel W. Waite, Stores Worker
Patrick H. McHaffie, Geologist/Geographer II

GEOLOGICAL DIVISION

Coal Section:
Lexington Office
James C. Cobb, Head
Russell A. Brant, Geologist V
Donald R. Chesnut, Jr., Geologist III
James C. Currens, Geologist III
Richard E. Sergeant, Geologist III
Blaine L. Fennell, Jr., Geologist I
Wayne T. Frankie, Geologist I
Elisabeth R. Portig, Geologist I
Ernie R. Slucher, Geologist I

Henderson Office
Allen D. Williamson, Geologist IV
David A. Williams, Geologist III
Roxanne Bingemer, Geologist I

Morehead Office
Kenneth L. Gill, Geologist II
Joseph P. Hamilton, Geologist I

Industrial and Metallic Minerals Section:
Preston McGrain, Head and Assistant State Geologist
Garland R. Dever, Jr., Geologist IV
Robert D. Trace, Geologist III, Princeton Office
Warren H. Anderson, Geologist II
Jack R. Moody, Geologist II
Mary E. Barron, Senior Laboratory Assistant

Oil and Gas Section:
Louis R. Ponsetto, Head
Martin C. Noger, Geologist IV
Frank H. Walker, Geologist IV
John G. Beard, Geologist IV, Henderson Office
Patrick J. Gooding, Geologist II
Brandon C. Nuttall, Geologist I
Julia Martin, Library Technician I
Richard W. Taulbee, Senior Laboratory Assistant
Robert R. Daniel, Laboratory Assistant

Water Section:
John D. Kiefer, Head and Assistant State Geologist
James S. Dinger, Geologist IV
Steven Cordiviola, Geologist III
Fred Lawrence, Geologist III
James Kipp, Geologist II
Margaret A. Townsend, Geologist II
Robert C. Holladay, Drafting Technician
Edwin A. Morford, Core Driller III

SPECIAL PROJECTS DIVISION

Projects

Kentucky Department for Natural Resources and Environmental Protection—Aquifer Characterization
Steven Cordiviola, Principal Investigator
Margaret A. Townsend, Geologist II
Robert C. Holladay, Drafting Technician

Kentucky Institute for Mining and Minerals Research—Coal Reserves, Eastern Kentucky
Lexington Office
Russell A. Brant, Principal Investigator
Donald R. Chesnut, Jr., Geologist III
Blaine L. Fennell, Jr., Geologist I
Wayne T. Frankie, Geologist I
Elisabeth R. Portig, Geologist I

Morehead Office
Kenneth L. Gill, Geologist II
Joseph P. Hamilton, Geologist I

Kentucky Institute for Mining and Minerals Research—Limestone Investigations
Garland R. Dever, Jr., Principal Investigator
Jack R. Moody, Geologist II

U.S. Geological Survey—Coal Hydrology, Eastern Kentucky
James S. Dinger, Principal Investigator
Fred Lawrence, Geologist III
James Kipp, Geologist II
Edwin A. Morford, Core Driller III

U. S. Geological Survey—Coal Sampling, Eastern Kentucky
James C. Currens, Principal Investigator

U. S. Nuclear Regulatory Commission—Geologic Studies of Faults and Terraces
Richard E. Sergeant, Principal Investigator
Roy Van Arsdale, Geologist III

U. S. Geological Survey—Compilation of Coal Data in the State of Kentucky
James C. Cobb, Principal Investigator
Ernie R. Slucher, Geologist I

U. S. Geological Survey—Kentucky Cartographic Inventory
Patrick H. McHaffie, Principal Investigator

Kentucky Department of Energy—Feasibility Assessment of Unconventional Gas in Kentucky
Louis R. Ponsetto, Principal Investigator

U. S. Geological Survey—Mine Map Inventory of Western Kentucky
Richard E. Sergeant, Principal Investigator
John K. Hiett, Geologist I
Bennie D. Perry, Laboratory Technician A

CONTENTS

ILLUSTRATIONS

TABLES

BARITE DEPOSITS OF KENTUCKY

Warren H. Anderson, Robert D. Trace, and Preston McGrain

ABSTRACT

Barite deposits are known to be present in 23 counties in Kentucky, principally in the Central Kentucky Mineral District and the Western Kentucky Fluorspar District. Field investigations and a literature search indicate the presence of barite at more than 170 outcrops, prospects, and abandoned mines.

Geologically, most of the Kentucky barite deposits are classified as vein or residual deposits. The vein deposits are cavity and breccia fills along faults and joints, commonly in limestone. Residual deposits occur in an unconsolidated clayey residuum formed by weathering of preexisting vein or breccia deposits. Most deposits are mixed ores commonly containing calcite, fluorite, galena, and sphalerite. Host rocks are almost exclusively formations of Ordovician and Mississippian ages.

Barite production in Kentucky has been small, and most has been from residual or "gravel" deposits in weathered material above fault zones. Since barite is commonly associated with fluorspar and the two minerals have been difficult to separate in milling operations, mixed ores have been bypassed in a number of instances and little quantitative information is available on them. Further evaluation will require additional exploration, and, particularly, more core drilling. There were no active barite mines in Kentucky at the time of this investigation.

INTRODUCTION

Barite is an important mineral which has a variety of industrial uses. The principal use of the mineral is as an important ingredient in heavy drilling muds for oil-field drilling. Barite is the mineralogical name for barium sulfate, chemical formula $BaSO_4$. It is a heavy mineral with a specific gravity of about 4.3 to 4.6, or approximately four and a half times the weight of water. It has also been called "barytes" and "heavy spar." For barite to be marketable, it requires a minimum specific gravity of 4.2.

According to U.S. Bureau of Mines data, in 1979 production of barite reached a record level of approximately 2 million short tons valued at $45 million from eight states. Nevada is the leading producer with 80 percent of the total United States output. Barite for use in oil- and gas-well drilling fluids represented 90 percent of the total barite consumed. The remainder was used in barium chemicals; glass; and as a pigment, filler, and extender in paint, rubber, and other materials.

The current energy shortage has increased the need to evaluate not only all potential sources of energy resources but also mineral materials used in the development and recovery of these resources. Barite, because of its weight, chemical inertness, nonabrasive character, and relatively lower cost than other heavy minerals, is well suited for oil-field drilling muds. Its principal function is as a weighting agent that is pumped into oil and gas wells to suppress high subsurface pressures in deep formations and prevent blowouts. It reduces the chance for waste of oil and natural gas and associated environmental problems.

Most of the barite produced in the United States comes from states west of the Mississippi River. As exploration for petroleum and natural gas increases in the eastern states and in the waters of the Atlantic Continental Shelf, closer sources of barite for drilling muds will be sought. Kentucky's geographic location and its navigable waterways make it an attractive hunting ground for barite.

The presence of barite in the vein-mineral deposits of central and western Kentucky has been known for many years. Deposits occur principally in carbonate rocks of Ordovician age in the Blue Grass region of central Kentucky in the area referred to by some geologists as the "Central Kentucky Mineral District," and in rocks of Mississippian age in the Western Kentucky Fluorspar District (Fig. 1).

An occurrence of barite in Union County in western Kentucky was noted in the first report of the Kentucky Geological Survey in 1856 (Lyon, 1856, p. 392). Since that time there have been many investigations of this mineral in Kentucky. The most comprehensive single report on the subject was prepared by F. Julius Fohs (1913), in which he described in detail many of the mineral exposures and barite prospect pits in central Kentucky and summarized many of the economic aspects of mining and development of that time. (An anticipated report on western Kentucky deposits which Fohs cited (Fohs, 1913, p. 14) was never published.)

According to Fohs (1913, p. 523), barite was first marketed in Kentucky in 1903 when shipments were made from both central and western Kentucky. Fohs (1913, p. 524) further reported that a barite mill was built at Nicholasville in central Kentucky in 1907 and that the

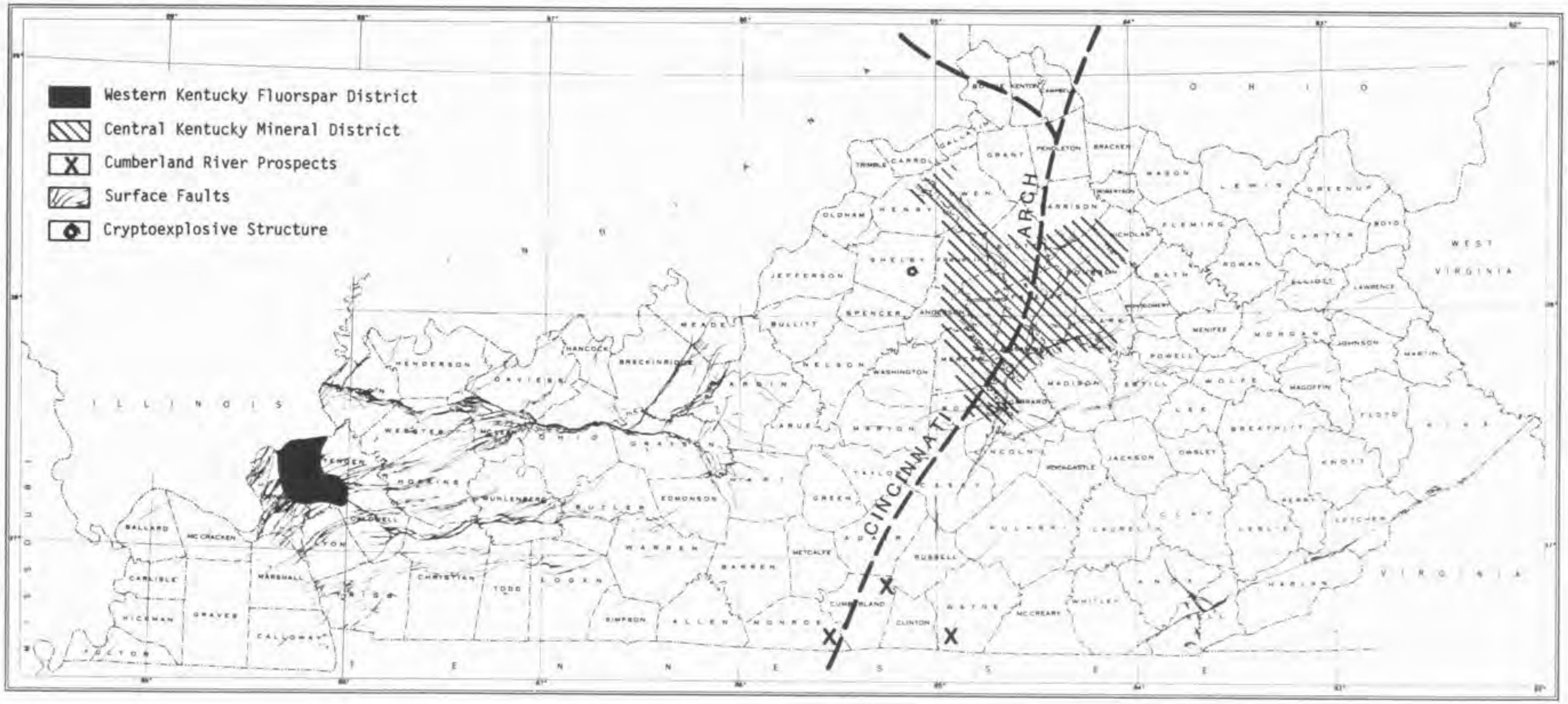


Figure 1. Map of Kentucky showing Central and Western Kentucky Mineral Districts and major structural features. Modified from Heyl (1972, Figs. 3 and 5).

following year Kentucky was the third largest barite-producing state, producing 11,051 tons.

McFarlan (1943, p. 389) wrote that barite development in Kentucky reached a maximum production of 11,068 tons in 1916, but more or less died out in the years following 1923.

Barite mining was rejuvenated in the 1950's, most of the production coming from Crittenden and Livingston Counties in western Kentucky and Boyle, Garrard, and Lincoln Counties in central Kentucky. There were no active barite mines in the State at the time of the present investigation.

As a part of an assessment of the United States' mineral resources, Brobst (1973, Table 13) estimated Kentucky's identified vein barite resources to be 5.5 million tons and hypothetical vein resources to be 6 million tons. Identified resources are specific, identified deposits that may or may not be evaluated as to extent and grade, and are within 1,500 feet of the surface. Hypothetical resources are undiscovered mineral deposits, also within 1,500 feet of the surface, of recoverable or subeconomic grade, that may be geologically predicted to exist in known districts.

Current field investigations and literature search have indicated the presence of barite at more than 170 outcrops, prospects, and abandoned mines in 23 Kentucky counties. The inventory of central Kentucky was conducted primarily by Warren H. Anderson; Robert D. Trace was the principal investigator in western Kentucky.

Since many of the older reports describing the barite deposits of Kentucky are out of print, this report will serve as a summary for those investigating the Kentucky deposits. Fohs (1913) and Robinson (1931) suggested the existence of more deposits than disclosed by the present study. This difference is because they listed multiple occurrences or prospects along single veins and occurrences in geodes, and because farmland renovation and various land development practices have obscured some occurrences.

Most of the Kentucky deposits are classified as vein and residual deposits. The vein deposits are cavity and breccia fills along faults and joints. The individual bodies are small, scattered, and irregular, and many are accompanied by calcite, fluorite, galena, and sphalerite. Residual deposits in Kentucky occur in a clayey residuum formed by weathering of preexisting vein or breccia deposits.

An exploration program to ascertain basic geologic data about a specific Kentucky barite deposit would require surface mapping, geochemical investigation, core drilling, analysis of materials, and beneficiation testing. Deposits should be sought in residuum overlying faults in the known mineral districts and in conjunction with exploration for associated minerals. Recently completed geologic maps for the whole State at a scale of 1:24,000 provide the general stratigraphic and structural framework for planning an investigation. Many of the deposits are located on the published maps, which are cited in the text.

The writers acknowledge with thanks the courtesies of many residents of both central and western Kentucky who granted access to their properties for field investigations and to geologists who supplied data on past exploration and development activities from their files.

CENTRAL KENTUCKY MINERAL DISTRICT

Geologic Setting

The Central Kentucky Mineral District, also called the Central Kentucky Fluorspar District, covers part or all of 16 counties in the Blue Grass region of central Kentucky. Barite, fluorite, calcite, galena, and sphalerite have been mined sporadically from this district since 1900. The latest mining activity occurred during the 1960's in Lincoln, Garrard, and Boyle Counties. Cumulative barite production from this district has been approximately 85,000 tons (Table 1).

Table 1.—Barite Production in Central Kentucky. (From Fohs, 1913, p. 524; Robinson, 1931, p. 26; and author's estimation.)

YEARS	TONS PRODUCED
pre-1900	no record
1900-1905	2,500
1906	3,375
1907	9,435
1908	11,051
1909	2,746
1910	2,754
1911-1913	6,000†
1915	7,753
1916	11,086
1917	6,720
1918	6,000
1919	5,435
1920	1,000
1924-1931	7,000†
1939-1940	no record
1940-1944	1,000†
1944-1956	no record
1956-1965	2,000†
1965-1980	no record
TOTAL PRODUCTION	85,837

†Author's estimation

Vein deposits of the Central Kentucky Mineral District are located on the Lexington Dome (also called Jessamine Dome) near the intersection of several regional fault systems and the axis of the Cincinnati Arch in central Kentucky (Fig. 1). The Lexington Dome is one of several major structural features that occur in the vicinity of an east-trending regional fault system commonly referred to as the 38th Parallel Lineament. This lineament, described by Heyl (1972), extends from Virginia through West Virginia, Kentucky, and southern Illinois to Missouri, and possibly through the Midwest to the Rocky Mountains. In eastern Kentucky it is in the vicinity of and parallel to the Irvine-Paint Creek Fault System and the Kentucky River Fault System, which intersect the broad, north-trending Cincinnati Arch to the west. The lineament further extends from the southern part of the Lexington Dome to an eastward extension of the Rough Creek Fault System, where it continues across western Kentucky into the area of the Kentucky-Illinois Fluorspar District.

Other structural features which occur along or near the lineament include some igneous dikes in Elliott County in eastern Kentucky and Livingston, Crittenden, and Caldwell Counties in western Kentucky. Also, three cryptoexplosive structures occur near the 38th Parallel Lineament.

The Lexington Dome, which is the structural high of the Cincinnati Arch, extends from Owen County in north-central Kentucky southward approximately 100 miles to Lincoln County in south-central Kentucky. It consists of nearly flat-lying to gently dipping Middle and Upper Ordovician sediments flanked by Silurian, Devonian, Mississippian, and Pennsylvanian rocks. From the dome's structural apex near Sulfur Well in southern Jessamine County, the rocks dip about 20 to 30 feet per mile to the east and west, and about 10 feet per mile north and south along the axis of the arch. The dome was uplifted in pre-Middle Devonian time and during the Appalachian revolution near the end of Permian time (McFarlan, 1943, p. 132). Plummer (1971, p. 256) stated that there was also some uplift during the Tertiary.

The structure is cut by four major fault systems: the Lexington Fault System (West Hickman and Bryan Station Fault Systems), the Kentucky River Fault System, and the Irvine-Paint Creek Fault System, all northeast-trending, and the east-trending Brumfield Fault, which could be an extension of the Rough Creek Fault System (Plate 1, in pocket). The Lexington Fault System has been traced from Mason County (McGuire and Howell, 1963, p. 37) through Bourbon County (Fig. 2) to Jessamine County, where it converges with the Kentucky River Fault System near the structural apex of the Lexington Dome. The Kentucky River Fault System extends from southern Fayette, through Clark and Montgomery Counties, into eastern Kentucky and western West Virginia where it may be represented by the Blaine Fault. In the subsurface of eastern Kentucky it is recognized as the northern boundary of the Rome Trough. The Brumfield Fault System occurs in Boyle County in the southwestern portion of the mineral district, and the Irvine-Paint Creek Fault System occurs in Madison, Garrard, and Lincoln Counties in the southern portion of the district.

According to Black and Haney (1975, p. 1), some normal faults along the Kentucky River Fault Zone have a vertical displacement of as much as 600 to 700 feet. Heyl (1972, p. 885) stated that the larger fault systems have smaller strike-slip faults which exhibit little or no vertical displacement. It is along these smaller strike-slip faults that much of the mineralization occurs in the Central Kentucky Mineral District.

Two cryptoexplosive structures are exposed in the Blue Grass region: Jeptha Knob in Shelby County, and the Versailles structure in Woodford County (Plate 1). Bucher (1933, p. 239) stated that the origin of the Jeptha Knob cryptoexplosive structure was volcanic, but more recently Seeger (1969, p. 630) suggested the Jeptha Knob structure is of meteorite-impact origin because drilling evidence showed the structure was confined to near-surface rocks. Black (1965, p. 44) described the Versailles cryptoexplosive structure as a circular depression, approximately 5,000 feet in diameter, bounded by normal faults. Based on structural relations, Black (1980) suggested that both of these cryptoexplosive structures are related to deep-seated faulting. Although their origin is debatable, their circular, faulted structure and brecciated rocks are similar to other cryptoexplosive structures.

The surface rocks exposed in central Kentucky consist of the High Bridge Group (Middle Ordovician); the Lexington Limestone (Middle and Upper Ordovician); and the Clays Ferry Formation, Garrard Siltstone, and Calloway Creek Limestone (Upper Ordovician) (Fig. 3). The High Bridge Group and the Lexington Limestone are the principal host rocks for mineralization, and the lateral extent of the Central Kentucky Mineral District is nearly coincident with the outcrop pattern of these Ordovician limestones (Plate 1).

The High Bridge Group consists of three formations: the basal Camp Nelson Limestone (calcilutite mottled with dolomite), Oregon Formation (dolomite), and the Tyrone Limestone (calcilutite) (Fig. 3). The lower contact of the Camp Nelson Limestone is not exposed on the surface, but core-hole information indicates that the combined average thickness of the Camp Nelson, Oregon, and Tyrone in central Kentucky is approximately 500 feet. The Tyrone Limestone is overlain disconformably by the Lexington Limestone (Cressman and Noger, 1976, p. 3).

The Lexington Limestone is a series of complexly inter-

Figure 2. Lexington Fault System along U. S. Highway 68 Bypass, north of Paris, Bourbon County. The Marsh Vein is exposed in the limestones on the left side of the fault.

tonguing lithofacies units ranging from calcilutites to fossiliferous limestones (Fig. 3). The Lexington Limestone has been divided into 10 members for this investigation: basal Curdsville Limestone (calcarenite), Logana (calcisiltite and shale), Grier Limestone (fossiliferous limestone), Perryville Limestone (calcilutite), Tanglewood Limestone (calcarenite), Brannon (calcisiltite and shale), Sulphur Well (bryozoan limestone), Stamping Ground (nodular fossiliferous limestone and shale), Devils Hollow (gastropodal calcirudite and calcilutite), and Millersburg (nodular fossiliferous limestone and shale). The thickness of the Lexington Limestone ranges from 200 feet on the northern border of the Central Kentucky Mineral District to 320 feet along an east-west line from Frankfort to Paris.

Overlying the Lexington Limestone are the Clays Ferry Formation (interbedded shale, limestone, and siltstone), the Garrard Siltstone (siltstone and shale), and the Calloway Creek (limestone and shale).

Barite Mineralization

Barite occurs in vertical, mostly north-trending veins associated with faults, fractures, and joints. These veins pinch and swell along strike, and most range from less than 1 foot to a maximum of 12 feet in width, although Fohs (1913) reported a zone of closely spaced veins 18 and 35 feet wide. Most of the veins are 100 to 1,000 feet in length, although three veins, Gratz (Owen County, Plate 1, no. 108), Faulconer (Mercer County, Plate 1, no. 96), and Cole (Fayette County, Plate 1, no. 36), have been traced for several miles. The known vertical extent of the veins varies from several feet to more than 300 feet at the Chinn Mine (Plate 1, no. 93) near Mundys Landing in Mercer County. The veins contain barite, fluorite, calcite, sphalerite, galena, pyrite, chalcopyrite, and marcasite; some secondary carbonates have also been observed or reported, including malachite, smithsonite, witherite, strontianite, and cerussite. Fohs' (1913, p.

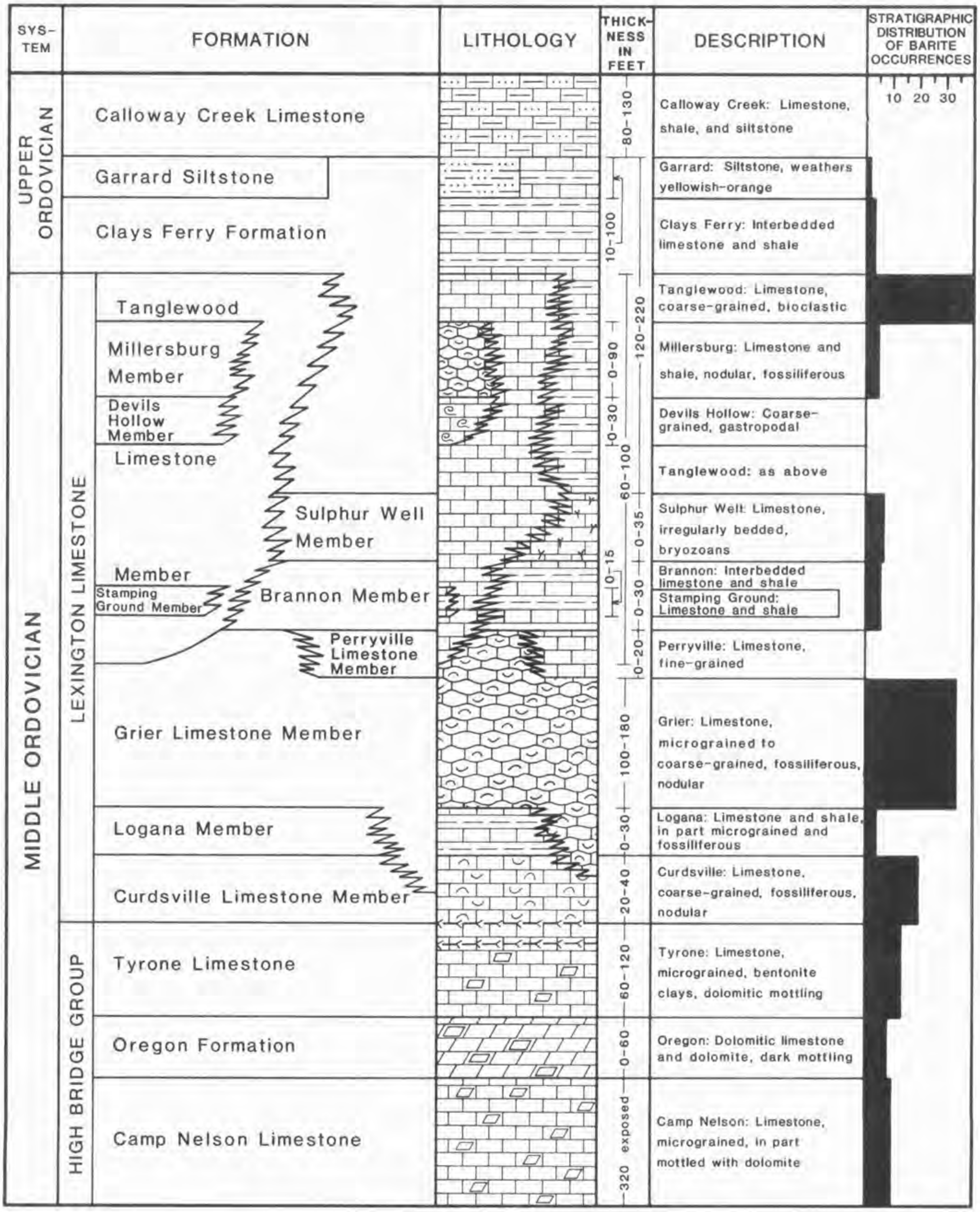


Figure 3. Generalized stratigraphic column of exposed rocks in the Central Kentucky Mineral District.

451) analyses of eight central Kentucky barite samples show strontium concentrations ranging from less than 1 percent to as much as 21 percent strontium sulfate; most of these samples were from Mercer, Boyle, and Woodford Counties. Jolly and Heyl (1964, p. 614) reported that some barite contains 26 percent strontium sulfate and that the strontium is deposited in the crystal lattice of the barite, and not as celestite.

The contacts between the veins and wall rock are generally sharp; little or no wall alteration is observed, although breccia fragments are prevalent in many of the veins. Calcite and barite veinlets also occur in the wall rock adjacent to the mineralized zone.

Based on mineral assemblages, this district has been zoned laterally by Jolly and Heyl (1964) and later redefined by Plummer (1971). The redefined zoning (Plate 1) consists of two central fluorite-calcite zones (zone 1) which Jolly and Heyl (1964) considered to be centers of mineralization. Zone 1 is surrounded by a fluorite-barite-calcite zone (zone 2) in the southern half of the district. The northern half of the district is a barite-galena-sphalerite zone (zone 3). Brecke (1979, p. 1334) stated that the barite is more concentrated in the northern half of the district. The 128 mineral deposits investigated during this project confirmed both Plummer's (1971, p. 252) and Brecke's (1979, p. 1334) zonal patterns (Plate 1).

The mineral paragenesis (Table 2) and zonation described by Jolly and Heyl (1964) is consistent within narrow limits. Barite was generally the first mineral deposited in all three zones. The two central zones (zone 1) of mineralization have irregularly alternating (banded) sequences of fluorite, calcite with some barite, and sphalerite. Fohs (1913, p. 483) reported 14 distinct depositional sequences in the Chinn Mine (zone 1). Zone 2 has sequences of barite and fluorite with some sphalerite. Zone 3 sequences are barite, calcite with galena, and sphalerite. Jolly and Heyl (1964) provided a more detailed paragenetic sequence (Table 2) by examining the texture, morphology, color, and relative abundance of mineral deposition.

A feature of the mineral district useful to the explorationist is the localization or concentration of mineral veins into several areas. Bondurant (1978, p. 17) listed five major areas, but a further examination reveals that possibly six major and two minor areas are present (Plate 1). The major areas of mineral veins appear to be associated with the small faults or fractures near the intersection or terminus of the major fault systems. The major areas are:

(1) Mundys Landing; Woodford and Mercer Counties
(2) Boones Creek; Clark and Fayette Counties
(3) Garrard, Boyle, and Lincoln Counties
(4) Northern Fayette County
(5) Paris; Bourbon County
(6) Gratz; Owen and Henry Counties

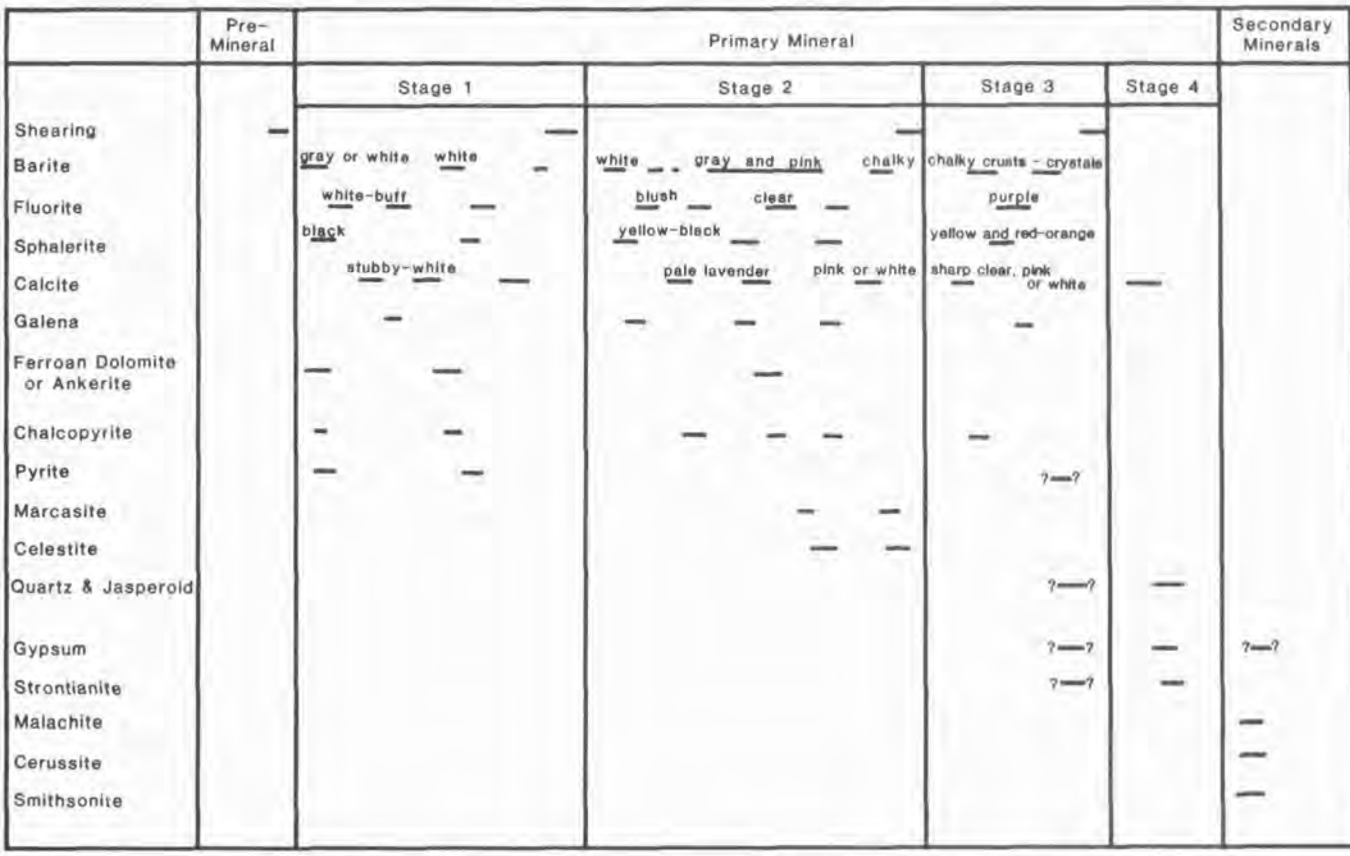
The minor areas are:

(1) Northern Elkhorn Creek along the Franklin-Scott county line.
(2) Silas Creek along the Harrison-Bourbon county line.

Two of these major areas, Mundys Landing and Boones Creek, are located in the central zones of mineralization (zone 1). The remainder of the groups of mineral veins appear to be located near the terminus or intersection of the major fault zones. The Garrard-Boyle-Lincoln County region has been mineralized near the intersection of the Rough Creek and Kentucky River Fault Zones in the southernmost part of the district. The Gratz Veins appear to be concentrated near the end of the surface traces of a northwest-trending fault system. The northern Fayette County veins are associated with the intersection of a series of northwest-trending faults which diverge from the northeast-trending Lexington Fault System. The Paris, Kentucky, and North Elkhorn Creek Veins are not as conspicuously associated with terminal or intersecting fault zones, but the veins near Silas Creek at the Harrison-Bourbon county line are associated with the terminus of the surface traces of faults. However, there are just as many faults in these regions which are void of mineralization, so faulting is not the only control of mineralization.

Evidence for stratigraphic control of mineralization (i.e., fluorite-calcite concentration in the High Bridge Group, and barite and galena in the Lexington Limestone) as described by Miller (1905) and Fohs (1913) is questionable, although it exists locally. Fluorite and calcite occur in the High Bridge Group at Mundys Landing and in other places along the Kentucky River, but abundant barite also occurs in the High Bridge Group near Ford and Camp Nelson on the Kentucky River. The presence of barite in some veins within the High Bridge Group does not lend support to the stratigraphic control of mineralization. More than 70 percent of the barite veins observed in this investigation occur in the Lexington Limestone and appear to favor calcarenitic and fossiliferous lithologies. Approximately 60 percent of the mineral veins containing barite observed in this investigation occurred in the Curdsville, Grier, and Tanglewood Limestone Members of the Lexington Limestone (Fig. 3). This evidence seems to support stratigraphic control of mineralization. Twenty percent of those mineral veins observed in the field investigations occurred in the more micrograined lithologies of the High Bridge Group; however, this percentage is conservatively biased because the outcrop exposures are limited to the Kentucky River gorge and some of its tributaries. Several barite veins are exposed in the High Bridge Group in three underground

Table 2.—Paragenesis of the Central Kentucky Mineral District. The Lines Indicate the Periods of Deposition of the Minerals in Relation to Each Other; the Mineral Habit Descriptions of Some of the More Distinctive Varieties Appear Above the Lines. (From Heyl, 1964).



limestone mines, which may indicate that more barite occurs in the High Bridge Group than is indicated in outcrop alone. Two of these mines (Plate 1, nos. 34 and 74) are located near the Lexington Fault System in Fayette and Jessamine Counties, and one (Plate 1, no. 86) is located in the Kentucky River Fault Zone in Madison County.

The age and origin of the central Kentucky mineral deposits and other Mississippi Valley-type ore deposits are the subjects of much debate. Volumes have been written on these topics, but only brief mention of several ideas on ore genesis that apply to central Kentucky will be made here.

Ohle (1959) established a criterion for Mississippi Valley-type deposits which suggests that these occurrences are vein and bedded deposits located on domal or structurally positive areas at shallow depths in carbonate rocks. These deposits also have a simple mineralogy with a low precious metal content, and they generally occur in non-orogenic regions. The absence of igneous activity and evidence of solution activity are also representative of Mississippi Valley-type ore deposits.

Norwood (1877) cited lateral secretion from the surrounding rocks as the source of mineral-bearing fluids, and Fohs (1907) classified the Kentucky deposits as hydrothermal.

Jolly and Heyl (1964, p. 620) concluded that hydrothermal fluids in central Kentucky were derived "from the rising heated solutions that used major faults and minor wrench faults as channels . . . from a deeply buried pluton or other deep seated heat source."

Roedder (1971), however, performed fluid inclusion studies which suggest that the composition of the Mississippi Valley-type ore fluids (including those in central Kentucky) were hot, connate, saline brines similar in composition to basinal oil field brines. Hall and Friedman's (1963) studies at the Cave in Rock District in Illinois further suggest that there were several episodes of mineralization, including a connate-magmatic fluid combination.

If the basinal brine hypothesis for ore mineralization is accepted, the ore fluids which precipitated the mineralization could have come from the Illinois or Appalachian Basins. Brecke (1979) postulated that the hydrothermal solutions migrated to central Tennessee, central Kentucky, and western Kentucky from the Mississippi Embayment Syncline. Although the basinal brine theory of ore mineralization is commonly accepted, Ohle (1980) points out that more research is needed to fully understand the ore genesis of Mississippi Valley-type deposits.

The age of mineralization in the Central Kentucky Mineral District is placed during the late Paleozoic (or the same time as the mineralization of the Western Kentucky Fluorspar District), but Brecke (1979, p. 1327) and Plummer (1971, p. 252) gave a younger age (Late Cretaceous and Tertiary) for mineralization. Plummer (1971, p. 252) stated that the ore genesis is related to an "ore-fluid groundwater interface" across central Kentucky which restricts mineralization to ancient aquifer and ground-water levels or deposits close to the ground surface. Breeding (1972, p. 33), however, stated that several vertical core holes were drilled in the bottom of the Chinn Mine (Mercer County) to a depth of 600 feet and that "no wall rock was encountered the entire 600 feet. . . . The vein was 22 feet wide at the top of the core holes." If no wall rock was encountered, a pure calcite vein must extend to a depth of 600 feet, which would place the total depth into the Cambro-Ordovician Knox Dolomite. The Chinn Mine is located in zone 1 of Jolly and Heyl (1964, p. 615), which they called a center of mineralization.

Description of Occurrences of Mineral Deposits

The mineral deposits described below include mapped, observed, and reported barite occurrences. Some of the deposits are shown on the geologic quadrangle maps, some were reported in previous literature by earlier investigators, and some were located in the course of the present investigation. Plate 1 shows the major fault systems, zoning characteristics, extent of the Middle Ordovician limestones, the barite occurrences, and where the length of the mineral vein is sufficient, the approximate strike or trend of the vein. Many of the deposits are still evident by prospect pits, trenches, adits, shafts, and barite fragments, but some of the veins have been obscured by land development. Some veins which were not observed in this investigation but were reported from previous literature are also listed in order to present a more accurate representation of the mineral district. The veins have been listed numerically and alphabetically by county and deposit, and, unless otherwise stated, are shown on the geologic quadrangle maps. The names of the veins used in this report are the same names used by previous writers. Many veins have multiple names which are also listed. The numerical designations of the Robinson (1931) and Jolly and Heyl (1964) veins have been included in the text and on the barite occurrence list for reference; this should simplify correlation between older and more recent literature.

Anderson County

Bear Branch Creek (Routt) Vein—This vein (Plate 1, no. 1; Robinson, 1931, no. 5; Carter coordinate section 1-R-56) is located 1 mile west of the Kentucky River near the northern boundary of the Salvisa Quadrangle (Cressman, 1968). Although the vein is not exposed, its approximate location can be traced by a north-trending trench that is 4 feet deep by 3 to 5 feet wide and 350 feet long. Barite is the predominant mineral observed on dump piles, but some galena, sphalerite, and malachite are also present. This vein could be a southern extension of the Shyrock Ferry Vein in Woodford County, where Fohs (1913, p. 465-466) reported secondary malachite after chalcopyrite. The host rock is the Tanglewood Limestone Member of the Lexington Limestone.

Hammonds Creek Vein—Although this vein (Plate 1, no. 2; Robinson, 1931, no. 1) is not shown on the geologic quadrangle map, it is reportedly located 2 1/2 miles southwest of Lawrenceburg, which should place it on the Lawrenceburg Quadrangle (Cressman, 1972b). The vein strikes N 24° W, is 6 inches wide, and contains barite and sphalerite (Fohs, 1913, p. 488).

Watts Vein—This vein (Plate 1, no. 3; Robinson, 1931, no. 2) is not shown on the geologic quadrangle map, but according to Fohs (1913) it is located 6 1/2 miles northeast of Lawrenceburg, 1 1/2 miles west of the Kentucky River, and is probably on the Tyrone Quadrangle (Cressman, 1964). A 70-foot shaft was sunk on a vein that contained barite, galena, and sphalerite (Fohs, 1913, p. 489).

Bourbon County

Caldwell Veins—One-half mile southwest of Millersburg near the junction of U.S. Highway 68 and Kentucky Highway 1940, two northeast-trending, parallel fissure veins (Plate 1, no. 4; Robinson, 1931, no. 11; Carter coordinate section 15-V-65; Millersburg Quadrangle, Cuppels and Outerbridge, 1974) occur about 1,500 feet apart in the Tanglewood Limestone and Millersburg Members of the Lexington Limestone. These veins were reportedly developed by five shafts (Fohs, 1913, p. 489), one to a depth of 80 feet with a drift at the 42-foot level, but only two shafts were observed in this study. The veins are 1,500 and 1,000 feet in length and Fohs reported a maximum width of 40 inches, and an average width of 25 inches. These veins may contain as much as 70 percent barite; the remainder is composed of galena, sphalerite, and limestone breccia. In 1906 a small mining plant was installed and some shipments were made, according to Fohs (1913, p. 489).

Cassius Clay Veins—Four miles southeast of Paris, off Spears Mill Road, a group of irregularly trending barite veins (Plate 1, no. 5; Robinson, 1931, no. 7; Carter coordinate sections 22- and 23-U-64; Paris East Quadrangle, Outerbridge, 1974a) occur in the Grier and Tanglewood Limestones, and the Millersburg Member of the Lexington Limestone. Miller (1905a, 1905b) reported 20 veins on this farm; six veins were observed in the current investigation, five containing barite and galena. Four of the veins trend northward and range from 500 to 1,000 feet in length and 2 to 3 feet in width; a 3,300-foot-long vein containing barite occurs along a northeast-trending fault.

Fohs (1913, p. 472) reported veins containing sphalerite and limestone breccia, the average width being 2 or 3 feet, some attaining a 5-foot width. Fohs (1913, p. 472) also stated, ". . . One vein is said to measure 35 feet between walls but none of its mineral veins exceed 2 feet."

Clay Vein—This vein (Plate 1, no. 6; Carter coordinate section 13-U-64; Paris East Quadrangle, Outerbridge, 1974a) is located at the junction of Highway 460 and County Road 537, and is 2 1/2 miles north of the Cassius Clay Veins. A north-trending fault has been mineralized with barite and galena approximately 2,000 feet along strike in the Tanglewood Limestone Member.

Houston Creek Veins—Southwest of Paris, three barite-calcite veins (Plate 1, no. 7; Carter coordinate sections 13- and 18-U-63; Paris West Quadrangle, Outerbridge, 1974b) occur along Houston Creek in the Grier Limestone Member. The southernmost vein, which is adjacent and parallel to the Lexington Fault System, can be located by barite fragments approximately 100 feet along a northeast trend. The intermediate vein is obscured and was not observed during this investigation. The northernmost vein is located in a quarry near the Frankfort and Cincinnati Railroad along Houston Creek. The vein trends east and is predominantly calcite with some dolomite, sphalerite, and galena; Outerbridge (1974b) reported this vein contained some bladed barite crystals.

Paris and Marsh Veins—Barite mineralization (Plate 1, nos. 8, 9; Robinson, 1931, nos. 6, 12; Carter coordinate sections 11-, 18-, and 19-U-63, 6- and 15-U-64; Paris East and Paris West Quadrangles, Outerbridge, 1974a, 1974b) occurs in the Grier and Tanglewood limestones along the northeast-trending Lexington Fault System and extends for 3 miles southwest, and 1 mile northeast of Paris (where it is called the Marsh Fault). No exposures were observed in the southwestern part of the fault, but a 120-foot-wide zone of veinlets ranging in width from 1/2 inch to 3 inches was observed in a roadcut at the intersection of U.S. Highway 68 Bypass and U.S. Highway 68 Business Route, 1 mile northeast of Paris (Miller, 1905a) (Figs. 4 and 5). These veins were all steeply inclined or vertical fault-associated veins and contained barite with sphalerite, calcite, and galena. Miller (1905b, p. 25) reported that two shafts were sunk on the Paris Veins, one to a depth of 100 feet. The vein consists of a 1-foot-wide barite-galena-sphalerite vein and a 7-foot-wide zone of limestone breccia. Northeast of Paris, Robinson (1931, p. 96) reported that a 114-foot shaft was sunk on the Marsh Vein, which is a brecciated zone as wide as 30 inches. Fohs (1913) reported the vein was encouraging for mining lead and zinc but not barite. No surface evidence of a vein mapped by Outerbridge (1974a) in a quarry northeast of Paris could be found during this investigation.

Peacock Road Vein—This vein (Plate 1, no. 10; Carter coordinate sections 21-V-63 and 1-U-63; Shawhan Quadrangle, Cuppels, 1973, and Paris West Quadrangle, Outerbridge, 1974b) is located 1/4 mile east of Peacock Road on the southeastern corner of the Shawhan Quadrangle and the northeastern corner of the Paris West Quadrangle. A north-trending, 500-foot-long barite vein was mapped by Cuppels (1973) and Outerbridge (1974b) along a fault in the Grier and Tanglewood limestones.

Purdy Vein—Northwest of Millersburg on Hinkson Creek, a barite vein (Plate 1, no. 11; Robinson, 1931, no. 10; Carter coordinate section 5-V-65; Millersburg Quadrangle, Cuppels and Outerbridge, 1974) is exposed in the Millersburg Member of the Lexington Limestone. Fohs (1913, p. 489) reported the vein is 4 inches wide and contains barite, galena, sphalerite, and fluorite; according to Cuppels and Outerbridge (1974), the vein is 500 feet long. A 5-foot-wide adit, now partly caved, and an abandoned shaft 94 feet deep (Fohs, 1913, p. 489) were sunk on this vein. No barite was observed on the adit dump.

Ruddels Mill Vein—Cuppels and Outerbridge (1974) recorded a northeast-striking barite vein (Plate 1, no. 12; Carter coordinate section 6-V-64; Millersburg Quadrangle, Cuppels and Outerbridge, 1974) 1,000 feet in length in the Tanglewood Limestone Member. This vein was not observed in the field during this investigation.

Silas Creek Vein—One-half mile northeast of the Lail Veins (Plate 1, no. 13; Carter coordinate section 15-V-63; Shawhan Quadrangle, Cuppels, 1973), although not shown on the geologic quadrangle map, abundant barite float occurs along Silas Creek in the Tanglewood Limestone Member. The zone is 4 feet wide and the length is unknown. Cuppels (1973) reported some barite boulders on the Harrison County side of Silas Creek adjacent to this vein.

Boyle County

Baughman Vein—This vein (Plate 1, no. 14; Robinson, 1931, no. 18) is not located on the geologic quadrangle map but is probably located on the Danville Quadrangle (Cressman, 1972). The vein is reportedly 2 feet wide, trends N 30° E, and contains barite, fluorite, and 12 to 16 percent strontium sulfate (Fohs, 1913, p. 490).

Figure 4. Barite and calcite veinlets, part of Paris and Marsh Veins north of Paris, Bourbon County.

Faulconer Vein—This vein (Plate 1, no. 15; Robinson, 1931, no. 13; Carter coordinate section 13-O-57; Danville Quadrangle, Cressman, 1972) is located on the Mercer-Boyle county line, but parts of it are no longer exposed and are not mapped on the geologic quadrangle map. A north-trending trench was opened in the Preachersville and Brannon Members of the Lexington Limestone, and barite, fluorite, and calcite are present on the dumps. The trench is 4 to 5 feet wide, 3 to 5 feet deep, and 400 feet long. This is a southern extension of the Faulconer Vein in Mercer County, which has been traced for several miles along a northwestern trend. Fohs (1913, p. 490-491), who referred to this as the Faulconer Shaft, reported the vein is 2 feet wide and crosses the Southern Railroad in Mercer County.

Gunn Vein—This vein (Plate 1, no. 16; Robinson, 1931, no. 19) is reportedly located 2 1/2 miles northwest of Danville and should be located in the Bryantsville Quadrangle (Wolcott and Cressman, 1971). The vein varies from 6 inches to 4 feet wide, contains barite with a little fluorspar, and is traceable for 1 1/2 miles (Robinson, 1931, p. 99).

Hayden Vein—Portions of this vein are not mapped, but 2 miles north of Junction City along the Southern Railroad a northeast-trending barite vein (Plate 1, no. 17; Robinson, 1931, no. 15; Carter coordinate section 13-N-57; Junction City Quadrangle, Harris, 1972) occurs along the Brumfield Fault. The vein occurs in the Tanglewood and contains barite, calcite, sphalerite, and some limestone brecciation. A 27-foot-wide mineralized zone of veinlets extends along a creek bed and includes a 1- to 3-foot-wide vein of barite and calcite (Fig. 6). Fohs (1913, p. 468-469) stated that the vein "consists of two to three bands of ore," ranging in width from 6 to 36 inches; "the bands have a total width of 4 to 6 feet. . . . The entire width of the zone is from 8 to 14 feet." MacFarlan (1943, p. 390) also reported that this vein is 8 to 14 feet wide. Several hundred feet to the west, a 500-foot-long trench has revealed barite and sphalerite, but current industrial construction and de-

Figure 5. Barite, sphalerite, and galena mineralization on the Marsh Veins, Bourbon County.

velopment have covered the trench and obscured traces of this vein. Fohs (1913, p. 469) stated that a considerable tonnage was mined by an open cut by the Kentucky Barytes Company, and that the vein can be traced northeastward to the Stanford Pike.

Hubble Vein—This vein (Plate 1, no. 18; Robinson, 1931, no. 29) is not shown on the geologic quadrangle map but should be located on the Stanford Quadrangle (Shawe and Wigley, 1974). The vein is 2 feet wide, strikes N 55° W, and contains barite, fluorite, calcite, and limestone breccia (Fohs, 1913, p. 494).

Sandidge Vein—Parts of this vein are not exposed and are not mapped on the geologic quadrangle map, but the vein (Plate 1, no. 19; Robinson, 1931, no. 17; Carter coordinate section 8-N-58; Bryantsville Quadrangle, Wolcott and Cressman, 1971) is exposed 4 miles northeast of Danville on Clarks Run Creek and strikes N 30° E along the Sandidge Vein System. The vein has been worked by a 5-foot-wide, 700-foot-long trench, and showed abundant barite and some fluorite on the dumps. The host rocks are the Grier-Curdsville Limestone Members of the Lexington Limestone. Fohs (1913, p. 468 and 494) reported that the veins ranged from 1 foot to 18 feet wide, averaged 92 percent barite, and locally contained some breccia and fluorite deposits. According to Fohs' descriptions, several parallel veins occur 1/2 mile east of this main vein. This vein system was supposedly traceable for several miles, but subsequent urbanization and farm improvement have destroyed most surface traces of the veins.

Walker Vein (Caldwell Stone Company quarry)—This vein (Plate 1, no. 20; Robinson, 1931, no. 16; Carter coordinate section 15-N-58; Bryantsville Quadrangle, Wolcott and Cressman, 1971, Stanford Quadrangle, Shawe and Wigley, 1974) is mapped as a fault on the geologic quadrangle map and was observed in the Caldwell Stone Company quarry 2 miles southeast of Danville. An east-trending brecciated fault zone contains barite, fluorite, calcite, and sphalerite in a zone of fissures 200 feet wide and 2,000 feet long (Fig. 7). The main vein pinches and swells along strike from several inches to 5 to 6 feet wide in an open cavern on the westernmost end of the quarry (Fig. 8). Cubes of fluorite, scalenohedrons of calcite, and rosettes of barite are common in this cavernous opening. Apart from normal limestone quarrying operations, the vein is not being mined for its mineral content; however, it has been a source of mineral specimens for local rock collectors. The vein occurs in the

Figure 6. Hayden barite and calcite vein, Boyle County. At this locality the vein material is more resistant to erosion than the surrounding rocks.

Tanglewood and Grier-Curdsville Limestone Members of the Lexington Limestone.

Walker West Vein—On Kentucky Highway 52, 3 miles east of Danville, a 200-foot-long, northeast-trending vein (Plate 1, no. 21; Carter coordinate section 14-N-58; Bryantsville Quadrangle, Wolcott and Cressman, 1971) of barite, calcite, and fluorite occurs in the Tanglewood limestone. This vein appears to be located along a fracture between two faults.

Clark County

Doctor Cole Prospect—This prospect (Plate 1, no. 22; Robinson, 1931, no. 30; Carter coordinate section 22-R-64; Winchester Quadrangle, Black, 1974) is located 5 miles south of Winchester and 1/2 mile south of the central part of the quadrangle on Stoner Branch Creek. Two outcrops of barite occur in the Tanglewood Limestone Member along Stoner Branch Creek, and 1-foot-diameter boulders of barite have been observed on the hillsides along the creek. Some calcite-barite veins in brecciated limestone matrix were also observed. Black (1974) reported these veins to be 3 feet wide.

Dry Fork Vein—Two miles southwest of Ruckerville a northwest-trending barite vein (Plate 1, no. 23; Carter coordinate section 3-Q-65; Hedges Quadrangle, Black, 1975) is associated with the northwestern terminus of a northwest-trending graben-type fault system in the Millersburg and Tanglewood Limestone Members. Black (1975) reported the vein is 300 feet long and is composed chiefly of barite.

Hampton Vein—This vein (Plate 1, no. 24; Robinson, 1931, no. 32; Winchester Quadrangle, Black, 1974) was not mapped on the geologic quadrangle map but is located 2 miles south of Flanigan, is 3 feet wide, and is composed of barite (Robinson, 1931).

Jones Nursery Road Veins—A series of post-mineralization en echelon faults strike N 60° E in the Tanglewood Limestone Member and offsets a N 20 to 30° E-trending barite-fluorite-calcite vein (Plate 1, no. 25; Carter coordinate sections 13-, 14-, and 17-R-63; Ford Quadrangle, Black, 1968). The vein is 9 feet wide on the surface; however, W. W. Weigel (1979, personal commun.) stated that several feet below the surface the vein is 12 feet wide. The longest exposed segment of this offset vein is 250 feet. If the offset segments were recon-

Figure 7. Breccated limestone fragments in the Walker barite vein, Caldwell Stone Company quarry, Boyle County.

nected the total length of the vein would be approximately 750 feet. Black (1968) indicated that the N 60° E-trending fault has a total right lateral movement of at least 3,000 feet. The southwesternmost vein occurs in the Grier-Curdsville Members of the Lexington Limestone. Barite float also occurs 1/2 mile northeast of the vein associated with the Tanglewood Limestone Member.

Rice Vein—This vein (Plate 1, no. 26; Carter coordinate section 14-R-63; Ford Quadrangle, Black, 1968) is located along Boone Creek on the Clark-Fayette county line approximately 1/2 mile west of the en echelon fault on Jones Nursery Road. The vein, traced by barite fragments, is 2,800 feet long, 1 to 2 feet wide, trends northeast, and is intermittently exposed in the Grier and Curdsville. Mineralization includes banded barite, fluorite, and calcite, and abundant limestone breccia.

Smitha-Dugan Vein—This vein (Plate 1, no. 27; Robinson, 1931, nos. 35, 60; Carter coordinate section 16-R-63; Ford Quadrangle, Black, 1968) is located 3/4 mile northeast of Blue Grass Christian Camp on Boone Creek on the Clark-Fayette county line. It has a length of 2,400 feet, is 32 to 50 inches wide, strikes N 35° E into Clark County, and is associated with a fault zone in the Grier and Curdsville. Miller (1905a) mapped the Smitha Vein as a north-trending vein several thousand feet long on the Fayette County side of Boone Creek, but in Clark County the vein was mapped along a northeastern strike by Black (1968) and is traceable by a 110-foot shaft, two caved adits, sinkholes, and barite fragments. An inclined adit 5 feet wide, 5 feet high, and 115 feet long was sunk on a 5- to 6-foot-wide vein (Fohs, 1913, p. 475). The dump was 35 feet long, 10 to 20 feet wide, and 5 feet high and contained barite, fluorite, calcite, and sphalerite. Fohs (1913, p. 475) stated that a small shipment of fluorspar was made from the mine. A second caved adit lies on the Fayette County side of Boone Creek. The Dugan Vein "parallels the Smitha fault" (Fohs, 1913, p. 495) and is probably the fork in the northeastern extension of the Smitha Vein.

A 1-foot-wide and 200-foot-long fluorite-barite vein is exposed in an unnamed creek bed southwest of the Smitha Vein. The vein trends north-northeast in the Grier-Curdsville Limestone Members.

Stevenson Vein—This vein (Plate 1, no. 28; Robinson, 1931, no. 34; Carter coordinate sections 12- and 13-R-63; Ford Quadrangle, Black, 1968) is located 1/2 mile southwest of Becknerville on Jones Nursery Road. This vein trends approximately N 25° E, extends approx-

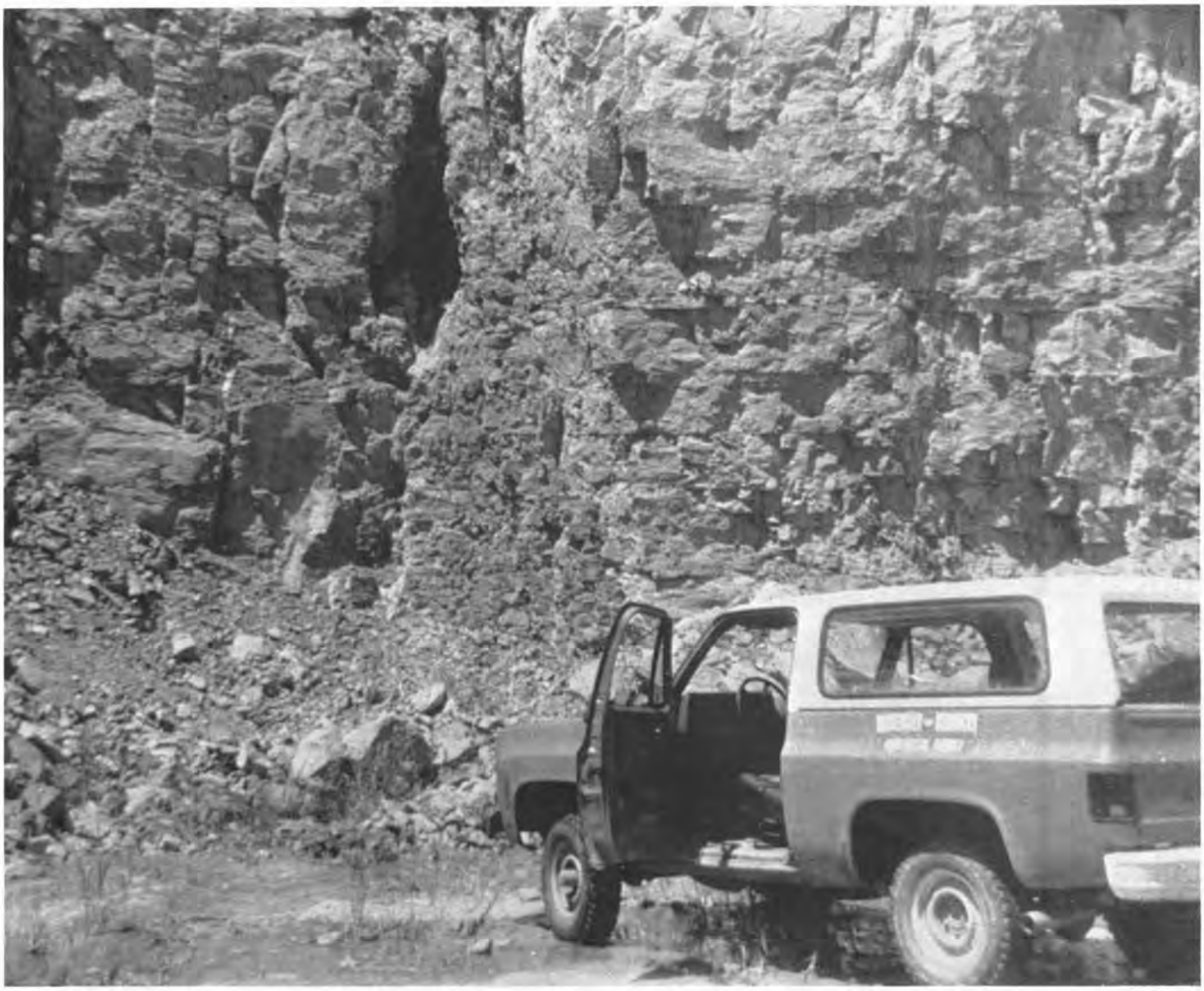


Figure 8. A cavern along a fault on the Walker Vein, Caldwell Stone Company quarry, Boyle County, exposes barite, fluorite, and calcite.

imately 2,500 feet, is 2 feet wide, and occurs in the Grier-Curdsville Limestone, Brannon, and Tanglewood Limestone Members of the Lexington Limestone. The vein includes a brecciated limestone matrix, barite, and fluorite. Fohs (1913, p. 472) reported that the vein is 36 inches wide and that zinc blende (sphalerite) is present. Barite, fluorite, and calcite fragments were observed in the southern extension of this vein.

Thomas-Stevenson Vein—This vein (Plate 1, no. 29; Robinson, 1931, no. 31; Winchester Quadrangle, Black, 1974) was not mapped on the geologic quadrangle map, but is reportedly located 2 miles south of Flanigan on the Louisville and Nashville Railroad and is 6 to 26 inches wide, trends N 40° E, and is composed of barite, fluorite, calcite, and galena (Fohs, 1913, p. 495).

Waterworks Road Vein—One-half mile north of Waterworks Cemetery, Black (1968) mapped a 300-foot-long barite vein (Plate 1, no. 30; Carter coordinate section 9-R-63; Ford Quadrangle, Black, 1968), but it is not currently visible because of a farm pond inundation.

Fayette County

Fohs (1913) and Robinson (1931) discussed 35 and 34 veins, respectively, in Fayette County. The present investigation examined several of these veins. The remainder have been obscured by farm improvement and urbanization. Sellier (1913) mapped several veins, and they are indicated as reported occurrences on the map (Plate 1).

Boggs Fork Creek Veins—These veins (Plate 1, no. 31; Carter coordinate sections 19- and 22-R-62; Ford Quadrangle, Black, 1968) are located 1 1/2 miles south-southeast of Athens. There, the presence of two trenches suggests two northeast-trending veins in the Grier-Curdsville limestones. The first trench, 1,000 feet east of Cleveland Road, is 3 feet wide, 150 feet long, and contains barite with some fluorite. The second trench is 800 feet long, trends northeast, and contains barite, fluorite, and calcite. These trenches are now used as trash dumps. A third vein, which was mapped by Black (1968), was not located, but some 1/4- to 2-inch-wide calcite veinlets were observed near Boggs Fork Creek. Judging by the dump's appearance, the veins were worked in the 1940's, although no data are available.

Bosworth Vein—This vein (Plate 1, no. 32; Robinson, 1931, no. 40; Lexington West Quadrangle, Miller, 1967) was not mapped on the geologic quadrangle map, but is located by Sellier (1913) near Bosworth Lane on Manchester Branch Creek and contains barite and galena (Robinson, 1931, p. 101).

Blue Grass Christian Camp Vein—A northeast-trending barite vein (Plate 1, no. 33; Carter coordinate sections 20- and 21-R-62; Ford Quadrangle, Black, 1968) is located near Boone Creek west of the Blue Grass Christian Camp. Barite fragments can be traced intermittently on the Grier-Curdsville Limestone Members of the Lexington Limestone. The vein is 1,000 feet long and contains barite and fluorite, but no workings were observed.

Central Rock Company Quarry Vein—Although not exposed on the surface, several north-trending barite veins (Plate 1, no. 34; Carter coordinate section 9-S-60; Lexington West Quadrangle, Miller, 1967) occur in an underground limestone mine in Lexington, Kentucky. The veins are located in the Oregon Formation and Tyrone Limestone and contain barite, sphalerite, calcite, and fluorite (G. R. Dever, Jr., personal commun., 1980). The veins are reportedly discontinuous, 0 to 10 inches wide, and have been traced for approximately 2,000 feet along strike.

Chilesburg Railroad Vein—This vein (Plate 1, no. 35; Carter coordinate section 21-S-62; Clinton Quadrangle, MacQuown, 1968a) is located approximately 1 mile east of Chilesburg on the Chesapeake and Ohio Railroad. Neither vein nor barite float were observed, but according to the geologic quadrangle map, the vein is 1,000 feet long in the lower Tanglewood Limestone and Brannon Members of the Lexington Limestone.

Cole and Russell Cave Veins—These veins (Plate 1, no. 36; Robinson, 1931, nos. 53, 54, respectively; Carter coordinate sections S- and T-61; Centerville Quadrangle, Kanizay and Cressman, 1967, and Lexington East Quadrangle, MacQuown and Dobrovolny, 1968) are multiple exposures along the same vein. The veins are intermittently exposed in the Grier and Tanglewood and were traced N 10° W by sinkholes and barite fragments for a distance of 5 miles from the Lexington Fault System (West Hickman Fault Zone) to Lemons Mill Pike (Fohs, 1913, p. 473). Fohs also reported a "width of 1 to 4 feet" for the Cole Vein and that it "is chiefly barytes with which either zinc blende or galena is locally associated." Robinson (1931, p. 103) stated that the Russell Cave Vein was located near Russell Cave and was developed by a 200-foot shaft. Miller (1913, p. 340) described an unnamed vein as being from 2 to 7 feet wide, and containing barite, calcite, galena, and sphalerite, which were developed by a 355-foot shaft. Although Miller's description of the location is ambiguous, these workings could have been on the Cole Vein. Additional veins reported by Fohs (1907), Miller (1913), and Robinson (1931) are no longer exposed. Kanizay and Cressman (1967) mapped a 1,500-foot-long, north-trending barite vein in the Tanglewood about 2 miles northeast of the Cole Vein which might have been the Inness or Pritchett Vein of Fohs (1913, p. 500).

Craig Vein—This vein (Plate 1, no. 37; Robinson, 1931, no. 49; Carter coordinate section 13-T-61; Lexington East Quadrangle, MacQuown and Dobrovolny, 1968) is located north of Ironworks Pike 3/4 mile west of Russell Cave Road. Barite and calcite were observed during this investigation along a N 4° W fault zone. Fohs (1913, p. 473) reported galena and sphalerite in a vein which ranged from 15 to 54 inches wide.

Crenshaw Vein—This vein (Plate 1, no. 38; Robinson, 1931, no. 42; Carter coordinate sections 14- and 17-T-60; Lexington West Quadrangle, Miller, 1967) is located between Leestown and Spurr Roads, 1,500 feet east of the Federal Correctional Institute. Sellier (1913) mapped this vein as trending northwest, whereas Miller (1967) mapped a 3,700-foot-long barite vein; the southern third of the vein trends northeast and the northern two-thirds trends northward, both occurring in the Grier and Tanglewood Limestone Members. The vein is 20 inches wide and contains barite, galena, and sphalerite (Robinson, 1931, p. 102). Fohs (1913, p. 497) reported an additional unnamed barite vein 300 yards east of the Crenshaw Vein.

Dolan Vein—This vein (Plate 1, no. 39; Robinson, 1931, no. 41; Carter coordinate section 9-T-59; Georgetown Quadrangle, Cressman, 1967) is located on the Scott-Fayette county line and is mapped as 500 feet long. No barite was observed in this investigation; however, local residents donated a barite sample with 1/2-inch galena cubes which had reportedly come from this vicinity. Robinson (1931, p. 102) reported the barite vein is 4 inches wide, strikes N 10° W, and contains barite and sphalerite.

Downing and Pettit Vein—This vein (Plate 1, no. 40; Robinson, 1931, nos. 45, 44; Carter coordinate section 11-T-60; Lexington West Quadrangle, Miller, 1967) is intermittently exposed on the University of Kentucky

Agricultural Experiment Station farm off Georgetown Road on Cave Run Creek. The vein trends N 30° E and contains barite. Sellier (1913) mapped two barite veins, the Pettit Vein (Robinson, 1931, p. 102), which is 2 feet wide, trends N 20° W, and contains barite, calcite, galena, and sphalerite, and an unnamed barite vein, 1 mile west of the Downing Vein. Fohs (1913, p. 498) wrote, "Shallow open cuts opened on the G. N. Pettit land and barytes [were] shipped."

Erdman Veins—One vein of a series of parallel veins (Plate 1, no. 41; Robinson, 1931, no. 38; Lexington East Quadrangle, MacQuown and Dobrovolny, 1968) was mapped 2 miles north of Lexington. The vein trends northeast and contains barite, sphalerite, and some limestone breccia (Robinson, 1931, p. 101). Fohs (1913, p. 499) reported that one of the veins, which contained barite and sphalerite, was mined by an open cut and some ore shipments were made.

Goff Vein—This vein (Plate 1, no. 42; Robinson, 1931, no. 63; Coletown Quadrangle, Black, 1967) was not mapped, but is reportedly located 3 1/2 miles southeast of Athens on Raven Run Creek. Robinson (1931, p. 105) reported the vein is 20 inches wide, strikes N 10° E, and contains fluorite, barite, and calcite.

S. Haggins Vein—This vein (Plate 1, no. 43; Robinson, 1931, no. 43; Georgetown Quadrangle, Cressman, 1967) was not mapped in the geologic quadrangle map, but is reportedly located 1 1/2 miles west of Donerail, 1 mile west of the Georgetown Pike, strikes N 15° W, and is composed of barite (Robinson, 1931, p. 102).

Interstate 75 Veins—Four N 35° E-trending mineral veins (Plate 1, no. 44; Carter coordinate section 18-R-62; Ford and Coletown Quadrangles, Black, 1968, 1967) occur in the Grier, Curdsville, and Tanglewood Limestone Members along Interstate Highway 75, approximately 10 miles south of Lexington. The veins range from 250 to 900 feet in length and 6 inches to 1 foot in width. Mineralization in the southernmost vein is calcite, fluorite, and sphalerite. The intermediate vein is 6 inches wide by 500 feet long, and contains barite, fluorite, and calcite. The northernmost veins are 1/2-inch-wide, calcite-bearing fissures.

McChord and McChord Schoolhouse Veins—These veins (Plate 1, no. 45; Robinson, 1931, nos. 61, 65; Carter coordinate sections 23- and 24-R-63; Coletown Quadrangle, Black, 1967) are located southeast of the intersection of the Old Richmond Road and Evans Mill Road on Elk Lick Creek south of Athens, where a local resident showed W. H. Anderson the former location of the McChord (McCord) School. Fohs (1913, p. 502) referenced several veins from the old McChord School, and Jolly and Heyl (1964) referred to these veins in the easternmost zone (zone 1) of mineralization. Fohs (1913, p. 461) stated, "The McChord vein (Fayette County) exposed for almost the full section of the Lexington Limestone and partly also in the Tyrone Limestone, shows barytes in excess of the former and fluorspar in excess where the vein cuts the Tyrone Limestone. . . ." Black (1967) mapped the lower Lexington Limestone at this locality but did not map the Tyrone Limestone, although the Tyrone Limestone is exposed along Elk Lick Creek about 1 mile south of this locality. Four veins are exposed along Elk Lick Creek in the Grier-Curdsville and Tanglewood Limestone Members of the Lexington Limestone. These veins are 400 to 500 feet long, 2 to 3 feet wide, consist of barite, fluorite, and calcite, and are considered to be a part of the McChord Veins. All veins trend northeast except the westernmost vein, which trends east. No evidence of mining activity was observed during this investigation.

Moore Vein—This vein (Plate 1, no. 46; Robinson, 1931, no. 52; Centerville Quadrangle, Kanizay and Cressman, 1967) was not mapped on the geologic quadrangle map, but is parallel to the northern segment of the Cole Vein. Fohs (1913, p. 499) reported that the vein is 3 feet wide, strikes N 5° W, and contains barite and galena.

Mortons Mill Vein—This vein (Plate 1, no. 47; Robinson, 1931, no. 59; Carter coordinate section 20-R-62; Ford Quadrangle, Black, 1968) is located near Boone Creek, is 500 feet long, trends northward, and contains barite and fluorite. Robinson (1931, p. 104) reported the vein is 32 to 50 inches wide, trends N 76° W, and contains calcite and sphalerite.

Peter Vein—This vein (Plate 1, no. 48; Robinson, 1931, no. 47; Georgetown Quadrangle, Cressman, 1967, and Centerville Quadrangle, Kanizay and Cressman, 1967) according to Robinson (1931, p. 102), is located 8 miles northeast of Lexington between Newtown and Mt. Horeb Pikes. The vein is 1 to 3 feet wide and contains barite, calcite, and sphalerite.

Potters Field (Stoll) Vein—Although this vein (Plate 1, no. 49; Robinson, 1931, no. 37; Lexington East Quadrangle, MacQuown and Dobrovolny, 1968) is not mapped on the geologic quadrangle map, Miller (1905a) mapped it just east of Lexington in what is now one of the older industrial areas in Lexington. The vein has been obscured and is no longer exposed, but Fohs (1913, p. 497) reported that the vein is 2 to 5 feet wide, contains barite, calcite, sphalerite, and limestone breccia, and that some barite was shipped from an open cut.

Smitha-Dugan Vein—This vein (Plate 1, no. 27; Robinson, 1931, nos. 35, 60; Ford Quadrangle) is described under Clark County.

Ware Vein—This vein (Plate 1, no. 50; Robinson, 1931, no. 46; Lexington East Quadrangle, MacQuown and Dobrovolny, 1968) reportedly contains barite and trends N 12° W (Robinson, 1931, p. 102), but no vein or barite were observed in this investigation.

Yarington Vein—This vein (Plate 1, no. 51; Robinson, 1931, no. 51; Centerville Quadrangle, Kanizay and Cressman, 1967, and Lexington East Quadrangle, MacQuown and Dobrovolny, 1967) has been traced for a distance of 4 miles from the Lexington Fault System (West Hickman Fault Zone) to Ironworks Pike. The vein strikes N 10° W and contains barite, galena, and sphalerite (Robinson, 1931, p. 103). Several occurrences of barite on the Yarington Vein are shown on both of the geologic quadrangle maps.

Yawl Vein—This vein (Plate 1, no. 52; Carter coordinate section 22-S-60; Nicholasville Quadrangle, MacQuown, 1968b) is exposed in a roadcut at the intersection of Nicholasville Road and New Circle Road. The vein is steeply dipping, pinches and swells from 2 to 15 inches wide, and contains barite, calcite, fluorite, and sphalerite. The vein strikes N 10° W, and occurs in the Tanglewood Limestone Member. A parallel zone of barite, calcite, and dolomite veinlets extends 50 feet to the east of the main vein.

Franklin County

Abandoned adit on Camp Pleasant Branch—This occurrence is not recorded on the geologic quadrangle map, but a north-trending vein (Plate 1, no. 53; Carter coordinate section 3-V-57; Switzer Quadrangle, Moore, 1975) occurs in the Tanglewood limestone on Camp Pleasant Branch, 1/2 mile east of Camp Pleasant Church. The vein was worked by an adit whose exposed dimensions are 5 to 6 feet wide by 50 to 60 feet long by 15 feet deep; the adit dump contains barite and galena. This adit, now caved, is located within a mile west of the reported Camp Pleasant Branch lead mine.

Camp Pleasant Branch Lead Mine—This lead mine (Plate 1, no. 54; Robinson, 1931, no. 73; Carter coordinate section 2-V-57; Switzer Quadrangle, Moore, 1975) is mapped 2 1/2 miles east of the Federal fish hatchery and 4 miles northwest of Kissinger, in the Clays Ferry formation. Although the mine could not be located in the field, Fohs (1913, p. 503) stated that the vein trends northeast, has a maximum width of 4 feet, and contains barite, galena, and sphalerite. Fohs (1913) also stated that a 200-foot shaft, which encountered salt water at 140 feet, was sunk on the property.

Clark Vein—This vein (Plate 1, no. 110; Robinson, 1931, no. 71; Carter coordinate section 16-V-58; Stamping Ground Quadrangle, Moore, 1977d) is described under Scott County.

Jones Vein—Although not mapped on the geologic quadrangle map, Miller (1905a) mapped this vein (Plate 1, no. 55 Robinson, 1931, no. 70; Frankfort East Quadrangle, Pomeroy, 1968) about 1 1/4 miles south of Switzer, and Fohs (1913) reported the vein strikes N 7° W, and contains barite and galena.

Switzer Prospect Pits—Two prospect pits (Plate 1, no. 56; Carter coordinate sections 21-, 22-V-57) are mapped on the Switzer Quadrangle (Moore, 1975) near the town of Switzer on North Elkhorn Creek. These were lead prospects, presumably in a barite vein, but most of the veins are no longer visible. No barite was found in these prospect pits.

Wait Vein—This vein (Plate 1, no. 57; Robinson, 1931, no. 72; Polsgrove Quadrangle, Moore, 1977c) was mapped by Jillson (1940) on Flat Creek 1 mile west of the Kentucky River, although it is not shown on the geologic quadrangle map. Miller (1914, p. 50) described it as "zinc and lead ore, from a vein on Flat Creek, Franklin County, Kentucky. . . ." Robinson (1931, p. 106) stated that the vein is 6 to 36 inches wide and contains barite.

Garrard County

John Burdette (Boone Creek) Vein—This vein (Plate 1, no. 58; Robinson, 1931, no. 76; Carter coordinate sections 4- and 7-N-59; Bryantsville Quadrangle, Wolcott and Cressman, 1971) is located 3/4 mile west of Pleasant Valley Church along the Kentucky River Fault Zone.

A northeast-trending barite vein crosses Boone Creek and is associated with the easternmost normal fault of the Kentucky River Fault Zone. Fohs (1913, p. 477) stated that the vein width varies from 6 to 48 inches and was worked by an open cut and a 42-foot shaft. Earl (1959) reported a maximum vein width of 6 feet and that samples from an abandoned stockpile were assayed and contained 65 percent barite, 15 percent fluorite, and 10 percent zinc. The vein can be traced northeast 2,000 feet to an exposure in an unnamed creek bed. Mineralization includes barite, calcite, fluorite, and sphalerite, with some of the limestone being replaced by barite, fluorite, and calcite. In 1955 the U.S. Bureau of Mines drilled five inclined holes which penetrated the fault zone. Earl (1959) reported a 1-inch vein of barite in drill hole 2 at 143.2 feet (Grier Limestone Member) and a 1- to 2-inch vein of barite in drill hole 5 at 200 feet (lower Perryville or upper Grier Limestone Members). Calcite, sphalerite, and pyrite were also noted in the core descriptions. At the surface, the upthrown side of the fault is the nodular, fossiliferous, calcarenitic Tanglewood limestone, and the downthrown side is interbedded shale and limestone of the Clays Ferry Formation.

Campbell Veins, Kentucky River Fault Zone—Northeast-trending barite veins (Plate 1, no. 59; Robinson, 1931, no. 81; Carter coordinate section 22-P-59; Little Hickman Quadrangle, Wolcott, 1969) occur in a 1/2-mile-wide zone near the Garrard-Jessamine county line, where U.S. Highway 27 crosses the Kentucky River and where the Kentucky River Fault Zone enters Garrard County. Mineralization includes barite and calcite; Fohs (1913) reported "barytes-limestone breccia," and a little sphalerite. Some barite was mined and shipped (Fohs, 1913, p. 504-505). The host rocks are the Camp Nelson Limestone, Oregon Formation, and Tyrone Limestone. According to Wolcott (1969), the vein is 300 feet in length, trends N 25° E, and dips 75° W. The barite in the Camp Nelson is the lowest stratigraphic occurrence of barite exposed in the Central Kentucky Mineral District.

Dunn Vein—This vein (Plate 1, no. 60; Robinson, 1931, no. 79; Carter coordinate section 6-O-59; Bryantsville Quadrangle, Wolcott and Cressman, 1971) is located 1/2 mile northwest of Bryantsville and is associated with the westernmost fault of the Kentucky River Fault Zone. A 500-foot-long, north-trending barite vein occurs in the Grier and Curdsville Limestone Members of the Lexington Limestone.

Fox Vein—This vein (Plate 1, no. 61; Robinson, 1931, no. 86; Bryantsville Quadrangle, Wolcott and Cressman, 1971) was not mapped on the geologic quadrangle map, but Fohs (1913, p. 505) reported that this vein occurs 2 1/2 miles south of Camp Dick Robinson. Fohs (1913) also stated that the vein strikes N 2° W, is from 1 to 4 feet wide, contains barite, fluorite, and sphalerite, and "considerable tonnage" was mined from open cuts. A brecciated Grier-Curdsville cemented with calcite, aragonite, and travertine was observed in the approximate location of the southern tip of this vein on Herrington Lake-Dix River, 1/2 mile south of Chenault Bridge, but no barite was observed.

Hogg Vein—Although not mapped, this vein (Plate 1, no. 62; Robinson, 1931, no. 78; Bryantsville Quadrangle, Wolcott and Cressman, 1971) is reportedly located 1 mile east of Camp Dick Robinson, strikes N 21° W in the Barrett Knob Fault Zone, and contains limestone breccia with barite cement (Robinson, 1931, p. 107).

McKenzie Moss Veins—These parallel veins (Plate 1, no. 75; Robinson, 1931, no. 108) are described under Jessamine County.

Microwave Tower Vein—This vein (Plate 1, no. 63; Carter coordinate section 6-N-59; Bryantsville Quadrangle, Wolcott and Cressman, 1971) is not mapped on the Bryantsville geologic quadrangle map, but was located during this investigation near the Dix River approximately 2,000 feet west of the John Burdette Vein. It was mined in the early 1960's and the barite from this vein and several veins in Lincoln County were taken to a mill on the Dix River (Fig. 9). Since no production figures are available, the estimated production from this vein is approximately 250 tons. The barite vein extends along a N 20° W-trending fracture in the Grier-Curdsville Limestone Members. Although the vein is not exposed, it can be traced for 500 feet by trenches, prospect pits, and barite fragments. An abandoned prospect pit 5 feet wide, 10 feet long, depth unknown, but probably less than 20 feet, is now used as a trash dump. The vein occurs along the westernmost fault of the Kentucky River Fault Zone. The Grier-Curdsville is upthrown, and the Garrard Siltstone is on the downthrown side of the fault. Approximately 1 mile southwest, Fohs (1913, p. 506) reported the Herring Vein, where "considerable shipments were made."

Tuggle Vein—This vein (Plate 1, no. 64; Robinson, 1931, no. 85; Bryantsville Quadrangle, Wolcott and Cressman, 1971) was not mapped but is reportedly located 1 mile east of Fox Vein, 2 1/2 miles south of Camp Dick Robinson, strikes N 2° W, is 24 inches wide, and contains barite (Robinson, 1931, p. 107).

Harrison County

Hoggins Vein—This vein (Plate 1, no. 65; Robinson, 1931, no. 91; Carter coordinate section 3-V-63; Shawhan Quadrangle, Cuppels, 1973) is located near the South Licking River where "there are two veins, one of which strikes N 21° E and the other N 30° W" (Robinson, 1931, p.109). These veins occur in the Tanglewood Limestone Member and are about 1 foot wide; the northeast-trending vein is 500 feet long. A 50-foot-deep shaft was sunk on the vein (Fohs, 1913), but is now filled with water and debris, and the vein is still partly visible at the top of the shaft. The vein consists of barite, galena, sphalerite, and limestone breccia, and Fohs (1913) reported that sphalerite has replaced the limestone breccia. The location of this vein would suggest a strain fracture associated with faulting as discussed by Cuppels (1973). Although not mapped on the geologic quadrangle map, Fohs (1913, p. 506) reported that the Hinkston Vein was 250 yards southwest of the Hoggins Vein and that a 50-foot shaft was sunk.

Lail Vein—On Silas Creek abundant veins (Plate 1, no. 66; Robinson, 1931, No. 89; Carter coordinate section 11-V-62; Shawhan Quadrangle, Cuppels, 1973) containing barite with some galena crop out intermittently along a northeast trend in the Tanglewood. The length of the exposed veins is 300 feet, and width of the veinlets is 1/2 inch to 3 inches in a 25-foot zone containing abundant barite. Cuppels (1973) stated, "The strike, location and distribution of veins and barite float suggest that the veins are along strain fractures related to the fault." The landowner stated that a company wanted to mine the vein around 1920, but no mining was ever initiated.

Silas Creek Barite Occurrence—Barite boulders are mapped (Plate 1, no. 67; Carter coordinate section 6-V-

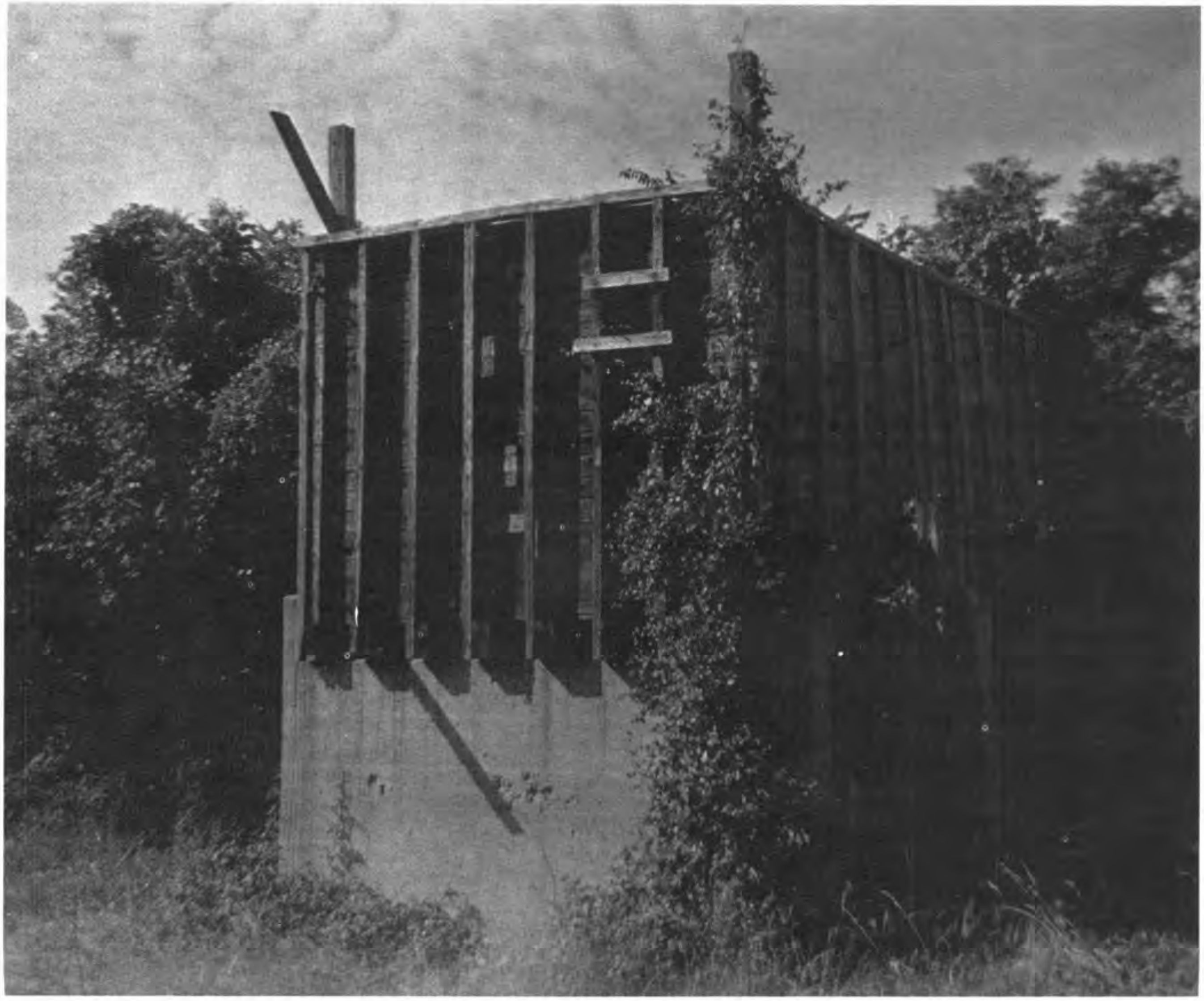


Figure 9. Storage bin at abandoned barite mill on Dix River, Garrard County.

63; Shawhan Quadrangle, Cuppels, 1973) near the confluence of Silas and Townsend Creeks and are associated with the Tanglewood Limestone Member. (See Silas Creek Vein described under Bourbon County.)

Henry County

Drennon Springs and Green Vein—This vein (Plate 1, no. 68; Robinson, 1931, nos. 100, 99; Carter coordinate section 23-Y-54; Worthville Quadrangle, Gibbons, 1975) is not shown on the geologic quadrangle map, but is located 50 feet south of Drennon Creek at Drennon Springs. Fohs (1913, p. 507) and Robinson (1931, p. 100) reported a 2-foot barite vein trending N 15° W at the springs, but the current field investigation observed only alluvium and creek float containing barite and galena on the undifferentiated upper Lexington Limestone. Fohs (1913, p. 10) also reported a southern extension of this vein, which was worked in the early 1800's (Norwood, 1877, p. 24), and is known as the Green Vein. It is located 2 1/2 miles east of Franklin and contains barite and galena. There was no surface evidence that the Drennon Springs Vein has been worked.

James and Montgomery Veins—Although not mapped, these veins (Plate 1, no. 69; Robinson, 1931, nos. 93, 94; Gratz Quadrangle, Moore 1977a) are reportedly located on the south side of Six Mile Creek, 1 mile south of Lockport. They are 3 to 20 inches wide, trend northeast, and contain barite and galena. The James Vein, worked as early as 1866, was developed by a 40-foot shaft (Norwood, 1877, p. 24).

Lockport Vein—A N 5° W-trending, steeply dipping mineral vein (Plate 1, no. 70; Robinson, 1931, no. 95; Carter coordinate section 17-X-55; Gratz Quadrangle, Moore, 1977a) occurs in the Tanglewood just west of Lockport on the Kentucky River. Barite, galena, sphalerite, and calcite are the predominant minerals and are accompanied by some limestone brecciation. The vein is 2,000 feet long and 1 to 2 feet wide. The vein was prospected in 1823-1824, and in 1866 a Wisconsin company attempted to mine it but was unsuccessful (Norwood, 1877, p. 7), probably because they attempted to recover only the lead. Two caved and filled shafts have been sunk on the land, one to a depth of 260 feet (Fohs, 1913, p. 479). Several prospect pits, an open cut, dump, and mill foundation are all that remain. Miller (1905b, p. 33) reported 1,400 tons of barite and galena ore had been mined.

Miller traced the vein across Six Mile Creek (Montgomery Vein (?), Plate 1, no. 68; Robinson, 1931, no. 94) as the southern extension of the Gratz Vein, and theorized that it possibly extended as far as the James Veins (Plate 1, no. 68; Robinson, 1931, no. 93). Robinson also reported that the Lockport Vein has a northeastward extension called the Gratz Vein (Union Mine) in Henry County.

Union Mine (Gratz Vein)—This vein (Plate 1, no. 71; Robinson, 1931, no. 95; Carter coordinate section 7-X-55; Gratz Quadrangle, Moore, 1977) is located 1 mile west of Gratz on Kentucky Highway 389. A north-trending, vertical fissure vein consisting of barite, galena, sphalerite, and calcite is exposed in a trench, 3/4 mile south of the Gratz Mine on the south side of the Kentucky River. The trench is 1,000 feet long, averages 20 feet deep, and is 4 to 5 feet wide in the Lexington Limestone. Fohs (1913, p. 508) reported that the vein was "tested to a depth of 100 feet." Two shafts and an adit were sunk and a lead smelter was in operation in 1875 (Norwood, 1877), but only one shaft was observed at the southern end of the trench during this investigation. Barite is the most abundant mineral along with some galena, fluorite, sphalerite, calcite, malachite, and smithsonite.

White Sulfur Springs Vein—This vein (Plate 1, no. 72; Robinson, 1931, no. 101; Franklinton Quadrangle, Gibbons, 1976) is reportedly located on Drennon Creek, 4 miles south of Drennon Springs, and consists of barite and galena in a zone 4 feet wide (Robinson, 1931, p. 110). It is not mapped on the geologic quadrangle map.

Jessamine County

Ambrose Fault and Horine Vein—One mile south of Ambrose (Sulphur Well) on the Kentucky River Fault Zone, a N 30° E-trending barite vein (Plate 1, no. 73; Robinson, 1931, no. 104; Carter coordinate sections 3- and 4-P-60; Little Hickman Quadrangle, Wolcott, 1969) crops out near Hickman Creek. The vein varies from 4 to 72 inches wide, was worked by a 6- to 8-foot-wide trench that is 800 feet in length. Fohs (1913, p. 479-480) reported that a shaft was sunk on this vein and stated that "the limestone is favorable to shearage and brecciation, the deposition of fluorspar rather than barytes in breccia . . ." and "is a combination of a fissure and breccia deposit." Barite, fluorite, calcite, and sphalerite are the vein minerals. The Camp Nelson Limestone is on the downthrown side, and the Sulfur Well Member of the Lexington Limestone is on the upthrown side of the fault zone. Horizontal slickensides are present along the vein. This vein occurs near the structural apex of the Lexington Dome and 1 mile southeast of the intersection of the West Hickman and Kentucky River Fault Zones. The southern extension of this vein is the Horine Vein, which Miller (1905a) mapped as trending northwest. Robinson (1931) reported that the vein was 25 inches wide and contained barite, calcite, and sphalerite.

Catnip Hill Quarry—This vein (Plate 1, no. 74; Carter coordinate section 24-R-60; Nicholasville Quadrangle, MacQuown, 1968) is not located on the geologic map, but is exposed in the Lexington Quarry Company limestone mine 8 miles south of Lexington on Catnip Hill Pike, west of U.S. Highway 27. In the underground limestone operation a north-trending, steeply dipping mineral vein occurs along a subsurface fault zone in the Oregon Formation and Tyrone Limestone. The vein pinches and swells along strike from several inches to 8 feet wide and has been traced for a length of 4,000 feet. Where the vein pinched northward, an 8- to 10-inch barite vein in the Oregon Formation was observed on the quarry floor. Southward, the vein widens to 8 feet, where it is mineralized with abundant sphalerite. At the time of this investigation a raise was being driven toward the vein and zinc was being mined as a byproduct of the normal limestone quarrying operations.

McKenzie Moss Veins—These parallel veins (Plate 1, no. 75; Robinson, 1931, no. 108; Wilmore Quadrangle, Cressman and Hraber, 1970) are not shown on the geologic quadrangle map but are located in western Jessamine County near Hall, Kentucky, on the Kentucky River. Fohs (1913, p. 510) reported four parallel veins that range from 12 to 25 inches wide, trend northeast, and contain barite, calcite, and some limestone breccia; the veins should be located in the Tyrone Limestone. These veins have been traced northward through Garrard County to the Overstreet Vein in Jessamine County (Fohs, 1913).

Noel Vein—At the Woodford-Jessamine county line near Bethany Chapel and west of the Brooklyn Bridge, a vein (Plate 1, no. 76; Robinson, 1931, no. 112; Carter coordinate sections 13- and 18-Q-58; Wilmore Quadrangle, Cressman and Hraber, 1970) occurs in a light-gray, coarse-grained, bioclastic, fossiliferous calcarenite of the Grier limestone. This vein strikes N 10° W and can be traced intermittently by a trench and dump for 2,200 feet.

The dump is from 5 to 10 feet high, 3 to 10 feet wide, and 2,000 feet long. The trench is about 20 feet deep, 5 to 15 feet wide, and 200 feet long. The dump contains abundant barite, calcite, and fluorite. Fohs (1913, p. 509) stated that the vein is from 0 to 24 inches wide, and enlarges to a zone 36 inches wide; it probably extends south into Mercer County. Since no production data are available, it is estimated from the preceding vein widths that 1,000 tons of barite-fluorite ore was mined.

Overstreet Vein—This vein (Plate 1, no. 77; Robinson, 1931, no. 109; Wilmore Quadrangle, Cressman and Hraber, 1970) is not shown on the geologic quadrangle map, but is reportedly located approximately 1 mile southwest of Bethel Church on Jessamine Creek. Fohs (1913, p. 461, 510) reported that this vein trends northward, is 2 to 4 feet wide, was worked by an open cut, is composed chiefly of barite with some fluorite, and that "barytes may predominate in local shoots in a fluorbarytes vein." The vein reportedly extends northward and can be traced south of the Kentucky River to the McKenzie Moss Veins in Garrard County (Fohs, 1913, p. 510). Some northeast-trending calcite veins were observed trending northeast in the Tanglewood Limestone Member on Overstreet Creek.

Prentiss Vein—This vein (Plate 1, no. 78; Robinson, 1931, no. 110; Carter coordinate section 16-Q-59; Wilmore Quadrangle, Cressman and Hraber, 1970) was not mapped, but is located approximately 1/2 mile southeast of Wilmore. A descendent of the family for which the vein was named located the approximate position of the vein, but farm improvements had removed all surface traces. Fohs (1913, p. 509) stated that this vein strikes N 62° W and is composed of barite.

Trinity Church Vein—Three-quarters of a mile northeast of Trinity Church near the Kentucky River, Greene (1966) mapped a 25-foot-long prospect adit (Plate 1, no. 79; Carter coordinate section P-61; Valley View Quadrangle, Greene, 1966) in the Grier and Curdsville, but the adit could not be found in this investigation. Several small, irregularly trending 1/4- to 1-inch calcite veins were observed in an unnamed creek bed at the approximate location of the adit.

John West Fault Vein—This vein (Plate 1, no. 80; Robinson, 1931, no. 105; Little Hickman Quadrangle, Wolcott, 1969) is not shown on the geologic quadrangle map, but Miller (1905a) mapped it 1 mile east of Ambrose (Sulfur Well). Fohs (1913, p. 512) described it as a 27-foot-wide, northeast-trending, brecciated zone with 50-inch- and 12-inch-wide barite bands containing small quantities of fluorspar and zinc blende (sphalerite).

Miscellaneous occurrences in Lexington Fault System—MacQuown (1968b) stated, "Barite float is common in the southern portion of the fault zone." Fohs (1913, p. 510) reported that the Cecil Vein was traced for 5 miles along a S 5° E trend and contained, barite, fluorite, and limestone breccia. The southern part of this vein probably extends into the vicinity of the fault zone in Jessamine County. There are also some 2- to 3-inch-wide barite veins near Camp Nelson adjacent to U.S. Highway 27 where it crosses the Kentucky River, as described under the Campbell Veins in Garrard County.

Lincoln County

Brassfield Dolomite Occurrence—This occurrence (Plate 1, no. 81; Carter coordinate section 7-L-60; Crab Orchard Quadrangle, Gualtieri, 1967) is located on U. S. Highway 150 at Cedar Creek. Barite occurs irregularly in the lower Silurian Brassfield Dolomite in nodular to lenticular, vuggy bodies, accompanied by dolomite and calcite; sometimes it is associated with fault zones in Lincoln and Garrard Counties.

Givens Vein—This vein (Plate 1, no. 82; Robinson, 1931, no. 129; Carter coordinate section 15-N-59; Stanford Quadrangle, Shaw and Wigley, 1974) is located on the Dix River in the northeastern corner of the quadrangle. Although Robinson did not give a description for no. 129, his map location indicates the Givens Vein, and he described the Givens Vein under the Engleman Vein (Robinson, 1931, no. 128). The Givens Barite Vein is 2,000 feet long and occurs along a N 10° E-trending fault zone where the Tyrone Limestone is upthrown and the Garrard Siltstone and Clays Ferry Formation are downthrown. The dumps of several prospect pits and open cuts contain abundant barite. Fohs (1913, p. 477-478) reported that "the deposit . . . [has] . . . a width of up to 7 feet or more . . . [and is] . . . prospected by open cut and by a shaft 50 feet deep. . . . The bottom of the shaft showed a width of 60 inches of solid barytes and 72 inches [of] additional barytes limestone breccia." Farm improvement has obscured most of the vein traces. The Engleman Fault Vein is southwest of the Givens Vein (see Kentucky 590 Vein, Plate 1, no. 84).

Hanging Fork Creek Vein—This barite vein (Plate 1, no. 83; Carter coordinate section 20-N-58; Stanford Quadrangle, Shawe and Wigley, 1974) is located 1 1/4 miles west-northwest of Hubble where a mineralized fault zone is exposed in a 1,000-foot-long trench on a ridge above Hanging Fork Creek. The trench strikes northward, is 3 to 4 feet wide, and contains abundant barite fragments. The host rocks are the Sulfur Well, Tanglewood Limestone, and Brannon Members (undifferentiated) of the Lexington Limestone.

Barite from these mines in Lincoln County and southwestern Garrard County was taken to a mill on the Dix River (Fig. 9). This mining activity during the 1960's was the latest barite production in central Kentucky. No production figures are available.

Kentucky 590 Vein (Engleman Fault Vein)—This barite vein (Plate 1, no. 84; Robinson, 1931, no. 128; Carter coordinate section 20-N-58; Stanford Quadrangle, Shaw and Wigley, 1974) occurs in a fault zone 1 mile northwest of Hubble, Kentucky. This normal fault has the Grier and Curdsville upthrown; the Clays Ferry Formation, Sulfur Well-Brannon, Perryville Limestone, and Tanglewood Limestone Members of the Lexington Limestone are downthrown. Barite float (Fig. 10) can be traced for 500 feet, and the east-trending vein varies from 5 to 12 feet in width. The landowner stated that 6 feet of barite were encountered at a depth of 30 feet in a water well near the house.

Swinebroad, White, and Kenton Veins—These veins (Plate 1, no. 85; Robinson, 1931, nos. 123, 124, 125, respectively; Stanford Quadrangle, Shawe and Wigley, 1974) are not mapped on the geologic quadrangle map; all are reportedly located approximately 5 miles southeast of Danville and 1/2 mile west of the Old Lancaster Pike. The veins trend northeast and contain barite with some fluorite and calcite (Robinson, 1931, p. 113).

Madison County

Boonesboro Quarry Veins—These veins (Plate 1, no. 86; Carter coordinate section 2-Q-63; Ford Quadrangle, Black, 1968) are located in the Boonesboro Quarry underground limestone mine on the Madison-Clark county line at Boonesboro on the Kentucky River, where a north-trending barite vein occurs in the Camp Nelson Limestone along the Kentucky River Fault Zone. The main vein is 1 to 2 feet wide and is exposed for 120 feet along strike. Several smaller veins are parallel to the main vein. The total width of this zone of veins is 80 feet. Mineralization consists of barite, calcite, fluorite, and sphalerite. Another fault is exposed at the mine entrance in the quarry. This vein contains calcite and barite in the Oregon Formation and Camp Nelson Limestone. The vein trended east and the gouge zone was 1 foot wide. There was no attempt to mine either of the veins during the period of investigation.

Boonesboro Vein near Kentucky River—One-half mile northwest of Boonesboro, and 1/2 mile north of the Kentucky River Fault Zone, on a steep slope overlooking the Kentucky River, a north-trending barite vein (Plate 1,

Figure 10. Barite float marks the trace of the Kentucky 590 (Engleman) Vein, Lincoln County.

no. 87; Carter coordinate section 2-Q-63; Ford Quadrangle, Black, 1968) occurs in the Camp Nelson Limestone and lower Oregon Formation. The vein pinches and swells to as much as 3 feet in width and can be seen splitting into two veins and reconverging into one. The length of the vein is unknown, but it is exposed vertically for 50 feet along the cliffs on the Kentucky River. Mineralization includes barite, fluorite, calcite, and sphalerite.

Clays Ferry at Interstate 75 Vein—A barite vein (Plate 1, no. 88; Carter coordinate section 10-Q-62; Ford Quadrangle, Black, 1968) occurs adjacent to the Kentucky River at Clays Ferry along the Kentucky River Fault Zone. Black (1968) mapped the vein as 250 feet in length, trending northeast, and containing barite and calcite in the Camp Nelson Limestone.

Clear Creek Fault—One mile south of Doylesville a barite vein (Plate 1, no. 89; Robinson, 1931, no. 133; Union City Quadrangle, Simmons, 1967), although not mapped on the geologic quadrangle map, reportedly occurs along a fault zone on Clear Creek (Robinson, 1931, p. 114).

Hines Creek Vein—This vein (Plate 1, no. 90; Carter coordinate section 12-Q-62; Ford Quadrangle, Black, 1968) is located in the southwestern portion of the Ford Quadrangle on the southernmost fault zone, 1/2 mile east of the Kentucky River. Barite, calcite, and galena occur in the gouge zone of an east-trending fault. The vein occurs in a zone approximately 3 feet wide and can be traced for 200 feet. The Camp Nelson lies on the upthrown side, and the Tyrone Limestone lies on the downthrown side of the fault. A minor fold occurs adjacent to the mineralization.

Reynolds Vein—The vein (Plate 1, no. 91; Robinson, 1931, no. 107; Little Hickman Quadrangle, Wolcott, 1969) trends N 7° W, is 2 feet wide, contains barite, calcite, and fluorite, and is reported (Robinson, 1931, p. 114) to be located 1/2 mile below Hunter Ferry in northwestern Madison County, although it is not shown on the geologic quadrangle map. Fohs (1913, p. 514) reported that this vein extends into Jessamine County.

Y.M.C.A. Occurrence—A barite occurrence (Plate 1, no. 92; Carter coordinate section 23-Q-61) is located in northern Madison County, south of the Kentucky River, and is mapped on the Valley View Quadrangle (Greene, 1966) along the Kentucky River Fault Zone. Barite, calcite, and limestone breccia fragments can be traced vertically for about 300 feet along the fault from the Camp Nelson Limestone to the Grier-Curdsville Limestone Members. Although the horizontal extent of the vein is not known, some calcite veins occur along the fault zone north of the Kentucky River; no barite was observed. The northern side of the fault has been upthrown relative to the southern side.

Mercer County

Chinn Calcite Mine (California, Green Million Veins, and Lone Oak Mine)—A N 10° W-trending, slightly brecciated calcite vein (Plate 1, no. 93; Robinson, 1931, nos. 143, 144; Jolly and Heyl, 1964, no. 147A; Carter coordinate section 21-Q-57; Harrodsburg Quadrangle, Allingham, 1972) occurs in the Camp Nelson Limestone, Oregon Formation, and Tyrone Limestone. This vein is located on Shaker Creek near the Kentucky River in the northeastern section of the quadrangle. Mineralization includes abundant calcite and fluorite and some barite and sphalerite. Fohs (1913, p. 483) stated that 14 depositional sequences were involved in mineralization of the Chinn and northward extension Faircloth Mines in Woodford County, but Jolly and Heyl (1964, p. 610) illustrated that more than 20 depositional sequences occurred. The vein extends along the strike of a fault for 3,500 feet and ranges in width from 1 1/2 to 8 feet (Allingham, 1972). The difference in elevation between highest and lowest surface exposures on the vein is approximately 200 feet. Two shafts and a trench were worked on this vein; one shaft near the north end of the vein was sunk to below river level (Miller, 1905b). A second shaft of unknown depth was observed near the southern end of the vein. Fohs (1913) stated that 200,000 tons of calcite were mined; Breeding (1972) stated that 4 million tons of calcite were mined and several core holes showed that the vein continues into the Knox Dolomite. The mineralization occurs along a slightly brecciated normal fault zone that is inclined 75° west (Allingham, 1972). The vein and workings are still evident, but parts of the open cuts and shafts are used as a trash dump.

Cummins Ferry Road Vein—One mile east of U.S. Highway 127 and 6 1/2 miles northwest of the Faulconer Vein, a 150-foot shaft was sunk on a barite vein (Plate 1, no. 94; Carter coordinate section 15-Q-57; Harrodsburg Quadrangle, Allingham, 1972) in the Tanglewood Limestone Member of the Lexington Limestone. The vein is mapped as 800 feet long and trending northwest. The landowner had a specimen of baseball-size white barite rosettes on clear fluorite which had been taken from the mine. No production figures are available.

Curry Lane Vein—This vein (Plate 1, no. 95; Robinson, 1931, no. 138; Carter coordinate section 7-P-57; Harrodsburg Quadrangle, Allingham, 1972) is located 1 mile north of U.S. Highway 68 at the intersection of Curry, Chinn, and Bonta Lanes, and 2 miles northwest of the Faulconer Vein. This northwest-trending vein occurs in the Tanglewood and could be a northern extension of the Faulconer Vein. The vein is 1,000 feet long and contains barite and some sphalerite (Robinson, 1931).

Faulconer Vein—This vein (Plate 1, no. 96; Robinson, 1931, nos. 139, 140; Carter coordinate sections 18- and 23-P-57; Harrodsburg Quadrangle, Allingham, 1972) is located 2 1/2 miles northeast of Harrodsburg on Handy Road, trends N 10° W, and occurs in the Tanglewood. The vein extends for 4,000 feet and is 1 1/2 to 3 feet wide; the vein is also exposed in northern Boyle County. Mineralization includes barite, fluorite, and some sphalerite.

Gate Vein—One-half mile north of the Gloebbel Dean Fluorite Mine and 1.85 miles northeast of Ebenezer, a northeast-trending vein (Plate 1, no. 97; Carter coordinate section 12-Q-57; Salvisa Quadrangle, Cressman, 1968) occurs in the Grier Limestone Member. The vein is traced for 200 feet by a trench and a caved adit. The dump is 11 feet long, 9 feet wide, and 5 feet high, and contains fragments of banded barite, fluorite, and calcite. A northwest-trending fault is located approximately 100 feet south of this vein.

Gloebbel Dean Mine—An old fluorite mine (Plate 1, no. 98; Jolly and Heyl, 1964, no. 147b; Carter coordinate section 12-Q-57; Salvisa Quadrangle, Cressman, 1968) is located 1.9 miles east of Ebenezer, where a north-trending fissure vein is exposed in an open pit in the Grier Limestone Member. The open pit is 50 feet long, 25 feet deep, 15 feet wide, and contains barite, fluorite, and calcite. Cressman (1968) reported that a shaft has been sunk on a 3-foot-wide vein which was mined for fluorite during World War II, but no production figures are available.

Kentron Mine—This vein (Plate 1, no. 99; Robinson, 1931, no. 142; Carter coordinate section 12-Q-57; Harrodsburg Quadrangle, Allingham, 1972) is located 9 miles northeast of Harrodsburg, 1 1/2 miles northwest of Mundys Landing, in the northeastern section of the quadrangle. The vein is present for 1,800 feet along a north-trending fault in the Grier Limestone Member of the Lexington Limestone. The vein is 1 1/2 feet wide and contains abundant fluorite, calcite, and barite; golf-ball-size barite rosettes occur on clear fluorite. The vein was developed by two vertical shafts. One is filled and the other is 7 feet wide by 9 feet long; depth is unknown. This vein was probably mined for fluorite during World War II along with other mines in this district, but production figures are not available.

Old Dean (James Britton) Mine—A N 15° W-trending fissure vein (Plate 1, no. 100; Jolly and Heyl, 1964, no. 147c; Carter coordinate sections 11- and 12-Q-57; Salvisa Quadrangle, Cressman, 1968) occurs in the Tyrone Limestone, 3/4 mile east of the Gloebbel Dean Fluorite Mine. The Old Dean Mine was developed by a trench 200 feet long, 8 feet wide, and 15 feet deep. Mineralization includes fluorite, barite, and calcite. Cressman (1968) stated that there are several parallel veins; the main vein is 2 to 2 1/2 feet wide. Another exposure of this vein occurs 1,500 feet northward along strike, which could be a northern continuation of the Twin Chimneys Vein. The vein was mined for fluorite in 1920 and during World War II.

Riker Vein—This vein (Plate 1, no. 101; Robinson, 1931, no. 136; Carter coordinate section 25-P-57; Harrodsburg Quadrangle, Allingham, 1972) is located near the southern boundary of the quadrangle within the Harrodsburg city limits. This vein is mapped for 600 feet as a northwest-trending vein along a fault in the Sulfur Well Member. Fohs (1913, p. 517) reported a vein 1 1/2 feet wide that contains fluorite, barite, and calcite.

Thompson Vein—This vein (Plate 1, no. 102; Robinson, 1931, no. 137; Carter coordinate section 10-P-56; Harrodsburg Quadrangle, Allingham, 1972) is located 3/4 mile east of U.S. Highway 127 and 3 miles north of Harrodsburg on Warwick Road. Barite, fluorite, sphalerite, and galena occur in a 1,000-foot, northwest-trending fissure vein in the Sulfur Well Member. This vein was prospected by several shallow pits, but no production is recorded.

Twin Chimney Mine—This vein (Plate 1, no. 103; Jolly and Heyl, 1964, no. 143; Carter coordinate section 11-Q-57; Harrodsburg Quadrangle, Allingham, 1972) is located in the extreme northeastern section of the quadrangle, 1 mile north of the Faircloth Mines on the Kentucky River. It occurs along a northwest-trending fault which had been developed by a 221-foot shaft (Currier, 1923, p. 165) and a 100-foot inclined adit in the Tyrone Limestone. This mine was active during Currier's (1923) investigation. According to Allingham (1972), 11,000 tons of commercial-grade fluorite were produced. The vein can be traced for 2,000 feet and ranges from 1 1/2 to 5 feet wide in the Tyrone Limestone, Oregon Formation, and Camp Nelson Limestone. Mineralization includes irregularly banded barite, purple fluorite, calcite, and sphalerite; wall rock breccia is cemented by vein minerals.

Unity Road Veins—Two veins (Plate 1, no. 104; Carter coordinate sections, 16-, 25-Q-57; Harrodsburg Quadrangle, Allingham, 1972) are located 4 1/2 miles northwest of the Faulconer Vein at the intersection of Mundys Landing-Unity Road; one vein trends northeast for 300 feet in the Tanglewood Limestone, Brannon, and Sulfur Well Members of the Lexington Limestone. Some clear and purple fluorite was the only mineral observed. The second vein is located 1/2 mile northward and consists of calcite in the Tanglewood Limestone and Sulfur Well Members; Fohs (1913) reported the occurrence of barite. The vein is 1,000 feet long and trends north-northwest. Most of the prospect pits are filled.

Owen County

Big Twin Creek Prospects—Norwood (1877), Fohs (1913), Jillson (1931), and Wolford (1932) reported these veins (Plate 1, no. 105; Robinson, 1931, nos. 149, 150; New Liberty Quadrangle, Gibbons and Swadley, 1976) early in the 1900's. The veins, which have been called the Hoosier, Barnett, and Cantor Veins, ranged from 12 to 36 inches wide and contained barite, calcite, galena, and sphalerite. Fohs (1913, p. 519) reported that the veins also contained 19 percent strontium sulfate. Several shafts were sunk to depths of 80 to 130 feet, and Jillson (1931) reported a 200-foot shaft was developed on the Hayden Farm, probably located on the Barnett Vein. Fohs (1913) stated that a mill had been operated by the Twin Creek Mining and Smelting Company. Wolford (1931) and Jillson (1931) mapped these veins on Big Twin Creek; however, these veins are not mapped on the geologic quadrangle map, and no veins or workings were observed during this investigation.

Browns Bottom Fault—This vein (Plate 1, no. 106; Robinson, 1931, no. 154; Carter coordinate sections 13- and 19-X-55; Gratz Quadrangle, Moore, 1977a) is located 1 1/2 miles south of Gratz in Browns Bottom on the east side of the Kentucky River. A fault mapped on the geologic quadrangle map contains barite and numerous calcite-bearing veins 1/2 to 3 inches wide in a zone 10 feet wide. Massive barite and rosettes of barite were observed in the vein along the ledges of the river. The host rocks are medium-gray, medium- to coarsely crystalline, bioclastic calcarenite of Tanglewood and Grier limestones. A local resident reported that barite fragments 1 foot in diameter occurred along the shore of the Kentucky River and that barite could be traced eastward along strike to the termination of the fault.

Browns Bottom Prospect—A barite vein is exposed in a prospect pit (Plate 1, no. 107; Carter coordinate section 12-X-55; Gratz Quadrangle, Moore, 1977a) in Hogthief Hollow (Jillson, 1931) on the east side of Browns Bottom on the Kentucky River. A 25-foot-wide, northwest-trending zone of 1- to 3-inch-wide calcite-, barite-, and galena-bearing veins occurs in the Grier limestone.

Gratz Veins—The Gratz Veins (Plate 1, no. 108; Robinson, 1931, no. 148; Carter coordinate section 4-X-55; Gratz Quadrangle, Moore, 1977a), located 1 1/2 miles northwest of Gratz, have a known history dating back to 1856 and inferences can be made as far back as 1812 (Jillson, 1941). Dr. David Dale Owen (1857, p. 103) briefly described some of the lead ores and their occurrences in Franklin, Owen, and Henry Counties. More recent information came from the U.S. Bureau of Mines investigation by Beck (1949).

The Gratz Veins consist of a north-trending vertical vein which is paralleled by two smaller veins. These veins contain barite, calcite, galena, and sphalerite. The main vein pinches and swells from 2 to 4 1/2 feet wide along strike and can be traced northward to Big Twin Creek and southward through the Union and Lockport Veins in Henry County; total extent is 8 to 10 miles.

Four shafts were sunk on the Gratz Vein, ranging in depth from 60 to 560 feet (Beck, 1949). The deepest, the Ohio Shaft, reportedly cut vein widths as much as 57 inches. Several drifts were run northward in these shafts at different levels. Most of the interest was in lead and zinc; the companies did not attempt to mine the barite or fluorspar. According to Miller (1905), 50 tons of undefined ore per day was being mined in 1904, yielding 5 or 6 tons of galena. Mining apparently ceased between 1913 and 1940. Operations were resumed in the 1940's and the ore was again mined and milled for lead and zinc. Development ceased in the 1940's, when the subsidy on zinc expired, and has not resumed since that time. Four abandoned shafts, a trench, and a tailings pond were observed during the current investigation. Most of the shafts were uncovered and full of water. Dump associated with a 2,100-foot, north-trending, intermittently exposed trench contains barite, calcite, sphalerite, and galena. The old tailings pond is 50 feet long, 50 feet wide, and 4 feet deep and contains impure, lime-rich barite and some scattered sphalerite and pyrite.

In 1948 the U.S. Bureau of Mines drilled four holes on the Gratz Vein. All holes were drilled south of the Ohio Shaft and the Kentucky River in Henry County (Beck, 1949). Almost 3 feet of calcite and barite were observed in the vein in core hole 4 near the base of the Lexington Limestone; traces of barite were reported in core hole 2 about 85 feet below the top of the Tyrone Limestone. Beck (1949, p. 5) stated that the vein dips to the east at the Ohio Shaft in Owen County but dips west in northern Henry County. A local resident who worked at the mine reported that the vein changes from vertical to an inclined dip at the base of the Ohio Shaft.

Sandridge Creek Prospects—These prospects (Plate 1, no. 109; Carter coordinate sections 1-W-56, 21-X-56; Monterey Quadrangle, Moore, 1977b) are located near Sandridge Creek on Bowen Creek. Jillson (1931) mapped these veins, and Wolford (1932, p. 74) described them as "just above the mouth of Bowen Branch" and "about a mile up Bowen Branch" near Monterey. Barite and galena were reported in veins that trend N 22° W. About 3 miles south, several other prospect pits occur along Cedar and Indian Creeks. Jillson (1931) mapped the veins, but no mineralization was observed in the current investigation.

Scott County

Clark (Kissinger) Vein—This vein (Plate 1, no. 110;

Robinson, 1931, no. 71; Carter coordinate section 16-V-58; Stamping Ground Quadrangle, Moore, 1977d) is located on the Scott-Franklin county line in the southwestern section of the quadrangle. This northwest-trending barite vein occurs in the Tanglewood Limestone and Millersburg Members and has been developed by two shafts, 40 and 90 feet deep, and a trench; Miller (1905b, p. 32) reported a milling and smelting plant, presumably a lead smelter, at Kissinger near the Frankfort and Cincinnati Railroad. The vein was traced for 3/4 mile and Miller (1905b) stated that "the Clark vein does not show up thicker than one foot at the surface, but, like the Johnson and other veins, widens out into chambers as followed downward." Fohs (1913, p. 503) stated that the vein ranged from 0 to 36 inches wide and contained barite and large masses of galena and encrustations of strontianite. A filled shaft and prospect pit remain as evidence of previous activity, but production figures are not available.

Coleman Vein—This vein (Plate 1, no. 111; Robinson, 1931, no. 160; Georgetown Quadrangle, Cressman, 1967) is not mapped on the geologic quadrangle map but is reportedly located 1 1/2 miles northwest of Donerail, strikes N 2° W, and contains barite and galena (Robinson, 1931).

Davis Vein—This vein (Plate 1, no. 112; Robinson, 1931, no. 161; Carter coordinate section 17-V-59; Stamping Ground Quadrangle, Moore, 1977d) is located 3 1/2 miles east of Stamping Ground in the southeastern section of the quadrangle. It trends N 10° W for 3,200 feet in the Tanglewood Limestone and Stamping Ground Members of the Lexington Limestone and has been developed by a 100-foot shaft and an open-cut trench. Barite and galena were seen on dumps; strontianite (Fohs, 1913) and witherite (Robinson, 1931) have also been reported. Fohs (1913, p. 487) stated that the mineralization showed evidence of dissolution and redeposition in stalagmitic form, and that "a small tonnage of barytes was mined by the Mutual Mining Co. in 1908."

Dolan Vein—This vein (Plate 1, no. 39; Georgetown Quadrangle, Cressman, 1967) is described under Fayette County.

Johnson-Hooke Veins—These veins (Plate 1, no. 113; Robinson, 1931, nos. 162, 163, respectively; Stamping Ground Quadrangle, Moore, 1977d) were not mapped on the geologic quadrangle map, but Miller (1905a) located them 1 1/2 miles south of Stamping Ground, and 1 mile east of Stamping Ground, respectively. No evidence of the veins or previous mining activity could be found during this investigation. Fohs (1913, p. 487) reported that the Johnson Vein was 18 to 48 inches wide, trended N 20° E, and contained barite, galena, and sphalerite. A 100-foot shaft was sunk on the property, which produced barite and galena. According to Miller (1905b, p. 32), "there is a notable increase in the percentage of zinc at the expense of the lead in this [Johnson] vein as it has been followed downward." The Hooke Vein contained barite, calcite, and sphalerite, and trended N 12° E. Presumably, these veins occurred in Tanglewood Limestone.

J. L. Lisle Vein—This vein (Plate 1, no. 114; Robinson, 1931, no. 159; Georgetown Quadrangle, Cressman, 1967) is not mapped on the geologic quadrangle map but is probably located 3 miles southeast of Georgetown. The vein is reported to contain barite, galena, and sphalerite (Robinson, 1931, p. 118). Some of the galena has altered to cerussite.

Nally-Gibson Quarry (Thomas Vein)—This vein (Plate 1, no. 115; Robinson, 1931, no. 156; Carter coordinate section 12-U-60; Georgetown Quadrangle, Cressman, 1967) is located 1 mile east of Georgetown on North Elkhorn Creek. Parts of a vertical joint system that contains barite, calcite, and sphalerite are exposed in the Nally-Gibson Limestone Quarry. The veins trend N 40° E, range from 1 inch to 1 foot in width, and can be traced for 100 feet along strike in Grier limestone. No attempt has been made to mine these veins.

North Elkhorn Creek (Crumbaugh) Vein—This vein (Plate 1, no. 116; Carter coordinate section 10-U-60; Georgetown Quadrangle, Cressman, 1967) is located 2 miles east of Georgetown on North Elkhorn Creek opposite the mouth of Miller Run Creek. This north-trending vertical vein occurs in the Grier, is 400 to 500 feet long, and was mapped by Sellier (1913). The vein was developed by a shaft of unknown depth and a partially caved adit. Abundant barite float was observed in the dumps, but production data are unknown. Kanizay and Cressman (1967) mapped some north-trending barite fragments in the Tanglewood Limestone Member about 2 miles northeast of the North Elkhorn Creek Vein. Located near Newton, this is probably the Arnspiger Vein; the Offutt Vein, reportedly located several miles east, is no longer visible.

Woodford County

East Faircloth Veins (Hayden Mine)—Near Mundys Landing on the Kentucky River at the Woodford-Mercer county line, two north-trending veins (Plate 1, no. 117; Robinson, 1931, no. 177; Jolly and Heyl, 1964, no. 144a; Carter coordinate section 20-Q-57; Harrodsburg Quadrangle, Allingham, 1972) occur along faults in the Oregon Formation and Tyrone Limestone of the High Bridge Group and the Curdsville Limestone, Logana, and Tanglewood Limestone Members of the Lexington Limestone. These veins have been called extensions of the Chinn Vein in Mercer County. Each vein is approximately 2,000 feet long, 2 to 3 feet wide, and extends vertically for about 300 feet. Allingham (1972) reported that mining extended to a depth of 100 feet below river level. Mineralization includes fluorite and calcite, and some barite and sphalerite. The vein has been mined sporadically since 1905; the latest activity occurred during 1936-1943, when approximately 6,000 tons of fluorite were produced (Allingham, 1972). Several adits, drifts reportedly as much as 800 feet, trenches, and an abandoned shaft were observed in this investigation.

West Faircloth Vein (Moore Mine)—A northeast-trending vein (Plate 1, no. 118; Robinson, 1931, no. 177; Carter coordinate section 19-Q-57; Harrodsburg Quadrangle, Allingham, 1972) occurs along a fault and roughly parallel to and 1,000 feet to the west of the East Faircloth Vein. The vein occurs in the Oregon Formation and Tyrone Limestone of the High Bridge Group and the Curdsville Limestone, Logana, and Grier Limestone Members of the Lexington Limestone. The vein is 2,400 feet long, 3 1/2 to 6 feet wide, and has been explored by two adits (one 6 feet wide, 7 feet high, and 600 feet long), a shaft, and several trenches along strike. Mineralization includes fluorite, calcite, barite, and yellowish-orange sphalerite accompanied by some brecciated micritic limestone. Currier (1923, p. 166) stated that the barite is localized along shear planes and wall contacts. Allingham (1972) stated that 6,000 tons of 70 percent fluorite were produced between 1936 and 1943; data on barite production are unavailable. Allingham (1972) also stated that the Oregon Formation is displaced downward about 7 feet.

Hanna-Morgan Mine—About 1/2 mile north of the Faircloth Mines, this north-trending vein (Plate 1, no. 119; Jolly and Heyl, 1964, no. 176; Carter coordinate section 20-Q-57; Harrodsburg Quadrangle, Allingham, 1972) occurs in the Camp Nelson Limestone, Oregon Formation, and Tyrone Limestone. This vein was mined for fluorite in 1922-1923 and 1943-1944, and has the same N 20° W trend as the Twin Chimney Vein, but changes to a northeast trend toward the Faircloth Veins (Allingham, 1972). The vein is 4 feet wide and 400 feet long (Allingham, 1972) and contains barite, fluorite, and calcite.

Interstate 64 Vein—This vein (Plate 1, no. 120; Carter coordinate section 5-T-58; Midway Quadrangle, Pomeroy, 1970) is located 1 mile northeast of Spring Station and is not shown on the geologic quadrangle map. A N 10° W-trending barite vein occurs in the Tanglewood Member of the Lexington Limestone. P. E. Price (written commun., 1971) stated that the vein is 2 feet wide and consists of barite with 20 percent galena and minor sphalerite.

Noel Vein—(Plate 1, no. 76; Wilmore Quadrangle, Cressman and Hraber, 1970). Described under Jessamine County.

Nonesuch (Allender) Vein—This vein (Plate 1, no. 121; Robinson, 1931, no. 172; Keene Quadrangle, Cressman, 1965), although not shown on the geologic quadrangle map, was mapped by Miller (1924) 3/4 mile east of Nonesuch. The vein has been traced for 2 miles along a N 30° W strike, and contains barite, galena, fluorite, and sphalerite (Robinson, 1931, p. 120).

Orr Vein—This vein (Plate 1, no. 122; Robinson, 1931, no. 169; Salvisa Quadrangle, Cressman, 1968) was mapped by Miller (1924) 2 miles southwest of Mortonsville and is composed of barite, calcite, and some fluorite (Robinson, 1931, p. 120). It is not mapped on the geologic quadrangle map.

Prather (Troy) Vein—Located 3,000 feet southwest of Clover Bottom Church in the southwestern quarter of the quadrangle, this vein (Plate 1, no. 123; Carter coordinate section 15-Q-58; Keene Quadrangle, Cressman, 1965) is either the southern extension of the Nonesuch Vein or the northern extension of the Prewitt Vein or both (Fohs, 1913, p. 522). This vein trends northwestward in the Tyrone Limestone of the High Bridge Group and the Curdsville Limestone Member of the Lexington Limestone. Plummer (1971) stated that where the vein is in the Tyrone Limestone, it consists of fluorite and calcite, and while in the Curdsville it consists predominantly of barite with fluorite and calcite. The vein has been worked by a prospect pit and a 4-foot-wide trench for approximately 500 feet along strike. The vein can be traced further northward for 600 feet where it is several inches wide in Brushy Creek. Mineralization consists of barite, fluorite, and calcite.

Prewitt Vein—Near the western boundary of the quadrangle and on the steep slopes overlooking the Kentucky River, a northwest-trending vein (Plate 1, no. 124; Robinson, 1931, no. 175; Carter coordinate section 20-Q-57; Wilmore Quadrangle, Cressman and Hrabar, 1970) cuts the Tyrone Limestone of the High Bridge Group. The vein is 2 or 3 feet wide, 50 feet long, and has been explored by a prospect pit. Mineralization consists of barite, fluorite, galena, and sphalerite.

Shropeshire Vein—This vein (Plate 1, no. 125; Robinson, 1931, no. 173; Carter coordinate sections 7- and 8-Q-58; Keene Quadrangle, Cressman, 1965) was not mapped on the geologic quadrangle map, but is located at the intersection of Kentucky Highway 33 and Mundys Landing Road, 3/4 mile west of the Woodford-Jessamine county line (Fig. 11). A 500-foot-long, northwest-trending barite vein is suggested by intermittent barite and galena float in the Grier Limestone and Logana Members of the Lexington Limestone. Robinson (1931, p. 121) noted that the vein was 24 inches wide and contained fluorite and sphalerite. Miller (1905b, p. 31) reported a shaft was sunk on this vein.

Shyrock Ferry Road Vein—This vein (Plate 1, no.

Figure 11. Agricultural development obscures the Shropeshire Vein, Woodford County.

126; Carter coordinate section 17-S-57; Tyrone Quadrangle, Cressman, 1964) was not mapped on the geologic quadrangle map, but was located 3/4 mile south of Milner during this investigation. The vein occurs in the Grier and Tanglewood, strikes N 10° W, and contains barite, calcite, sphalerite, galena, and smithsonite. South of Milner the vein is exposed in an abandoned quarry and can be traced from a prospect pit north of Shyrock Ferry Road to several hundred feet south of the road (Figs. 12 and 13). The vein pinches and swells along strike, from 2 inches wide on the Shyrock Ferry Road to 12 inches wide in the quarry. The total length of this vein is approximately 3,500 feet.

Shyrock Ferry (Cotton) Vein—This vein (Plate 1, no. 127; Robinson, 1931, nos. 168, 166, respectively; Tyrone Quadrangle, Cressman, 1964) is not mapped on the geologic quadrangle map, but Miller (1905a, 1924) mapped the vein on the Kentucky River cliff 2 miles above Shyrock Ferry. P.H. McHaffie (1981, personal commun.) stated that the vein occurs 1/2 mile east of Camp Offutt along an unnamed creek on the Kentucky River, presumably in the lower Lexington Limestone. The vein is 12 to 24 inches wide, strikes north, and contains barite, calcite, fluorite with sphalerite, and chalcopyrite (Robinson, 1931, p. 120).

Withrow Vein—According to Miller (1905a, 1924) this vein (Plate 1, no. 128; Robinson, 1931, no. 165; Frankfort East Quadrangle, Pomeroy, 1968) is mapped 1 mile west of Spring Station, but it was not observed during this investigation. The vein is 2 feet wide, strikes N 14° W, and contains barite, galena, and cerussite (Robinson, 1931, p. 119).

MISCELLANEOUS OCCURRENCES IN SOUTH-CENTRAL KENTUCKY

Outside the Blue Grass region, the Cumberland Valley region of south-central Kentucky appears to contain the greatest number of known and reported mineral occurrences in the central part of the State (Fig. 14). These deposits are located on the Cumberland Saddle, a structural lowland along the Cincinnati Arch. The Cumberland Saddle is located between two domal structures, the Lexington Dome of central Kentucky and the Nashville Dome of central Tennessee. Vein mineralization is concentrated in fractures, joints, and strike-slip faults. Barite, fluorite, calcite, and sphalerite are the common minerals.

Surface rocks in south-central Kentucky consist of

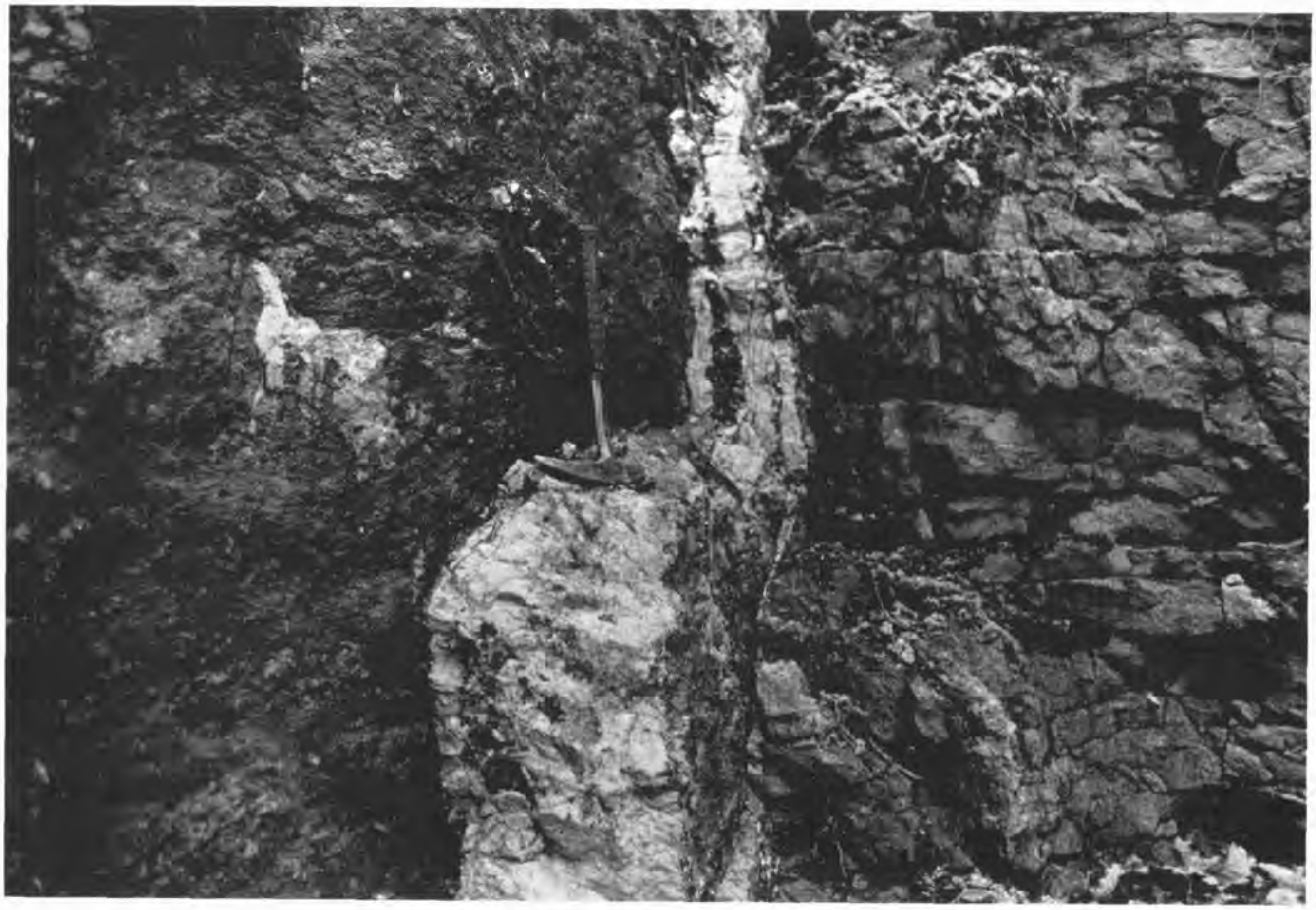


Figure 12. Shyrock Ferry Road Vein, in the abandoned Milner Quarry, Woodford County.

limestones, dolomites, shales, and siltstones which range in age from Ordovician to Mississippian (Fig. 15). Barite occurrences have been reported in some of the Ordovician and Mississippian rocks.

The oldest exposed unit in south-central Kentucky is the Ordovician Leipers Limestone (fossiliferous limestone). It is overlain by the Cumberland Formation (mainly dolomite), also Ordovician, and the Devonian Chattanooga Shale (black shale). The Fort Payne Formation is a series of complex, facies-related carbonates and shales of Early Mississippian age. Overlying the Fort Payne are the Salem and Warsaw Formations (calcarenite, dolomite, and shale), the St. Louis Limestone (bioclastic calcarenite, calcilutite, and dolomite), and the Monteagle Limestone (oolitic-bioclastic calcarenite), all of which are Late Mississippian age. Several of these formations contain well defined breccia zones.

Most of the deposits are supposedly too small to be of economic importance, although some exploratory drilling was conducted on the Monroe County veins.

Cumberland County (Mathews Veins)—These veins (Carter coordinate section 10-E-51; Amandaville Quadrangle, Taylor, 1962) are located along the Russell-Cumberland county line on the Cumberland River, where a zone of north-trending barite veins occur in a fault in the Leipers Limestone of Late Ordovician age. The mineralized zone is 80 feet wide along the Cumberland River cliffs, but only 38 feet wide on nearby Dove Branch Creek. The zone consists of numerous veinlets that range in width from 1/2 to 3 1/2 inches. Mineralization includes calcite and barite veins with some fluorite, sphalerite, pyrite, and galena. Based on its weight, some of the calcite is presumably barytocalcite. About 2,000 feet northward along strike in Russell County the vein is exposed in Barn Hollow, where barite and sphalerite have been reported.

Monroe County—The Sulfur Creek Veins (Carter coordinate section 20-C-47; Vernon Quadrangle, Lewis, 1972) are exposed in Sulfur Creek approximately 1 1/2 miles west of McMillians Ferry on the Cumberland River. A 37-foot-wide zone of veinlets occurs in the Cumberland Formation and is associated with fracturing caused by a left lateral strike-slip fault. The veinlets range from 1/2 to 2 inches wide and contain barite, calcite, galena, and sphalerite. The fault zone trends north; the mineralized veins are slightly offset and trend N 25° E. Lewis

Figure 13. Barite fragments from the Shyrock Ferry Road Vein, Milner Quarry, Woodford County.

(1972) reported a diamond drill hole reached a depth of 2,000 feet, although no other information is available.

Russell County—Amandaville Quadrangle (Taylor, 1962). See descriptions under Cumberland County.

Wayne County—Traces of barium (Carter coordinate section 24-C-55; Powersburg Quadrangle, Lewis, 1977) were detected by x-ray fluorescence in a quartz and celestite nodule in a relict evaporite zone (Dever and others, 1978, p. 167) in the St. Louis Limestone near Sunnybrooke, in southern Wayne County. This occurrence is located approximately 8 miles north of the Pall Mall Barite Mine in Fentress County, Tennessee, which was a residual barite deposit overlying the Warsaw Limestone (Jewell, 1947, p. 101); more recently Maher (1970, p. 14) stated that this deposit was overlying the St. Louis Limestone.

Other Occurrences

Barite occurs in other geological environments which are not associated with the vein deposits in central Kentucky. Bedded deposits, geodes, nodules, and concretions, although uneconomic, are additional occurrences of barite. The bedded deposits occur south and east of Lexington, and the geodes are located around the perimeter of the mineral district.

Bedded Deposits

Fohs (1913, p. 455) reported the occurrence of bedded deposits about 45 miles southeast of Lexington in Estill, Menifee, and Rockcastle Counties in the Keokuk Limestone (Lower Mississippian). These occurrences are described as limestone breccia cemented with barite. Numerous breccia zones occur in the upper part of the Borden Formation and Newman Limestone of south-central and east-central Kentucky. Some of the breccias such as the Bryantsville breccia at the top of the St. Genevieve Limestone, breccias associated with nodular quartz zones in the lower St. Louis Limestone (partly correlative with the Renfro Member of the Borden Formation), and an unnamed breccia in the upper Renfro Member of the Borden Formation are more widespread than other breccias. One of these breccia zones could be stratigraphically equivalent to Fohs' (1913, p. 455) "bed-veins." No barite mineralization was observed in these breccia zones, although some of the breccias have been mineralized with calcite, dolomite, sphalerite, and galena. Listed below are several occurrences of mineralized breccia zones in east-central Kentucky.

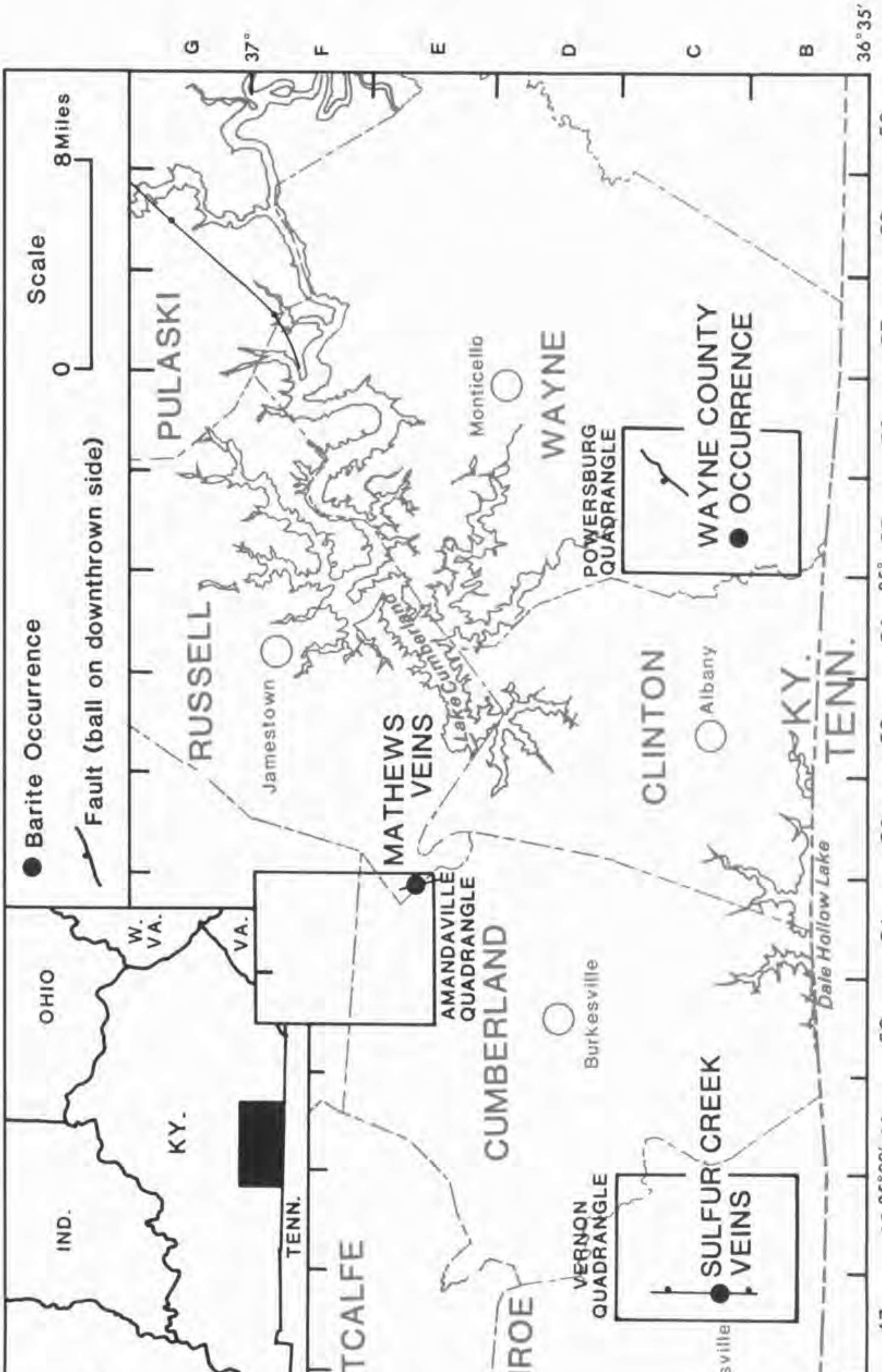


Figure 14. Location of barite deposits in south-central Kentucky.

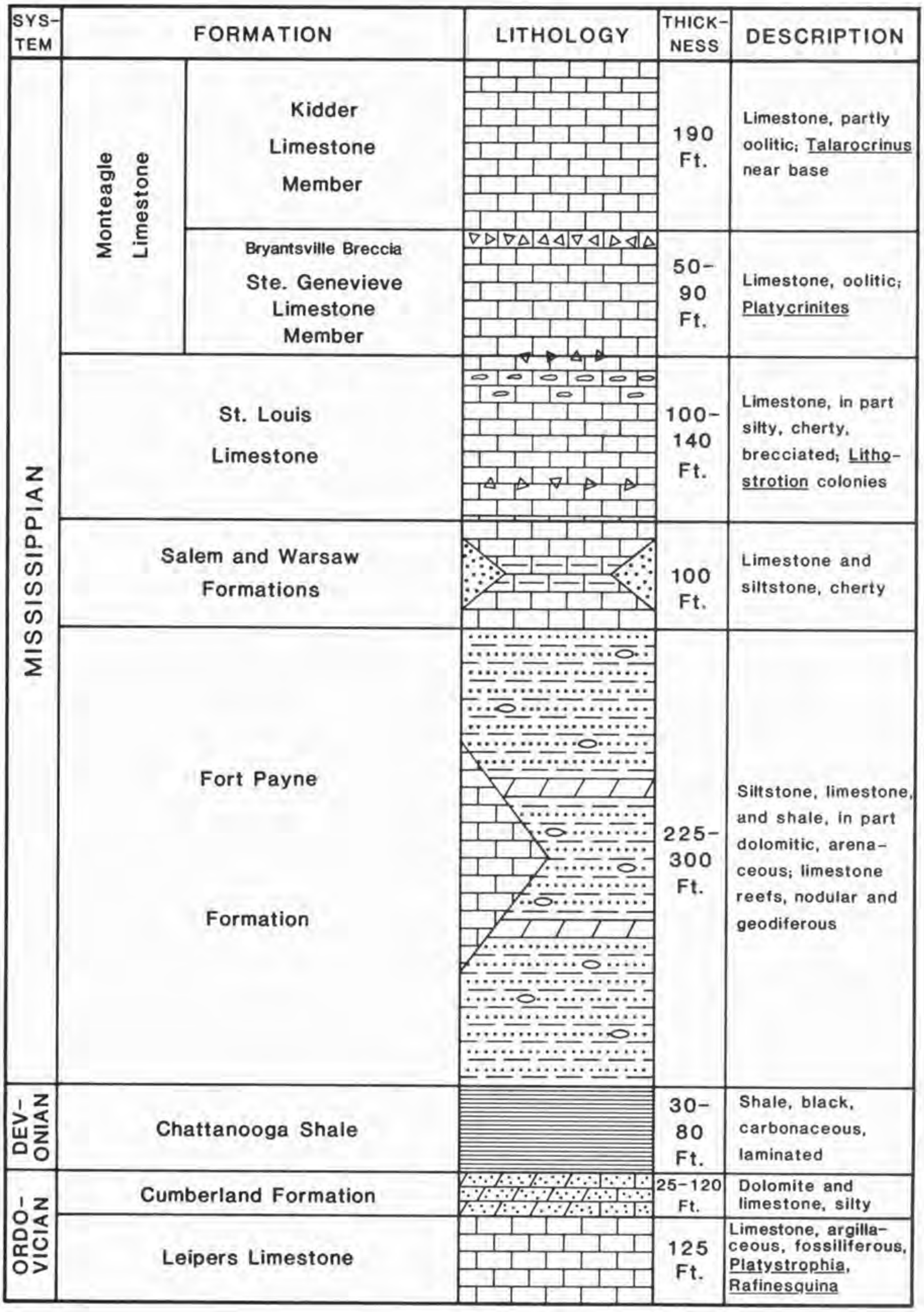


Figure 15. Generalized stratigraphic column of exposed rocks in south-central Kentucky.

Estill County—This occurrence (Panola Quadrangle, Green, 1968) is not mapped on the geologic quadrangle map, but according to Fohs (1913, p. 577), "barytes occur cementing Keokuk limestone breccia which caps the Knob at Knob Lick. . . ."

Menifee County—This occurrence (Pomeroyton Quadrangle, Weir and Richards, 1974) is not mapped on the geologic quadrangle map. Fohs (1913, p. 578) described a bed of magnesium limestone of Keokuk age that was brecciated and cemented with crystalline barite. He reported the presence of galena, zinc blende (sphalerite), pyrite, and calcite, and concluded that the deposit was not economic.

Rockcastle County—This occurrence (Mt. Vernon Quadrangle, Schlanger and Weir, 1971, and Livingston Quadrangle, Brown and Osolnik, 1974) is not mapped on the geologic maps, but is located in the northwestern section of the Livingston Quadrangle near the Dudley railroad station (Fohs, 1912, p. 110). Fohs (1913, p. 579) reported that "east of the railroad is a bed of Keokuk Limestone, brecciated and cemented barytes. . . ." He also reported this to be uneconomic. The current investigation failed to disclose any barite or brecciated limestone at this locality, but a barite nodule was observed lying next to a railroad cut several hundred feet west of the station, which would be located on the Mt. Vernon Quadrangle. This reported occurrence could be the stratigraphic equivalent of a breccia zone observed by W. H. Anderson in the upper Renfro Member of the Borden Formation in Jackson County which was mineralized with calcite, dolomite, sphalerite, and galena.

Geodes, Nodules, and Concretions

The origin of geodal minerals, based primarily on mineralogical features, has been considered by Shaler (1899) and Fohs (1907) to be from vein solutions or associated with the mineralization of the Central Kentucky Mineral District. However, a recent investigation by Fisher (1976) provides mineralogical evidence that the geodal-mineral formation and deposition may be associated with meteoric and formation waters, not ore fluids. Fisher cited the vein and geodal mineralogical differences, the geodal distribution pattern, the abundance of mercury in sphalerite, and fluid inclusion salinity variations to support the investigation.

Abundant geodes and concretions containing barite, celestite, calcite, quartz, dolomite, and fluorite occur in Quaternary fluvial terraces and stream deposits, in the Salem-Renfro Member of the Borden Formation, and in the Mississippian rocks around the perimeter of the mineral district.

In the Paint Lick Quadrangle of Garrard County (Weir, 1969) near the southeastern flank of the Lexington Dome, bladed crystals of barite occur in nodules, vugs, and lenses near the Irvine-Paint Creek Fault Zone in the Ashlock and Drakes Formation (Ordovician) and Brassfield Dolomite (Silurian). Another occurrence in the Brassfield Dolomite has been described under Lincoln County.

WESTERN KENTUCKY FLUORSPAR DISTRICT

Geologic Setting

The Western Kentucky Fluorspar District is a part of the Illinois-Kentucky Fluorspar District, which is the largest producer of fluorspar in the United States. The Kentucky district is in Crittenden, Livingston, and Caldwell Counties of western Kentucky, near the towns of Marion, Salem, Smithland, and Princeton.

About 3.23 million tons of fluorspar concentrate have been produced since mining began in about 1873. Approximately 70,000 tons of metallic zinc, 12,000 tons of metallic lead, and 100,000 tons of barite have been produced, commonly as a by- or co-product of the fluorspar ore.

The following discussion will summarize data on the general geology and the ore deposits of the district, and then will deal specifically with the barite deposits. Most of the background data have been taken from an earlier report (Trace, 1974b).

Sedimentary rocks comprise most of the rocks exposed in the district and range in age from early Carboniferous limestones to Quaternary fluvial and lacustrine deposits. Most of the rock units at the surface are Mississippian, although some Lower Pennsylvanian rocks are present also (Fig. 16). Small amounts of unconsolidated sand, silt, clay, and gravel of Cretaceous and Tertiary ages, and loess and alluvium of Quaternary age are present locally.

About two-thirds of the Mississippian rocks are fossiliferous marine limestones and the remainder are composed of clay- to sand-size, terrigineous clastic material. Meramecian marine limestones are at the surface in about half of the district, and Chesterian marine, fluvial, and fluvio-deltaic clastic sedimentary rocks and marine limestones underlie about a third of the district. Mississippian rocks are about 3,000 feet thick. The Pennsylvanian rocks are dominantly fluvial clastic rocks—shales, siltstone, and sandstone, with a few thin coals—and are as much as 500 feet thick.

Many thin mafic dikes and a few mafic sills are present. The mafic rocks are mostly altered mica peridotites or lamprophyres and are mostly composed of carbonates, serpentine, chlorite, and biotite, with some hornblende, pyroxene, and olivine. Most of the dikes are in a 6- to 8-mile-wide, northwest-trending belt. Commonly the dikes strike N 20° to 30° W, dip from 80° to vertical, and are

SYSTEM	SERIES	FORMATION AND MEMBER	LITHOLOGY	THICKNESS IN FEET	DESCRIPTION
PENNSYLVANIAN	Atokan	Tradewater Fm.		100 ±	Sandstone, shale, siltstone, and thin coals
PENNSYLVANIAN	Morrowan	Caseyville Formation		190–495	Sandstone, shale, siltstone, and thin coals
MISSISSIPPIAN	Chesterian	Kinkaid Limestone		0–165	Limestone, sandstone, and shale
MISSISSIPPIAN	Chesterian	Degonia Sandstone		5–38	Shale and sandstone
MISSISSIPPIAN	Chesterian	Clore Limestone		70–125	Shale, limestone and thin sandstone
MISSISSIPPIAN	Chesterian	Palestine Sandstone		30–75	Sandstone and shale
MISSISSIPPIAN	Chesterian	Menard Limestone		80–145	Limestone and shale; thin sandstone locally
MISSISSIPPIAN	Chesterian	Waltersburg Sandstone		20–60	Shale, siltstone, and sandstone
MISSISSIPPIAN	Chesterian	Vienna Limestone		15–35	Limestone, cherty
MISSISSIPPIAN	Chesterian	Tar Springs Sandstone		70–120	Sandstone and shale; thin coal locally
MISSISSIPPIAN	Chesterian	Glen Dean Limestone		40–95	Limestone and shale
MISSISSIPPIAN	Chesterian	Hardinsburg Sandstone		80–150	Sandstone and shale
MISSISSIPPIAN	Chesterian	Golconda Formation		90–165	Shale and limestone, thin sandstone common
MISSISSIPPIAN	Chesterian	Cypress Sandstone		45–140	Sandstone and shale; thin coal locally
MISSISSIPPIAN	Chesterian	Paint Creek Formation		5–100	Shale, limestone, and sandstone
MISSISSIPPIAN	Chesterian	Bethel Sandstone		20–120	Sandstone
MISSISSIPPIAN	Chesterian	Renault Limestone		70–125	Limestone and shale
MISSISSIPPIAN	Meramecian	Ste. Genevieve Limestone		200–300	Limestone, oolitic; thin sandstone
MISSISSIPPIAN	Meramecian	St. Louis Limestone — Upper Member		250± (500–530)	Limestone, cherty, partly oolitic
MISSISSIPPIAN	Meramecian	St. Louis Limestone — Lower Member		250–280 (500–530)	Limestone, cherty, containing *Lithostrotion* colonies
MISSISSIPPIAN	Meramecian	Salem Limestone		120 ±	Limestone; oolitic at top
MISSISSIPPIAN	Meramecian	Warsaw Limestone		230 ±	Limestone, large *Echinocrinus* spines at top
MISSISSIPPIAN	Osagean	Fort Payne Formation		600 ±	Limestone, mostly dark and very cherty or silty; locally, upper part is light gray

Figure 16. Generalized stratigraphic column of exposed Pennsylvanian and Mississippian formations in the Western Kentucky Fluorspar District.

5 to 10 feet wide. Based on radioisotopic study, the dikes have been determined to be Early Permian in age (Zartman and others, 1967, p. 860-861).

The dominant structural features of the district are a northwest-trending domal anticline, the Tolu Arch, and a series of normal faults or fault zones that trend dominantly northeastward and divide the area into several elongated, northeast-trending grabens.

Vertical displacement along the faults varies from a few feet to as much as 3,000 feet, although commonly it is no more than a few hundred feet. Available data suggest that the horizontal component of displacement is relatively minor compared to the vertical component. Many cross faults of small displacement trend northwestward and are occupied at places by mafic dikes. Faulting was mostly post-Early Permian to pre-Middle Cretaceous in age, although some movement continued through the Cretaceous and Tertiary to the present (Rhoades and Mistler, 1941, p. 2046-2047; Amos, 1967).

Nearly all of the faults are normal; generally, they dip 75 to 90°, although rarely they are inclined as low as 45°. Locally, the direction of dip may be reversed. Fault zones that consist of several subparallel and sinuously intersecting fractures are especially common along the edges of many of the grabens (Hook, 1974, Fig. 3). These zones are commonly a few hundred feet wide, although at places they are more than 1,000 feet wide. The total displacement attributable to a fault zone is distributed irregularly among the several individual faults, which are classified as step faults, antithetic faults that form small grabens within or along the edge of the fault zones, and cross faults (Hook, 1974, p. 79-81).

Most of the fluorspar-zinc-barite-lead ore bodies are steeply dipping to vertical vein deposits along faults, and "gravel" deposits that resulted from concentrations of fluorite and barite in residuum above vein deposits. A few deposits occur as very gently dipping to nearly horizontal bedding-replacement deposits in lower Chesterian or upper Meramecian rocks.

Most of the vein ore deposits are along northeast-trending faults; a few veins are along northwest- and north-trending fissures or faults that at places contain mafic dikes. The fluorspar veins commonly are fissure fillings in fault breccia, accompanied by replacement of vein calcite and some limestone wall rock. A typical vein is lenticular, pinches and swells erratically, and is composed mostly of fluorite, calcite, and country-rock fragments. Locally, the vein may be entirely calcite or fluorite. Commonly, contact with vein walls is sharp; however, at places, veinlets of fluorite and calcite extend a few hundred feet beyond a vein into slightly brecciated wallrock. In many veins sphalerite, galena, and barite are minor minerals; in a few veins sphalerite or barite is the major constituent.

The width of most mineralized veins is 3 to 10 feet, and mined ore shoots commonly range from 200 to 400 feet in length and 100 to 200 feet in height. Deposits have been mined to depths of about 700 feet. Based on stratigraphic relations, the age of mineralization is post-Early or Middle Pennsylvanian and pre-Late Cretaceous.

A few bedding-replacement deposits are present. These deposits are elongate bodies that trend north to northeast; they may be as much as 2 miles long, 150 to 250 feet wide, 5 to 10 feet thick (Trace, 1974b, p. 69).

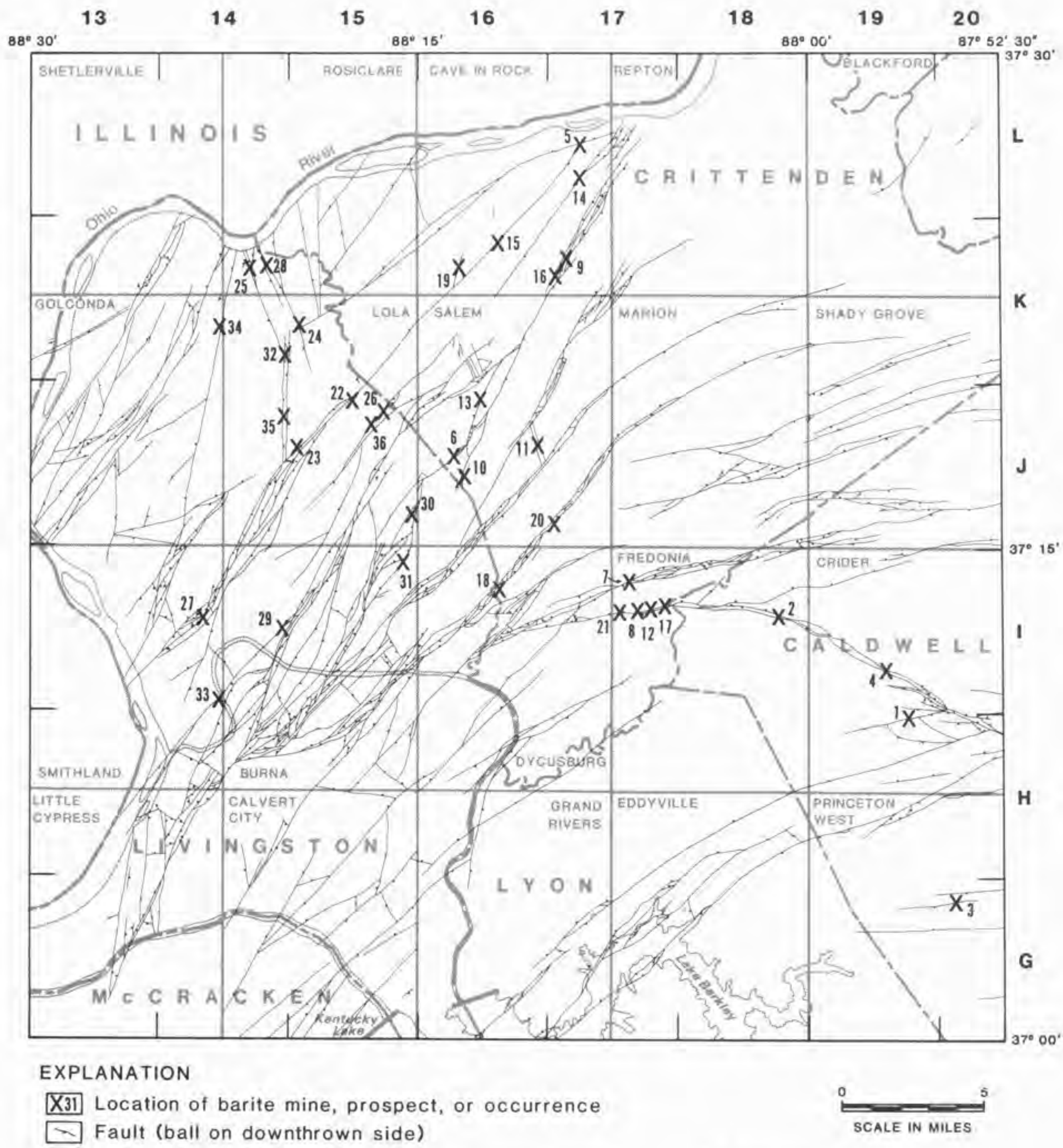
More than two-thirds of the vein-ore production within the district has come from five areas of 1 to 5 miles in length along fault zones. Several other areas also have produced small quantities of fluorspar, and a few areas have produced mostly zinc or barite.

Barite Deposits

Barite is commonly associated with fluorspar deposits, although many fluorspar deposits contain little or no barite. During most of the district's operation, barite has been difficult to separate from fluorspar and was therefore considered detrimental and was avoided in fluorspar mining operations (Currier, 1923, p. 44; Bradbury, 1959, p. 5). As a result, data on barite are relatively scarce.

A small quantity of barite was mined as early as 1903 (Ulrich and Smith, 1905, p. 135; Fohs, 1907, p. 24-25). From then until 1959, however, production probably did not exceed a few thousand tons. During the period 1959-1964, about 45,000 tons of barite were produced, according to the U.S. Bureau of Mines Minerals Yearbooks; since 1964, production has been less than 10,000 tons. In addition, approximately 40,000 to 50,000 tons of barite were contained in "fluorbarite" that was produced from the early 1930's to the early 1950's. "Fluorbarite" is a mixture of approximately equal amounts of fluorspar and barite that was marketed for ceramic use. Most of the barite and "fluorbarite" production has come from the Pygmy, Mico, Ellis-Carr, Wright, and Ainsworth Mines (Fig. 17). Lesser quantities have come from the May Mine area, Owl Hollow Mine, Lowery-Ray area, Satterfield Mine, Bateman-Mitchell area, Damron Mine area, and the Loveless Mine. Barite is mentioned in the literature or is otherwise known to be present in at least small quantities in the other occurrences that are shown on Figure 17 and described below.

The largest quantity of barite produced was from "gravel" deposits that resulted from concentrations of barite and some fluorite in residuum above vein deposits (i.e., the Mico Mine). The remainder of the barite has come from fluorspar-barite veins (i.e., the Ellis-Carr Mine). Few data are available on barite in the bedding-replacement deposits (i.e., the Shouse and Clement



CALDWELL COUNTY
1. Bright mine
2. Lowery-Ray area
3. Satterfield mine
4. Stone prospect

CRITTENDEN COUNTY
5. Ainsworth mine
6. Babb area
7. Bibb prospects
8. Blue-Marble mine area
9. Craighead-Coates mine area
10. Crosson Cave prospect area
11. Dike-Eaton area
12. Eva Tanguay property
13. Hick Jones prospect
14. Mico mine
15. Moore prospect
16. Owl Hollow mine
17. Pygmy mine area
18. Riley mine
19. Sullenger prospect area
20. Susie Beeler mine
21. Tabb (Lafayette) mine

LIVINGSTON COUNTY
22. Bateman-Mitchell area
23. Bonanza mine area
24. Bradshaw prospect
25. Clement mine
26. Damron mine area
27. Dyers Hill mine
28. Ellis-Carr mine
29. Klondike mine
30. Lindley barite prospect area
31. Loveless (Ramage) mine
32. May mine area
33. Royal (Silver) mine
34. Shouse mine
35. Sunderland mine area
36. Wright mine area

Figure 17. Index map of barite mines, prospects, and occurrences in the Western Kentucky Fluorspar District, Crittenden, Livingston, and Caldwell Counties, Kentucky.

Mines). Barite is present with fluorspar, however, in the bedding-replacement deposits of Illinois (Bradbury, 1959, p. 5-6), and during 1979, barite was produced in Illinois from bedding-replacement ore as a byproduct of a fluorspar operation.

The length of known "gravel" deposits may be as much as 1,500 feet, as at the Pygmy Mine; the amount of barite in the residuum, however, probably varied substantially within that 1,500 feet. The Ainsworth deposit area was explored for a little over 1,000 feet along the strike, but according to one of the operators, much of the barite occurred in one or two local areas no more than 100 to 300 feet long. The depth of "gravel" deposits commonly is no more than 50 feet, although in places the vein material and wallrock may be partly decomposed to depths of 100 feet or more, as at the Bill Wright Mine.

No vein deposits of barite alone have been mined. The mixed barite-fluorspar in the Ellis-Carr Mine is the principal vein deposit mined. Based on drill-hole data in several areas, the occurrence of barite in the veins is erratic, both along the strike and with depth; in most of the district, barite does not appear to be as persistently present as apparently it was in the Ellis-Carr deposit. As Bradbury (1959, p. 4-5) said regarding the southern Illinois deposits, "the barite deposits are small compared to the fluorspar deposits. . . ."

Specific details on the position of barite within the vein ore deposits are not well known because fluorspar operations have commonly avoided any deposits that had more than 5 percent barite. According to Bradbury (1959, p. 5), the barite in Illinois usually occurs in the middle or along the edges of the veins. R. D. Trace studied in some detail the core drill logs of about 25 holes in four different areas; each hole contained substantial quantities of barite at vertical depths of from 100 to 400 feet. Although the amount of data is probably too small to draw conclusions, the position of barite within the complex veins varies unpredictably. In a few cases, the middle zone of the vein is highly baritic, as compared to the outer parts, but in most cases the position of barite is very erratic and it may occur anywhere within the vein. Barite generally is associated with fluorspar rather than with those parts of the vein that are dominantly calcite.

Only few data are available on the variation of barite with depth of deposit. According to the operator, barite was more abundant at depth in the veins at both the Ellis-Carr and Bill Wright Mines. Some of the "gravel" deposits, however, were mostly barite near the surface but contained more fluorspar near the bottom of the "gravel" zone. For example, abundant barite was present in the upper part of the Pygmy "gravel" deposit, but fluorite was more abundant in the lower part; little barite was found in the underlying vein deposits as deep as 325 feet. Brecke (1964, p. 300) also mentioned vertical zoning at the Pygmy Mine. Similarly, the highly baritic "gravel" deposit at the Mico Mine did not appear to contain as much barite in the underlying vein. The variations of the barite/fluorite ratios within the residuum and between the residuum and the underlying veins suggest that fluorite may be relatively more soluble than barite in a near-surface environment. A similar possibility exists in a barite-fluorite mine in Tennessee, according to D. A. Brobst of the U.S. Geological Survey (personal commun., 1979).

The wall rocks of mined baritic veins or "gravel" deposits are commonly the Ste. Genevieve or St. Louis Limestones. Based on available drill-hole data, however, barite in veins is also present where the wall rocks are lower Chester units. A study was made of 18 of the most baritic occurrences described herein, in order to determine the stratigraphic position along the faults of the known barite or baritic fluorspar deposits. Every occurrence has either the Ste. Genevieve or St. Louis Limestone on the footwall. At least half of the occurrences have a hanging wall of limestone—Renault, Ste. Genevieve, or St. Louis. Most of the remaining half have Cypress or Bethel Sandstone as the hanging wall. The prevalence of barite operations with limestones may reflect, in part at least, the fact that substantial production has come from "gravel" deposits, which can occur only where limestone fault walls are present. Inasmuch as fluorspar and barite are usually associated together, it is also likely that, as with fluorspar (Tibbs, 1974, p. 88), the Ste. Genevieve Limestone may be the most favorable wall rock for the deposition of barite.

Barite is probably the youngest of the primary minerals in the fluorspar district. Hall and Friedman (1963, p. 891) described the paragenetic sequence for the bedding-replacement deposits near Cave in Rock, Illinois. The same sequence probably holds for the vein deposits in western Kentucky.

Brecke (1964, p. 299; 1979, p. 1333-1334) suggested that practically all of the outlying mineral deposits in the Illinois-Kentucky district are baritic. This district-wide zoning is clearer in Illinois than Kentucky. Brecke also suggested a zonal arrangement independent of the district zoning. In the Kentucky district, such a zonal arrangement of baritic deposits appears to occur around the central part of the domal Tolu Arch (Trace, 1974b, p. 66): the Ainsworth, Mico, Owl Hollow, Wright, Damron, Mitchell-Bateman, Sunderland, May, and Ellis-Carr Mines.

Description of Occurrences of Mineral Deposits

Data on individual mines, prospects, or areas are summarized below by county. Those areas where barite has been produced or where the literature or other data suggest the possibility of substantial quantities of barite are described in as great detail as possible. Other areas, where the data suggest only minor quantities of barite or where only a small amount of data are available, are described in less detail, although pertinent references may be cited for information.

A large number of areas in the district seem to contain only a small quantity of barite (less than 5 percent) associated with the fluorspar deposits. Abundant information is present in many mines to clearly indicate that the barite content is low, but in some other areas described below, the seemingly low barite content may be based upon inadequate or only few data.

No mines were in operation during this study. Almost all data, therefore, are from published or unpublished reports and maps, the records of many mine operators and geologists, and from the records and memory of R. D. Trace, who has worked in the district for about 30 years during the period 1942-1980.

Caldwell County

Bright Mine—The Bright Mine (Fig. 17, no. 1; Carter coordinate section 2-H-19) is located about 2 miles northeast of Crider, Kentucky, and is shown on the geologic map of the Crider Quadrangle (Rogers and Trace, 1976).

The Bright Mine was mentioned by Ulrich and Smith (1905, p. 207) and shown on their Plate II. The map in the front of Fohs' report (1907) shows the mine also. In 1919, according to an unpublished report by E. C. Reeder, a shaft was sunk to a depth of 100 feet and 300 to 400 tons of "spar" were taken out. Barite was not mentioned. Currier (1923) showed the mine on his Plate I and mentioned calcite (p. 130) on the waste piles, but did not mention barite.

In 1943, mine workings consisted of two shafts, about 60 and 80 feet deep and about 40 feet apart. Ore had been mined from a 60-foot level upward to the surface for a length of about 70 feet. The floor of the 60-foot level contained 4 1/2 feet of fluorspar ore. According to industry sources, some of the crude ore contained as much as 15 percent barite.

During the mapping of the Crider Quadrangle in 1971 by Trace, no barite was found in the vicinity of the caved mine openings. Judging by the area's appearance, little if any mining has been done since the 1940's.

Lowery-Ray area—The Lowery-Ray area (Fig. 17, no. 2; Carter coordinate section 12-I-18) is located about 2 miles northeast of Fredonia, Kentucky. The area is on the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967). From the intersection of Kentucky Highways 91 and 70 just east of Fredonia, it is about 7,000 feet east on Kentucky Highway 70, then north about 2,200 feet on a blacktopped road to the area. The Lowery property lies west of the road and Sinking Fork of Livingston Creek, and the Ray area lies just east of the road.

The Lowery-Ray area is shown and described by Ulrich and Smith (1905, Plate II, p. 135). "Here [Ray and Lowery shafts] the vein has a width of several feet near the surface, pinching to from 6 inches to a foot at a depth of 30 or 35 feet. It consists entirely of barite, with a very small proportion of fluorspar and calcite." Fohs (1907, p. 24-25, Plate I) stated that several carloads of barite were shipped in 1903 and a small tonnage in 1906 from open cuts at the Ray and Lowery Mines. Hoeing (1913, p. 575) mentioned barite at the Ray and Lowery Mines. Currier (1923, p. 128-129) also mentioned "gravel" barite at the Lowery and Ray Mines.

No other data were found regarding past operations on the Lowery property. When the area was examined in 1979, the Lowery area contained only a few scattered and obviously old prospect pits, possibly dating back to the work described by Fohs. Calcite, but no fluorspar or barite, was found in the dump material. Two caved shafts were found east of the road on the old Ray property (Rogers and Hays, 1967). The western shaft was active in the early 1950's. According to local sources, the shaft was about 100 feet deep; a few thousand tons of fluorspar were produced, but no barite. The shaft is now caved, but a collapsed headframe, water tower, and log washer are still present. As at the Lowery, only calcite could be found in the dump material, although the gravel on the short road into the mine contains fluorspar and sphalerite.

The Lowery and Ray Mines are probably on the footwall (southernmost) fault of the Tabb Fault System. According to Rogers and Hays (1967), the fault walls are the Cypress Sandstone and the Ste. Genevieve Limestone, indicating a displacement of 400 to 500 feet.

Satterfield Mine—The Satterfield Mine (Fig. 17, no. 3; Carter coordinate section 5-G-20) is located about 3 miles southwest of Princeton, Kentucky, just southwest of Wiley Bridge across Eddy Creek. Sample (1965) showed the location on the geologic map of the Princeton West Quadrangle and mentioned the mine in the text.

Ulrich and Smith (1905, p. 94 and Plate II) noted that "several shafts have been sunk on a vein of fluorspar and barite . . . on the Satterfield (now Mahan) farm. . . ." Currier (1923, p. 128, 130, and Plate I) mentioned and showed the location of the mine.

According to local sources, a 60-foot shaft was sunk in the early 1930's. Production figures are not available. During the 1940's between 400 and 500 tons of a mixture of fluorspar and barite were produced from a residual or "gravel" deposit. The ore was concentrated in a log washer. No further mining has been done.

Stone Prospect—Some barite was noted at the Stone Prospect (Fig. 17, no. 4; Carter coordinate section 18-I-19), according to Ulrich and Smith (1905, p. 145). Based on the location shown on their Plate II, this prospect is near the Black Sulphur Mines, as shown on the geologic map of the Crider Quadrangle (Rogers and Trace, 1976). No barite was seen at the surface during the mapping of the quadrangle. No other data are known.

Crittenden County

Ainsworth Mine—The Ainsworth Mine (Fig. 17, no. 5; Carter coordinate section 14-L-17) is located along the southern edge of the Ohio River flood plain, 1 1/2 miles southeast of Cave in Rock, Illinois, and about 1/2 mile east of Kentucky Highway 91. The mine is shown, although not named, as a southeast-trending, 1,200-foot-long open cut on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a).

Brecke (1964, p. 300) mentioned barite at the Ainsworth area. No other published data on the area are known.

Trace first visited the area in August 1947, at the request of Mr. Jesse Baldwin, diamond drill contractor, who had leased the property and planned some exploratory core drilling. In or prior to 1947, several very shallow shafts and prospect pits had been dug. The 22-foot Baldwin Shaft had been sunk in 1947 in a residual or "gravel" fluorspar and barite zone, approximately at the northwestern end of the later-dug open cut shown on the geologic quadrangle map (Trace, 1974a). Minerals in the Baldwin Shaft consisted of purple and white, coarsely granular fluorite; white, massive barite; and a small quantity of galena disseminated in the fluorite.

In October 1947, two 45°-angle core holes were drilled to test for mineralization near the Baldwin Shaft; one hole was drilled northward and the other eastward. "Gravel" fluorspar and barite were reported in the residuum by the driller in both holes at depths of 40 to 67 and 43 to 85 feet. Both holes were continued into bedrock to depths of about 200 feet but no definite faults or fractures were cut. Scattered veins and veinlets of calcite as wide as 1 foot, and veinlets, geode fillings, and disseminated crystals of barite were present in the limestone.

In 1963-1964, open-cut exploration by bulldozer and small dragline was done for as much as 1,000 feet and as deep as 30 feet along a southeast-trending mineralized zone in the residuum, as shown on the Cave in Rock geologic quadrangle map (Trace, 1974a). According to local sources, a few thousand tons of a mixture of barite and fluorspar were produced.

In 1970, six core holes were drilled to test for a possible vein under the southeast-trending residual deposit. The first hole was drilled under the Baldwin Shaft. Five additional holes were drilled along the southeast-trending zone for about 1,500 feet southeast of the Baldwin Shaft. All holes were drilled at an angle of 45°; five holes were drilled toward the northeast and one hole toward the southwest.

According to local sources, the drilling suggested a continuous fracture or fault zone that trends about S 60° E. Rocks near the surface on both walls of the fracture are medium-gray, finely crystalline, cherty limestone of the Upper Member of the St. Louis Limestone. Based on the available data, little if any displacement along the fracture is present. At vertical depths of 100 to 200 feet beneath the surface, the mineralized zone contained some calcite, barite, fluorspar, sphalerite, and galena. Detailed information on this drilling is not available.

In 1970, just after the core drilling, about 1,000 tons of an equal mixture of barite and fluorspar were produced from a cut as deep as 37 feet and about 200 feet long near the northwestern end of the bulldozed area.

In 1977, the open cut was deepened to about 50 feet and extended about 100 feet to the northwest toward the Ohio River. According to industry sources, 1,000 to 2,000 tons of an equal mixture of barite and fluorspar were produced. The ore was concentrated in a jig mill at the Hutson Mine near Salem, Kentucky. No further activity is known.

Babb area—The Babb area, in Crittenden and Livingston Counties (Fig. 17, no. 6; Carter coordinate section 14-J-16), is located about 2 miles north of Salem, Kentucky, and is shown along the Babb Fault System on the geologic map of the Salem Quadrangle (Trace, 1962a).

Some barite was reported at the Tom Babb (now Delhi Mine in Crittenden County) Prospect by Ulrich and Smith (1905, p. 202). According to M. M. Fine of the U.S. Bureau of Mines (1948, p. 4), dump samples from the Kentucky Babb Mine (in Livingston County) contained no more than 1 percent barite. Hardin (1955, p. 21) noted that barite is not common in the Babb area. No other reports of barite in the area are known.

Bibb Prospects—The Bibb Prospects (Fig. 17, no. 7; Carter coordinate section 2-I-17) are located about 1 mile northwest of Mexico, Kentucky, and approximately 3,000 feet west-southwest of Sulphur Spring Church. The Bibb Prospects are shown on the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967) as the two westernmost fluorspar prospects on the Mexico Fault System.

Ulrich and Smith (1905, p. 89) described the Bibb group of fractures but did not mention any mineralization; the Bibb Shaft is shown on their Plate II. Hoeing (1913, p. 575) mentioned barite at the Bibb deposit.

The surface area was examined by Trace in October 1979. The northeast-trending county road shown just north of the Bibb prospects on the geologic map of the Fredonia Quadrangle has been relocated downhill, just to the south of the prospects. No information is available on these abandoned Bibb shafts or prospects, but judging from the old dumps they were probably less than 100 feet deep.

Substantial quantities of bladed and massive white barite were found on the dumps just uphill (north) of the present (1979) county road. Some calcite, fluorspar, and galena are also present on the dumps.

The Bibb prospects and adjoining areas along the Mexico Fault System were explored by core drilling in 1956. According to local industry sources, no barite was found, although substantial quantities of fluorspar, sphalerite, and galena were reported.

Blue-Marble Mine area—The Blue-Marble Mine area (Fig. 17, no. 8; Carter coordinate section 9-I-17) is located less than a mile southwest of Mexico, Kentucky. The area is called the Blue Mine on the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967).

Ulrich and Smith (1905, p. 184) noted some barite "in a band, ranging from 2 inches up to about 1 foot in width. . . ." Although substantial quantities of fluorspar have been mined from this area, no production of barite is known. According to local sources, the fluorspar mined from residuum during the 1970's contained only 3 to 4 percent barite.

Craighead-Coates Mine area—The Craighead-Coates Mine area (Fig. 17, no. 9; Carter coordinate section 6-K-17) is located on the J. S. Stallion farm, about 6 miles northwest of Marion, Kentucky. The area includes the four shafts or prospects shown on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a) that are along the Commodore Fault System just south of its intersection with Hurricane Creek. The Carter coordinate location of the most recent and deepest of these shafts (Stallion Shaft) is 6-K-17, 2,950 ft. FNL x 2,000 ft. FWL.

The map in the front of Fohs' report (1907) shows the Old Glory Mine just south of the Beard Mines and Hurricane Creek, a location identical to or very close to the Craighead-Coates area. The Old Glory Mine was also shown by Fohs on a list of mines (p. 222), but no description is given. Brecke (1964, p. 300) mentioned the "Craighead-Coates mines where 4 to 10 feet of solid barite have been reported." No other published data are available.

No information is available regarding any prospecting prior to 1959, when the Stallion Shaft was begun. Trace visited the area when the shaft was 43 feet deep and a level trending N 12° E had just been started. According to local sources, the shaft was eventually sunk to a total depth of about 125 or 150 feet. At least two holes were core drilled along the fault northeast of the Stallion Shaft. During its operation from 1959 to 1963, according to industry sources, about 10,000 tons of marketable fluorspar were produced. No significant quantities of barite were in the ore; according to local miners, however, substantial quantities of barite are present in the residuum just northwest of the Stallion Shaft. Concentration of the fluorspar ore was done by log washer at the mine. No mining has been done since 1963.

In 1971, five holes were core drilled in an area about 1,500 feet north-northeast of the Stallion Shaft. The holes tested the vein on or near the footwall side of the fault system at vertical depths of 150 to 300 feet. Substantial quantities of fluorspar were found; only traces of barite, sphalerite, and galena were present. All of these core drill holes contained several mineralized fractures or faults, a common feature along a fault system where the wall rocks are massive and competent.

The Craighead-Coates Mine area is located along the northeast-trending Commodore Fault System. According to data gathered in 1963, the Stallion Shaft was sunk on a fault with Bethel Sandstone on the hanging wall and the Ste. Genevieve Limestone on the footwall to a depth of about 15 feet. Below 15 feet, the shaft was sunk entirely in limestone, probably the Ste. Genevieve. Displacement along the fault is probably a little over 100 feet. According to the operator, the vein dipped about 85° southeast.

The ore was light-gray and brown fluorspar with small quantities of barite, sphalerite, and galena. Based on an examination in 1979 of the mine dumps in the area, barite is abundant only in the dump from the shallow shaft about 500 feet northeast of the Stallion Shaft.

Crosson Cave Prospect area—The Crosson Cave Prospect area (Fig. 17, no. 10; Carter coordinate section 14-J-16) is located about 1 2/3 miles northeast of Salem, Kentucky. The prospect, as shown but not named on the geologic map of the Salem Quadrangle (Trace, 1962a), is the sinkhole leading into the cave with veins that was described by Ulrich and Smith (1905, p. 202-203). They noted some barite in the northwest-trending vein. During mapping of the Salem Quadrangle in 1960, Trace noted barite at the surface near some abandoned trenches that extended for about 500 feet south-southeast of the cave entrance. About 600 tons of fluorspar were produced from 1917 to 1932, but insofar as is known, no barite has been produced.

Dike-Eaton area—The Dike-Eaton area (Fig. 17, no. 11; Carter coordinate section 10-J-16) is located near Midway along U.S. Highway 60 between Marion and Salem, Kentucky. The mined areas are along the north-northwest-trending fractures and dike shown on the geologic map of the Salem Quadrangle (Trace, 1962a).

The area was shown by Ulrich and Smith (1905, Plate II) and Currier (1923, Plate I and p. 100), but barite was not mentioned. Trace (1962b, p. E-15, E-22) mentioned only small quantities of barite in the area.

Eva Tanguay Property—The Eva Tanguay property (Fig. 17, no. 12; Carter coordinate section 10-I-17) is located just south of Mexico, Kentucky, between the Pygmy and Haffaw Mines, as shown on the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967).

Only about 1,000 tons of fluorspar have been produced from the property, according to Thurston (1944, p. 1) and Starnes (1947, p. 1), although the property lies on the Tabb Fault System between the Pygmy and Haffaw Mines, both of which have produced large quantities of fluorspar.

No barite production has been recorded from the property, but according to core drilling by the U.S. Bureau of Mines in 1944-1945 (Starnes, 1947), substantial quantities of barite were cut in drill holes 88, 100, and 102. A summary of the barite data follows:

Drill hole	Hole inclination	In-hole depth (feet)	Barite (%)
88	50°	292-324	16-42
100	50°	165-182	10-30
102	50°	157-176	17-52

These three drill holes cut barite in or close to the footwall (southernmost) fault of the Tabb Fault System at vertical depths from a little over 100 feet to a little over 200 feet. According to Starnes (1947), the fault walls in the three holes were Hardinsburg or Bethel Sandstones and the St. Louis Limestone. No further work has been done on the property.

Hick Jones Prospect—The Hick Jones Prospect (Fig. 17, no. 13; Carter coordinate section 3-J-16) is located along the Hardin Knob Fault about 2,000 feet east of Hardin Knob. The prospect area is on the Salem Quadrangle (Trace, 1962a).

In 1957, barite fragments were noted on the surface in this area. Several shallow, northwest-trending trenches were dug for about 500 feet along the Hardin Knob Fault. Where the fault was exposed, only calcite veinlets were found. Some barite fragments were found, however, in the residuum on the southeastern, or Glen Dean Limestone, wall of the fault. No mining was done.

According to local industry sources, core drilling in this area did not show significant quantities of barite.

Mico Mine—The Mico Mine, also called the Cook-Spring or the Spring Barite Mine (Fig. 17, no. 14; Carter coordinate section 17-L-17) is located just south of Kentucky Highway 91, about 2 miles south of the Cave in Rock ferry on the Ohio River. The mine is shown on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a).

The Spring Mine is shown on the fault pattern map of Crittenden County (Weller and Sutton, 1929). The Spring Mine, or possibly another nearby shaft, was briefly examined by Trace during World War II. The shaft, probably less than 100 feet deep, had been sunk on the vein, which consisted only of scattered purple fluorite veinlets in limestone breccia. This shaft was located near the southwestern end of the now-abandoned open cut (Fig. 18). Just northeast, two shafts were reportedly sunk on the Cook property in 1943. A 48-foot shaft had been sunk in the overburden and contained barite but little fluorspar. A few hundred feet to the southwest, a 42-foot-deep shaft had been sunk in a 4-foot-wide zone of "gravel" barite and colorless fluorspar. Brecke (1964, p. 300) also mentioned barite at the Mico Mine.

In the 1950's, the Black Mining Company and the Mico Mining and Milling Company dug a series of 10- to 12-foot-deep trenches in the residuum, across the northeast-trending fault, for about 1,000 feet northeast and 1,000 feet southwest of Kentucky Highway 91. Another trench was dug about 3,000 feet northeast of Kentucky Highway 91 (Trace, 1974a).

On the basis of this trenching on the Cook and Spring farms, open-cut mining was begun in 1959 just south of Kentucky Highway 91. The now abandoned open cut is about 1,000 feet long, 50 to 100 feet wide, and 20 to 50 feet deep (Fig. 18). Exact barite production figures from this cut are not available; according to local trucking sources, however, as much as 10,000 tons of barite were shipped. Some of the mined material, mostly barite, chert fragments, and clay, was washed and concentrated at the mine site by metal log washers and a jig mill (Fig. 19). Some of the crude ore was concentrated at a jig mill near Mexico, Kentucky.

In the middle 1970's, some years after mining had ceased, the fault zone below the open-cut area was explored by about 10 core drill holes. No data are available. No further mining or exploration has been done.

The mined barite occurred as a residual or "gravel" deposit that was localized along an unnamed fault that trends about N 35° E (Trace, 1974a). Vertical displacement along the fault is probably about 25 to 50 feet. At the surface both fault walls are the Upper Member of the St. Louis Limestone; the identification is based on the abundant chert in the limestone, the oolitic chert in the residuum, and the absence of any Lithostrotionoid corals. Mineralization was primarily barite that was concentrated in a clay and chert residuum. Small quantities of fluorite and calcite were also present.

Moore Prospect—The Moore Prospect (Fig. 17, no. 15; Carter coordinate section 3-K-16) is located about 3,000 feet southeast of Hurricane Campground. Exploration on the property consisted of three prospect pits that are on the Lola Fault just southeast of a county road, as shown on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a).

Figure 18. Abandoned open cut at Mico barite mine in 1978, looking southwest.

Some shallow prospecting was done in the early 1960's, and according to the operator, about "one load," probably a few tons, of barite ore was taken out. Barite and calcite veinlets were found on the dump material during mapping of the geologic quadrangle in 1971 by Trace. According to local sources, some auger and core drilling was done in the middle 1970's. No other information is available. When examined in 1980, the area had been renovated for use as pasture and all evidence of prospecting had been destroyed.

Owl Hollow Mine—The Owl Hollow Mine (Fig. 17, no. 16; Carter coordinate section 6-K-17, 4,300 ft. FNL x 800 ft. FWL) is located about 1,800 feet southwest of the Stallion Shaft in the Craighead-Coates Mine area. The mine is shown, although not named, on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a).

According to industry sources, the mine was first started in the early 1950's. The shaft was sunk to a depth of 50 feet, and a few hundred tons of ore, mostly barite, were produced. In the middle 1960's the shaft was deepened to about 80 feet, and a few hundred tons of barite with some fluorspar were produced. The shaft and headframe have now collapsed; the dump material contains white veinlets of barite and some purple and translucent fluorspar veinlets. No other activity at the mine is known.

The mine is located on the footwall fault of the Commodore Fault System. The hanging wall is probably the Bethel Sandstone and the footwall is the Lower Member of the St. Louis Limestone, indicating a displacement of about 600 feet. No other data are available.

Pygmy Mine area—The Pygmy Mine area (Fig. 17, no. 17; Carter coordinate section 10-I-17) is located just south of Mexico, Kentucky, and adjacent on the east and west to the Evansville to Nashville line of the Illinois Central-Gulf Railroad. The mine area is shown on the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967).

The name "Pygmy Mine" refers to a series of shafts and open cuts that are present for about 2,000 feet along the Tabb Fault Zone. Three-fourths of the mined area is from the railroad eastward to Livingston Creek, and the remainder is from the railroad westward to Kentucky Highway 70. All the mine workings are abandoned and caved; many of the shafts were destroyed during open-cut operations in the 1960's.

The Pygmy Mine area is shown on Plate VIII and Figure 11 of Ulrich and Smith (1905) as the Myers Prospect.

Figure 19. Barite concentration mill at Mico Mine in 1958.

According to that report (p. 185), vein widths of 3 to 5 feet, largely of barite, are present near the shallow railroad cut.

The map in the front of Fohs' report (1907) also shows the Myers Prospects. In addition, Fohs (1907, p. 25) described the "Commercial Shaft on the Tabb lode, where the vein appears to be 20 feet in width." Based on this width, the shaft was probably sunk in a residual barite deposit. The shaft is not shown on Fohs' map but he may be referring to a shaft in the Pygmy Mine area or possibly the adjacent Eva Tanguay property. A composite of a series of residual surface samples was taken in 1957 for about 100 feet along the west side of the railroad cut. According to industry sources, the sample contained 25.6 percent barite. Brecke (1964, p. 300) mentioned the shallow barite deposit at the Pygmy Mine.

The Pygmy Mine area has probably produced as much as 150,000 tons of fluorspar concentrate since the early 1900's. Most of the mining was for vein deposits from shafts as deep as 325 feet. A small but recoverable quantity of galena was present also. Barite was not common in the ore mined from underground; according to local sources, overall barite content was less than 5 percent.

From 1959 to 1964, about 15,000 tons of barite were produced from an open cut by the J. Willis Crider Fluorspar Company (Fig. 20). Several thousand tons of metallurgical-grade fluorspar were also produced during and after this period. A log washer at the mine site and a jig mill at nearby Mexico, Kentucky, were used to separate and concentrate the barite and fluorspar.

Mining for barite was done by drag line from an essentially continuous open cut along the fault zone for approximately 1,500 feet between the Illinois Central-Gulf Railroad and Livingston Creek. The now-abandoned open cut is from 100 to 200 feet wide and as deep as 50 feet.

The ore mined from the open cut occurred as a residual or "gravel" deposit and consisted of a mixture of massive and bladed white barite; clear, brown, and purple fluorite; chert and sandstone fragments; and red clay. Barite was more abundant near the surface, reportedly making up 20 to 30 percent of the total residuum; fluorite became more abundant in the residuum near the bottom of the open cut.

The Hardinsburg Sandstone and cherty limestone of the Upper Member of the St. Louis Limestone are ex-

Figure 20. Open cut at Pygmy barite and fluorspar mine in 1962, looking west.

posed in the walls and floor of the cut. Scattered veinlets of fluorite, barite, and calcite are present in the limestone exposures.

The Pygmy Mine area is on the Tabb Fault System, in the eastern part of the most fluorspar-productive part of the Western Kentucky Fluorspar District. The Tabb Fault System here is about 200 to 300 feet wide and consists of a series of steeply dipping subparallel normal faults that trend about N 75° E. In places, the total vertical displacement of about 1,200 feet is distributed across the fault system in only two or three faults; elsewhere the displacement is spread more uniformly among numerous faults across the entire 200- to 300-foot-wide system. As a result, the rocks within the fault system are in places so badly brecciated that individual stratigraphic units cannot be recognized.

The Menard Limestone is on the hanging wall of the Tabb Fault System and the Upper Member of the St. Louis Limestone is on the footwall (Rogers and Hays, 1967); where the units can be recognized, the rocks at the surface between the bounding faults of the system are usually the Hardinsburg Sandstone or the Upper Member of the St. Louis Limestone.

In part of the area exposed in the open cut, three subparallel east-northeast-trending faults are present. At the surface the wall of the northernmost (hanging wall) fault are the Menard Limestone and the Hardinsburg Sandstone (Rogers and Hays, 1967), indicating about 350 to 400 feet of vertical displacement. The middle fault walls are the Hardinsburg Sandstone and the Upper Member of the St. Louis Limestone, indicating as much as 800 or 900 feet of displacement. The southernmost (footwall) fault has the Upper Member of the St. Louis Limestone on both walls. Rogers and Hays (1967) showed that the north side of each of these faults had been dropped down, indicating that the fault system is a series of three step faults.

Where the fault zone consists essentially of two bounding faults only, the fault wall units from north to south are Menard/St. Louis and St. Louis/St. Louis, with most of the fault system's displacement on the northern (hanging wall) fault. Core drilling under the open cut area in the 1970's suggested that in places the southernmost (footwall) fault was down-dropped on the south side, thus making a horst of the intra-fault system's 200- to 300-foot zone. Displacement along the southernmost fault is probably less than 100 feet.

Riley Mine—The Riley Mine (Fig. 17, no. 18; Carter coordinate section 9-I-16) is located about 3 1/2 miles southeast of Salem, Kentucky. The mine, although not named, is shown on the Claylick Fault System just north of Puckett Spring Creek on the geologic map of the Dycusburg Quadrangle (Amos and Hays, 1974).

Some barite at the Riley Mine was noted by Ulrich and Smith (1905, p. 196). Currier (1923, p. 127) also reported "considerable barite" in the vein residuum. Trace (1954) did not mention barite at the Riley Mine. No other data are available.

Sullenger Prospect area—The Sullenger Prospect area (Fig. 17, no. 19; Carter coordinate section 7-K-16) is located about a mile east of Irma, Kentucky. The area is shown on the geologic map of the Cave in Rock Quadrangle (Trace, 1974a).

Only a small amount of exploration, mostly surface, has been done here. According to Hoeing (1913, p. 575), barite is present in the area.

While mapping the Cave in Rock Quadrangle, Trace examined the prospect area labelled Sullenger Mine on the geologic map; no barite was noted. Some barite fragments were found, however, on the dump of a shallow prospect pit shown about 2,000 feet to the north-northwest. No other data are available.

Susie Beeler Mine—The Susie Beeler Mine (Fig. 17, no. 20; Carter coordinate section 25-J-17) is located on the Claylick Fault System about 9,000 feet west-southwest of View, Kentucky. Although not labelled, the mine area is on the geologic map of the Salem Quadrangle (Trace, 1962a).

Currier (1923, p. 126) stated, "A small amount of barite was found in the decomposed portions ['gravel' deposits] of the vein." No other information on barite was noted in the available mine and drill-hole data.

Tabb (Lafayette) Mine—The Tabb (Lafayette) Mine (Fig. 17, no. 21; Carter coordinate section 8-I-17) is located about 1 1/2 miles southwest of Mexico, Kentucky. The mine is shown on the Tabb Fault System at the western edge of the geologic map of the Fredonia Quadrangle (Rogers and Hays, 1967).

Ulrich and Smith (1905, p. 183 and Fig. 14) noted small quantities of barite at the Tabb Mines. According to Currier (1923, p. 120), "barite occurs in the residual clay over the limestone footwall but does not appear in the solid vein."

According to local industry sources, only small quantities of barite have been found in this mine, which was probably the largest single fluorspar mine in the district.

Livingston County

Babb area—Discussed under Crittenden County.

Bateman-Mitchell area—The Bateman-Mitchell or Lola Mine area (Fig. 17, no. 22; Carter coordinate section 3-J-15) is located just east of Lola, Kentucky. The area is shown on the geologic map of the Lola Quadrangle (Trace, 1976), and includes from 10 to 15 prospect pits and shallow shafts along the northern fault of the Lola Fault System from just southwest of Kentucky Highway 133 to the north side of Deer Creek, a distance of about 4,000 feet. Most of the old shallow shafts and pits in this area are now covered, and data on them are not available.

Ulrich and Smith (1905, p. 135 and Plate II) showed the Bateman prospects on the north side of Deer Creek and noted that barite is the chief constituent present. Currier (1923, p. 111 and Plate 1) mentioned several shafts in this area where much barite and a small amount of fluorspar were found in dump material.

In 1944, one hole was core drilled in the southwestern (Mitchell Mine) part of the area; the hole cut the vein at a vertical depth of about 150 feet. No barite was reported; however, core recovery was poor.

In the 1960's, some surface exploration was done on the Bateman Prospect (north side of Deer Creek). While mapping the Lola Quadrangle, Trace noted some barite and fluorspar on dump material at the Bateman Prospects. No other data are available.

Bonanza Mine area—The Bonanza Mine area (Fig. 17, no. 23; Carter coordinate section 6-J-15) is located about 1 1/2 miles southwest of Lola, Kentucky, and is shown on the geologic map of the Lola Quadrangle (Trace, 1976).

According to available data, the mine has produced only fluorspar. Some barite, however, was noted on two dump piles in the area by Trace during an examination in 1943. No barite was reported in several cores drilled in the area in 1943-1944.

Small quantities of barite were noted, however, in three widely scattered holes that were core drilled in 1963 for as far as 1 1/2 miles southwest of the mine along the Dyer Hill-Lola Fault Systems.

Bradshaw Prospect—The Bradshaw Prospect (Fig. 17, no. 24; Carter coordinate section 16-K-15, 1,600 ft. FNL x 1,400 ft. FWL) is located 3 1/4 miles north-northwest of Lola, Kentucky. The prospect is shown, although not named, on the geologic map of the Lola Quadrangle (Trace, 1976).

Ulrich and Smith (1905) showed the prospect on their Plate II, and indicated (p. 159) that barite is present in this area. Hoeing (1913, p. 575) mentioned barite at the Bradshaw Prospect.

While mapping the Lola Quadrangle, Trace examined a shallow open cut in which a residual or "gravel" zone of barite was exposed under the slumped Rosiclare Sandstone Member of the Ste. Genevieve Limestone. The barite appears to be in a weathered bedding-replacement deposit under the Rosiclare Sandstone Member.

The residuum around other prospects shown on the geologic quadrangle map for a little over a mile to the south-southeast to Hopewill Cemetery was auger drilled in 1957. Some fluorite was noted, but no barite.

Clement Mine—The Clement Mine (Fig. 17, no. 25; Carter coordinate section 9-K-14) is located less than a mile east of Carrsville, Kentucky, and a few hundred feet south of Kentucky Highway 135. The mine was opened about 1967 and is not shown on the geologic map of the Rosiclare Quadrangle (Amos, 1965); the mine shaft is located between the two subparallel north-northwest-trending faults just east of Buck Creek.

No data on the bedding-replacement deposits in the mine have been published. According to industry sources, the bedding-replacement ore that was mined contained relatively little barite; substantial quantities of vein barite, however, are reported (but not mined) along one of the north-northwest-trending faults. No other data are available.

Damron Mine area—The Damron (Odell Damron) Mine area (Fig. 17, no. 26; Carter coordinate section 2-J-15) is located about 2 miles east of Lola, Kentucky. The area is on the geologic map of the Lola Quadrangle (Trace, 1976), although it is not marked; the first mining was done in the middle 1970's after the mapping had been completed. The area lies between the Wright Mine area to the southwest and the Livingston-Crittenden county line to the northeast.

The first known exploratory activity on the Odell Damron property was in the early 1960's. According to local sources, auger drilling on the property at that time suggested substantial quantities of "gravel" barite. In the middle 1970's, additional auger drilling and some core drilling was done. The core drilling suggested that the vein was highly weathered, even at a vertical depth of over 100 feet. Subsequently, some barite was mined from a 10- to 30-foot-deep open cut, beginning about 300 feet southwest of the Livingston-Crittenden county line, and continuing southwesterly for about 300 feet. The open cut is about 100 feet wide and trends about S 55° W. Substantial quantities of barite were found in the residuum in the open cut; the material was concentrated in a jig mill at the Hutson Mine. Production figures are not available.

The barite occurs as a "gravel" deposit along an unnamed fault that strikes approximately N 50 to 60° E. At the surface, the hanging wall (southeastern side) is probably the Bethel Sandstone and the footwall (northwestern side) is the Ste. Genevieve Limestone, indicating about 200 to 300 feet of displacement along the fault.

Dyers Hill Mine—The Dyers Hill Mine (Fig. 17, no. 27; Carter coordinate section 14-I-14) is located about 5 miles north of Smithland, Kentucky. The mine (mislabelled as a fault) is shown on the geologic map of the Smithland Quadrangle (Amos, 1967).

According to Tibbs (1974, p. 88), minor concentrations of barite were present in the mine.

Ellis-Carr Mine—The Ellis-Carr (Karr?) Mine (Fig. 17, no. 28; Carter coordinate section 9-K-14) is located about 1 1/4 miles east of Carrsville, Kentucky. The mine opening (on the Ellis property) is shown as the Ellis Mine on the geologic map of the Rosiclare Quadrangle (Amos, 1965). The shaft shown about 1,200 feet to the southeast is on the Carr property and is an air shaft for underground workings.

No study of the Ellis-Carr Mine has been published; it was mentioned briefly by Brecke (1964, p. 299) and Amos (1965) as a fluorspar-barite mine.

The production and subsurface data given below were obtained from the operator. The mine was opened in the early 1930's and operated more or less continuously for 20 years until it closed in 1953. Approximately 250,000 tons of crude ore that contained about 25 percent barite and 25 percent fluorspar were mined. The barite and fluorspar were concentrated together and sold as "fluorbarite" for ceramic purposes.

The Ellis Shaft is about 320 feet deep with levels at 150, 170, 220, and 320 feet. Drifting extended as far south as 1,700 feet from the Ellis Shaft. Individual stopes ranged from 250 feet to nearly 900 feet along the strike of the deposit, and were 40 to 90 feet high.

The Ellis-Carr vein deposit is as wide as 22 feet but averaged about 6 feet. On the 170-foot level, a small deposit of bedding-replacement ore was present, probably just under the sub-Rosiclare or Spar Mountain unit of the Ste. Genevieve Limestone (Trace, 1974b, Fig. 4). In the upper levels of the mine, fluorspar was about twice as abundant as barite, but in the lower levels the barite content equalled or exceeded the fluorspar content.

The vein occurs along a north-northwest-trending fault of small displacement (Amos, 1965). The Ellis Shaft was started in the upper part of the Renault Limestone and probably bottomed near the base of the Ste. Genevieve Limestone. Both fault walls of the ore deposit were the Ste. Genevieve Limestone.

Klondike Mine—The Klondike Mine (Fig. 17, no. 29; Carter coordinate section 11-I-14) is located about 6 miles northeast of Smithland, Kentucky, and is shown on the geologic map of the Burna Quadrangle (Amos, 1974).

Ulrich and Smith (1905, p. 200) mentioned seams of barite. No mention of barite was given by Swanson (1949) in his U.S. Bureau of Mines summary of drilling near the mine. Also, no barite was present in the mine, according to a long-time operator.

Lindley Barite Prospect area—The Lindley Barite Prospect area (Fig. 17, no. 30; Carter coordinate section

21-J-15) is located a little more than 1/2 mile west of Salem, Kentucky, along U.S. Highway 60. According to Plate II of Ulrich and Smith (1905), the original prospects were located just north and south of the highway. No surface evidence of these original prospects is now present. The area is near the intersection of the Babb Fault and U.S. Highway 60, as shown on the geologic map of the Lola Quadrangle (Trace, 1976).

The Lindley barite deposit was mentioned by Hoeing (1913, p. 575). According to local industry sources, in 1948 a core drill hole just north of U.S. Highway 60 and along the Babb Fault cut both fluorspar and barite at a vertical depth of over 400 feet. Barite traces were also present in a core drill hole about 1/2 mile to the northeast in the Butler Mine area (Trace, 1976).

For about 2,000 feet along the Babb Fault south of the highway, some core and auger holes drilled in 1959 are reported to have contained small quantities of barite. In the same vicinity, vertical holes that were drilled in the 1950's for Salem's water supply are reported also to have contained small quantities of barite. No mining is known in this immediate area.

Loveless (Ramage) Mine—The Loveless (Ramage) Mine (Fig. 17, no. 31; Carter coordinate section 1-I-15) is located 1 3/4 miles southwest of Salem, Kentucky. The mine is named on the topographic map of the Burna Quadrangle and is shown, although not named, on the geologic map of the Burna Quadrangle (Amos, 1974).

According to local sources, as much as 3,000 tons of marketable ore containing two-thirds fluorspar and one-third barite have been produced from the mine. Operations took place in the 1930's, the 1950's, and as late as about 1970. Most of the work was done from one or possibly two now-caved and abandoned shafts that were no deeper than 100 feet.

Small quantities of barite were present on the dump material at the mine. No other data are available.

May Mine area—The May Mine area (Fig. 17, no. 32; Carter coordinate section 21-K-14) is located about 2 1/2 miles northwest of Lola, Kentucky. The area is shown on the geologic map of the Lola Quadrangle (Trace, 1976).

Little is known about past mining operations in the area. Small quantities of fluorspar with some barite probably have been produced during several small operations, the last of which was in the early 1970's.

Hardin and Thurston (1945, p. 639-640) described an occurrence of celestite ($SrSO_4$) at the Jameson Prospect (one of the shafts in the May Mine area). According to their description, the Jameson Shaft was at least 100 feet deep with a level to the northwest for about 120 feet. The shaft was sunk on a nearly vertical N 10° W-trending fault that had Bethel Sandstone and Renault Limestone walls at the surface, indicating a vertical displacement of about 60 feet. Below a depth of 60 feet in the shaft, the vein was 2 to 4 feet wide and was composed largely of massive brown fluorite with fine-grained barite and disseminated marcasite.

In 1977-1978, nine holes were core drilled on the two easternmost faults in the area. According to that drilling, the veins were vertical and averaged 20 feet in width. Calcite was the most abundant mineral, but substantial quantities of barite and fluorspar are also reported. The veins were explored at vertical depths of 100 to 400 feet.

Two faults that strike north and slightly west of north cross the area. Fault walls at the surface include the Bethel Sandstone, Renault Limestone, and the Ste. Genevieve Limestone; vertical displacement along the faults is as much as 65 feet. Where explored by drilling, the fault walls are the Ste. Genevieve and St. Louis Limestones.

Royal (Silver) Mine—The Royal (Silver) Mine (Fig. 17, no. 33; Carter coordinate section 23-I-14) is located about 2 1/2 miles northeast of Smithland, Kentucky, and is shown as the Silver Mine on the geologic map of the Smithland Quadrangle (Amos, 1967).

Ulrich and Smith (1905, p. 199) mentioned small quantities of barite. Amos (1967) also mentioned small amounts of barite in the general area. Klepser (1945) did not mention barite at the Royal Mine.

According to local industry sources, small amounts of barite were found only within 10 to 15 feet of the surface. No other data on barite are known.

Shouse Mine—The Shouse Mine (Fig. 17, no. 34; Carter coordinate section 18-K-14) is located about 3,000 feet northeast of Joy, Kentucky. The mine is shown as the Joy Mine on the geologic map of the Golconda Quadrangle (Amos, 1966).

Approximately 100,000 tons of crude fluorspar ore were mined during the 1960's and early 1970's; reportedly, the ore as mined contained no more than 1 percent barite. According to local mining sources, however, barite was present in the floor of this bedding-replacement deposit. Because of the milling problem in separating barite from fluorspar, the part of the deposits that contained barite was not mined. No further data on barite are available.

Sunderland Mine area—The Sunderland Mine area (Fig. 17, no. 35; Carter coordinate section 1- and 10-J-14) is located about 1 3/4 miles west of Lola, as shown on the geologic map of the Lola Quadrangle (Trace, 1976).

No published reference to ore deposits on this property is known. Currier (1923, p. 31), however, mentioned the dike that crosses the Sunderland property. In 1943, Trace examined the vein in a 27-foot prospect shaft along the dike on the Sunderland property. The vein between the lamprophyre dike on the western wall of the shaft and limestone on the eastern wall consisted of 3 feet of massive calcite; next to the limestone wall, an irregular veinlet of solid sphalerite as much as 2 inches wide was present. Five other shallow shafts or pits as deep as 50 feet had been sunk on the dike and the parallel fault about 150 feet to the east. According to the operator, only calcite with traces of sphalerite and galena were found.

In 1950-1953, extensive core drill exploration as deep as 600 feet was done on the Sunderland property. According to industry sources, several drill holes cut substantial quantities of fluorspar and barite and lesser quantities of sphalerite and galena on the fault about 150 feet east of the dike. No barite is reported along the dike. No further work on the property is known.

As shown on the geologic map of the Lola Quadrangle (Trace, 1976), the dike and adjacent fault strike north. The fault dips steeply to the east with the Renault Limestone on the footwall and the Bethel Sandstone on the hanging wall. The vein walls, where drilled, were mostly the Ste. Genevieve and St. Louis Limestones.

Wright Mine area—The Wright (Bill Wright) Mine area (Fig. 17, no. 36; Carter coordinate section 9-J-15) is located about 1 1/2 miles east-southeast of Lola, Kentucky. The area is shown on the geologic map of the Lola Quadrangle (Trace, 1976).

No published reference to the Bill Wright Mine area is known. Trace briefly examined the area in 1943 and 1944. At that time several shallow shafts, 15, 28, 50, and 110 feet in depth, had been sunk prior to or in 1943. The first two of these shafts contained abundant barite with lesser quantities of fluorspar in the residuum. A drift had been started at the 100-foot level in the 110-foot shaft and had exposed a 3- to 4-foot weathered zone of barite and fluorite between sandstone boulder and cherty, yellow clay "walls." Two holes had been core drilled, but the recovery in the veins was poor because of the depth of weathering.

According to the operator, the deepest shaft was 140 feet with about 360 feet of drifting on the 100-foot level. Vein widths are reported to have ranged from 2 1/2 feet to 30 feet; the latter width probably refers to a "gravel" zone. Approximately 10,000 tons of an equal mixture of barite and fluorspar (fluorbarite) were produced between the early 1940's and 1953, when the mine was closed. According to the operator, the ratio of barite to fluorspar increased with depth.

Several additional holes were core drilled in the late 1950's. None of the holes cut the vein area at vertical depths much greater than 100 feet. Detailed data are not available. Approximately 1,500 feet along the fault has been explored to some degree, but never much deeper than 100 feet vertically. No further operations have been done.

The ore deposit probably occurs mostly as a residual or "gravel" deposit along an unnamed fault that strikes N 40° E. At the surface, the Cypress Sandstone is the hanging wall (southeastern side) and the Ste. Genevieve Limestone is the footwall (northwestern side), indicating about 300 feet of displacement. This entire 300 feet of displacement appears to be concentrated in one fault or at least in a very narrow fault zone. Because both wall rocks at the surface are competent units and do not easily drag fold, the large displacement has created a zone of severe brecciation that has allowed weathering processes to be active to depths of at least 100 feet. At that depth, the walls apparently are not solid, although parts of the vein material are in place.

Other Western Kentucky Deposits

Union County

The ***Babb Barite Prospect*** (Carter coordinate section 23-O-18) is located about 8 miles west of Morganfield, Kentucky, and about 5 miles east of the bridge over the Ohio River at Shawneetown, Illinois (Fig. 21). Palmer (1976) mentioned and showed the location of the prospect on the geologic map of the Grove Center Quadrangle. Barite was first described here by Lyon (1856), who said, "A bold spring rises from a bed or vein of barytes or heavy spar; this mineral appears to be very abundant in this locality. . . ."

Few data are available regarding the history of the prospect. According to a nearby long-time resident, the prospect was core drilled for fluorspar in about 1920, but nothing has been done since. The spring that was mentioned by Lyon is now covered by a small concrete block house. Shallow surface exploration was done prior to 1920 for about 100 feet uphill (southwest) from the spring, in and adjacent to a small draw. Barite fragments are very common in and adjacent to this small draw, and a few chert fragments with barite veinlets are also present. The barite on the surface occurs in white, massive, and bladed fragments that are covered with a thin film of brown clay. No fluorite was found on the surface.

According to Palmer (1976), the prospect is on a fault of the Rough Creek Fault System that trends west-northwest; both walls of the fault are the Sturgis Formation of Pennsylvanian age. An outcrop of silicified and slickensided sandstone is present between the spring house and the prospected area. Based on the fragments of replacement chert, one of the thin Sturgis Formation limestone units is present near the surface on one of the fault walls. The texture of some of the chert shows that the original limestone was pelletal and contained some crinoid stems. The proximity of the fault to the prospect suggests that the subsurface barite is in a vein rather than a bed, although no direct evidence was seen.

Figure 21. Map of Union County, Kentucky, showing Rough Creek Fault System and Babb Barite Prospect.

SUMMARY

Barite is a potentially important mineral resource in Kentucky. It has been recognized at more than 170 mines, prospects, and outcrops in 23 counties in central, south-central, and western Kentucky.

Most of the Kentucky barite deposits are classified as vein or residual deposits. The deposits are scattered and irregular, and range in thickness from a fraction of an inch to a few feet and in length from tens to hundreds of feet. Bedded deposits of barite have not been mined in Kentucky; their presence, however, is suggested by beds or zones of brecciated carbonate rocks of Mississippian age on the southeastern flank of the Lexington Dome, a few bedding-replacement fluorspar deposits in western Kentucky, the bedded barite deposits in western Kentucky, the bedded barite deposits at Pall Mall in northern Tennessee, and the bedded fluorite-barite ore in southern Illinois.

The vein deposits are generally mixed ores. Most common co-products are fluorite (fluorspar), galena, and sphalerite. Because mixed ores, particularly barite and fluorite, were once considered difficult to separate economically, many deposits were bypassed in mining activities.

Quantitative reserve data are generally lacking, as little subsurface information is available, and farm-improvement and land-development activities have obscured a number of reported outcrops, prospects, and small mines. The writers can neither confirm nor modify Brobst's (1973, Table 13) estimate of 11.5 million tons of identified and hypothetical reserves for the State.

In the Central Kentucky Mineral District, veins in the northern half of the district are predominantly barite, while those in the southern part are mixed fluorite and barite veins. Some barite veins have a high strontium sulfate content.

The most favorable areas for prospecting in central Kentucky appear to be along mineralized faults and fractures in calcarenitic and fossiliferous lithologies in the Lexington Limestone in the northern part of the district. Small faults and fractures near the terminus or intersection of the major fault systems are also likely prospecting sites.

Most of the barite and "fluorbarite" production in the Western Kentucky Fluorspar District has come from the Pygmy, Mico, Ellis-Carr, Wright, and Ainsworth Mines. Most of these deposits and others with lesser production occur in a zonal arrangement around the domal Tolu Arch.

Every known barite or baritic fluorspar deposit in the Western Kentucky Fluorspar District occurs with the Ste. Genevieve or St. Louis Limestones on the footwall of the fault. Inasmuch as fluorspar and barite are usually associated together in this district, it is also probable that, as with fluorspar, the position of the Ste. Genevieve Limestone would guide exploration projects.

SELECTED REFERENCES

Allingham, J. W., 1972, Geologic map of the Harrodsburg Quadrangle, Mercer and Woodford Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1020.

Amos, D. H., 1965, Geology of parts of the Shetlerville and Rosiclare Quadrangles, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-400.

Amos, D. H., Geologic map of the Golconda Quadrangle, Kentucky-Illinois, and a part of the Brownfield Quadrangle in Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-546.

Amos, D. H., 1967, Geologic map of part of the Smithland Quadrangle, Livingston County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-657.

Amos, D. H., 1974, Geologic map of the Burna Quadrangle, Livingston County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1150.

Amos, D. H., and Hays, W. H., 1974, Geologic map of the Dycusburg Quadrangle, Western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1149.

Beck, W. A., 1949, Investigation of K. T. Dome Zinc-Lead Mine, Owen and Henry Counties, Kentucky: U.S. Bureau of Mines Report of Investigation 4575, 10 p.

Black, D. F. B., 1964, Geology of the Versailles Quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-325.

Black, D. F. B., 1967, Geologic map of the Coletown Quadrangle, east-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-644.

Black, D. F. B., 1968, Geologic map of the Ford Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-764.

Black, D. F. B., 1974, Geologic map of the Winchester Quadrangle, Clark and Madison Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1159.

Black, D. F. B., 1975, Geologic map of the Hedges Quadrangle, Clark County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1235.

Black, D. F. B., and Haney, D. C., 1975, Selected structural features and associated dolostone occurrences in the vicinity of the Kentucky River Fault System: Roadlog and Guidebook, Annual Field Conference, Geological Society of Kentucky: Kentucky Geological Survey, ser. 10, 27 p.

Black, D. F. B., and MacQuown, W. C., Jr., 1965, Lithostratigraphy of the Ordovician Lexington Limestone and Clays Ferry Formation of the central Bluegrass area near Lexington, Kentucky: Roadlog and Guidebook, Annual Field Conference, Geological Society of Kentucky: Kentucky Geological Survey, p. 6-43.

Black, D. F. B., MacQuown, W. C., and DeHass, R. J., 1981, The relation of dolomite associated with faults to the stratigraphy and structure of central Kentucky: U.S. Geological Survey Professional Paper 1151-A, 19 p.

Bondurant, W. S., 1978, A trace element study of sphalerite in the Central Kentucky Mineral District: Lexington, University of Kentucky, M.S. Thesis, 50 p.

Bradbury, J. C., 1959, Barite in the Southern Illinois Fluorspar District: Illinois State Geological Survey Circular 265, 14 p.

Brecke, E. A., 1964, Barite zoning in the Illinois-Kentucky Fluorspar District: Economic Geology, v. 59, no. 2, p. 299-302.

Brecke, E. A., 1979, A hydrothermal system in the Midcontinent region: Economic Geology, v. 74, no. 6, p. 1327-1335.

Breeding, N. K., Jr., 1972, Geochemical soil analysis for heavy metals in the Central Kentucky Fluorspar District: Lexington, University of Kentucky, M.S. Thesis, 41 p.

Brobst, D. A., 1973, Barite, *in* United States mineral resources: U.S. Geological Survey Professional Paper 820, p. 75-84.

Brown, W. R., and Osolnik, M. J., 1974, Geologic map of the Livingston Quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1179.

Bucher, W. H., 1933, Volcanic explosions and overthrusts: American Geophysical Union Transactions, 14th Annual Meeting, p. 238-242.

Cressman, E. R., 1964, Geology of the Tyrone Quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-303.

Cressman, E. R., 1965, Geologic map of the Keene Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-440.

Cressman, E. R., Geologic map of the Georgetown Quadrangle, Scott and Fayette Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-605.

Cressman, E. R., 1968, Geologic map of the Salvisa Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-760.

Cressman, E. R., 1972a, Geologic map of the Danville Quadrangle, Mercer and Boyle Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-985.

Cressman, E. R., 1972b, Geologic map of the Lawrenceburg Quadrangle, Anderson and Franklin Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1026.

Cressman, E. R., 1973, Lithostratigraphy and depositional environments of the Lexington Limestone (Ordovician) of central Kentucky: U.S. Geological Survey Professional Paper 768, 61 p.

Cressman, E. R., and Hrabar, S. V., 1970, Geologic map of the Wilmore Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-847.

Cressman, E. R., and Noger, M. C., 1976, Tidal flat carbonate environments in the High Bridge Group (Middle Ordovician) of central Kentucky: Kentucky Geological Survey, ser. 10, Report of Investigations 18, 15 p.

Cuppels, N. P., 1973, Geologic map of the Shawhan Quadrangle, Bourbon and Harrison Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1122.

Cuppels, N. P., and Outerbridge, W. R., 1974, Geologic map of the Millersburg Quadrangle, east-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1219.

Currier, L. W., 1923, Fluorspar deposits of Kentucky, a description and interpretation of the geologic occurrence and industrial importance of Kentucky fluorspar: Kentucky Geological Survey, ser. 6, v. 13, 198 p.

Dever, G. R., Jr., Sumartojo, Jojok, and Ellsworth, G. E., Jr., 1978, Features indicating the former presence of evaporites in the St. Louis Limestone (Mississippian) of eastern Kentucky [Abst.]: Geological Society of America Southeastern Section, Abstracts with Programs, v. 10, no. 4, p. 167.

Earl, K. M., 1959, John Burdette barite-fluorite deposits, Garrard County, Kentucky: U.S. Bureau of Mines Report of Investigations 5480, 14 p.

Fine, M. M., 1948, Concentration of fluorite from tailings and mine waste rock in Crittenden and Livingston Counties, Kentucky: U.S. Bureau of Mines Report of Investigations 4370, 21 p.

Fisher, I. S., 1977, Distribution of Mississippian geodes and geodal minerals in Kentucky: Economic Geology, v. 72, no. 5, p. 864-869.

Fohs, F. J., 1907, Fluorspar deposits in Kentucky: Kentucky Geological Survey, ser. 3, Bulletin 9, 296 p.

Fohs, F. J., 1912, Report on the geology and economic resources of Rockcastle County, Kentucky: Kentucky Geological Survey, ser. 3, County Report 4, 112 p.

Fohs, F. J., 1913, Barytes deposits of Kentucky: Kentucky Geological Survey, ser. 4, v. 1, p. 441-588.

Gibbons, A. B., 1975, Geologic map of the Worthville Quadrangle, Henry and Owen Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1265.

Gibbons, A. B., 1976, Geologic map of the Franklinton Quadrangle, Henry County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1330.

Gibbons, A. B., and Swadley, W C, 1976, Geologic map of the New Liberty Quadrangle, Owen County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1348.

Graton, L. C., and Harcourt, G. A., 1935, Spectrographic evidence on origin of ores of Mississippi Valley type: Economic Geology, v. 30, no. 7, p. 800-824.

Greene, R. C., 1966, Geologic map of the Valley View Quadrangle, Madison County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-470.

Greene, R. C., 1968, Geologic map of the Panola Quadrangle, Estill and Madison Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-686.

Gualtieri, J. L., 1967, Geologic map of the Crab Orchard Quadrangle, Lincoln County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-571.

Hall, W. E., and Friedman, Irving, 1963, Composition of fluid inclusions, Cave in Rock Fluorite District, Illinois, and Upper Mississippi Valley Zinc-Lead District: Economic Geology, v. 58, no. 6, p. 886-911.

Hardin, G. C., Jr., 1955, Babb Fault System, Crittenden and Livingston Counties, *in* Fluorspar deposits in western Kentucky: U.S. Geological Survey Bulletin 1012-B, pt. 1, p. 7-37.

Hardin, G. C., Jr., and Thurston, W. R., 1945, Celestite from Livingston County, Kentucky: American Mineralogist, v. 30, nos. 9 and 10, p. 639-640.

Harris, L. D., 1972, Geologic map of the Junction City Quadrangle, Boyle County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-981.

Hetterman, J. L., 1974, A trace element study of fluorite from the Central Kentucky and Kentucky-Illinois Mineral Districts: Lexington, University of Kentucky, M.S. Thesis, 147 p.

Heyl, A. V., 1972, The 38th Parallel Lineament and its relationship to ore deposits: Economic Geology, v. 67, no. 7, p. 879-894.

Hoeing, J. B., 1913, Barite, fluorspar, zinc, and lead: Kentucky Geological Survey, ser. 4, v. 1, pt. 1, p. 62-66.

Hook, J. W., 1974, Structure of the fault systems in the Illinois-Kentucky Fluorspar District *in* Hutcheson, D. W., ed., A symposium on the geology of fluorspar: Kentucky Geological Survey, ser. 10, SpecialPublication 22, p. 77-86.

Jewell, W. B., 1947, Barite, fluorite, galena, sphalerite veins of middle Tennessee: Tennessee Division of Geology, Bulletin 51, 114 p.

Jillson, W. R., 1931, Oil and gas map of Owen County: Kentucky Geological Survey, ser. 6.

Jillson, W. R., 1940, Lead mines of the lower Kentucky River Valley: Louisville, John P. Morton and Co., 51 p.

Jolly, J. L., and Heyl, A. V., 1964, Mineral paragenesis and zoning in the Central Kentucky Mineral District: Economic Geology, v. 59, no. 4, p. 596-624; Kentucky Geological Survey, ser. 10, Reprint 15.

Kanizay, S. P., and Cressman, E. R., 1967, Geologic map of the Centerville Quadrangle, eastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-653.

Klepser, H. J., 1945, Preliminary notes on the geology of the Royal Mine area, Livingston County, Kentucky: U.S. Geological Survey Open-File Report.

Lewis, R. Q., Sr., 1972, Geologic map of the Vernon Quadrangle, Cumberland and Monroe Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-966.

Lewis, R. Q., Sr., 1977, Geologic map of the Powersburg Quadrangle, Wayne and Clinton Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1377.

Lyon, S. S., Topographical geological report of that portion of Kentucky including Union and part of Crittenden Counties, surveyed during the years 1854 and 1855: Kentucky Geological Survey, ser. 1, v. 1, p. 381-400.

MacQuown, W. D., Jr., 1968a, Geologic map of the Clintonville Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-717.

MacQuown, W. C., Jr., 1968b, Geologic map of the Nicholasville Quadrangle, Jessamine and Fayette Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-767.

MacQuown, W. C., Jr., and Dobrovolny, Ernest, 1968, Geologic map of the Lexington East Quadrangle, Fayette and Bourbon Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-683.

Maher, S. W., 1970, Barite resources of Tennessee: Tennessee Division of Geology, Report of Investigations 28, 40 p.

McFarlan, A. C., 1943, Geology of Kentucky: Lexington, University of Kentucky, 531 p.

McGuire, W. H., and Howell, Paul, 1963, Oil and gas possibilities of the Cambrian and Lower Ordovician in Kentucky: Lexington, Spindletop Research (for Kentucky Department of Commerce), 216 p.

Miller, A. M., 1905a, Map of the Highbridge and Trenton areas, showing location of mineral veins: Kentucky Geological Survey, ser. 3, Scale 1:300,000.

Miller, A. M., 1905b, The lead and zinc bearing rocks of central Kentucky: Kentucky Geological Survey, ser. 3, Bulletin 2, 35 p.

Miller, A. M., 1913, Geology of the Georgetown Quadrangle: Kentucky Geological Survey, ser. 4, v. 1, pt. 1, p. 317-342.

Miller, A. M., 1914, Geology of Franklin County: Kentucky Geological Survey, ser. 4, v. 2, pt. 3, p. 11-87.

Miller, A. M., 1924, Geologic map of Woodford County: Kentucky Geological Survey, ser. 6.

Miller, R. D., 1967, Geologic map of the Lexington West Quadrangle, Fayette County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-600.

Moore, F. B., 1975, Geologic map of the Switzer Quadrangle, north-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1266.

Moore, F. B., 1977a, Geologic map of the Gratz Quadrangle, Owen and Henry Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1359.

Moore, F. B., 1977b, Geologic map of the Monterey Quadrangle, Owen County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1400.

Moore, F. B., 1977c, Geologic map of the Polsgrove Quadrangle, north-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1349.

Moore, F. B., 1977d, Geologic map of the Stamping Ground Quadrangle, north-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1430.

Norwood, C. J., 1877, A reconnaissance report on the lead region of Henry County with some notes on Owen and Franklin Counties: Kentucky Geological Survey, ser. 2, v. 2, pt. 7, p. 245-276.

Ohle, E. L., 1959, Some considerations in determining the origin of ore deposits of the Mississippi Valley type: Economic Geology, v. 54, no. 5, p. 769-789.

Ohle, E. L., 1980, Some considerations in determining the origin of ore deposits of the Mississippi Valley type—Part II: Economic Geology, v. 75, no. 2, p. 161-172.

Outerbridge, W. F., 1974a, Geologic map of the Paris East Quadrangle, Bourbon County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1167.

Outerbridge, W. F., 1974b, Geologic map of the Paris West Quadrangle, Bourbon and Fayette Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1162.

Owen, D. D., 1857, Third report of the geological survey in Kentucky: Kentucky Geological Survey, ser. 1, v. 3, 589 p.

Palmer, J. E., 1976, Geologic map of the Grove Center Quadrangle, Kentucky-Illinois, and part of the Shawneetown Quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1314.

Plummer, L. N., Jr., 1971, Barite deposition in central Kentucky: Economic Geology, v. 66, no. 2, p. 252-258.

Pomeroy, J. S., 1968, Geologic map of the Frankfort East Quadrangle, Franklin and Woodford Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-707.

Pomeroy, J. S., 1970, Geologic map of the Midway

Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-856.

Rice, C. L., 1972, Geologic map of the Alcorn Quadrangle, east-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-963.

Rhoades, R. F., and Mistler, A. J., 1941, Post-Appalachian faulting in western Kentucky: American Association of Petroleum Geologists Bulletin, v. 25, no. 11, p. 2046-2056.

Robinson, L. C., 1931, Vein deposits of central Kentucky: Kentucky Geological Survey, ser. 6, v. 41, p. 3-127.

Roedder, E. H., 1971, Fluid-inclusion evidence on the environment of formation of mineral deposits of the Southern Appalachian Valley: Economic Geology, v. 66, p. 777-791.

Roger, W. B., and Hays, W. H., 1967, Geologic map of the Fredonia Quadrangle, western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-607.

Rogers, W. B., and Trace, R. D., 1976, Geologic map of the Crider Quadrangle, Caldwell County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1283.

Sample, R. D., 1965, Geology of the Princeton West Quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-385.

Schlanger, S. O., and Weir, G. W., 1971, Geologic map of the Mt. Vernon Quadrangle, Rockcastle County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-902.

Seeger, C. R., 1968, Origin of the Jeptha Knob structure, Kentucky: American Journal of Science, v. 266, no. 8, p. 630-660; 1969, Kentucky Geological Survey, ser. 10, Reprint 28.

Sellier, L. M., 1913. Map of Georgetown Quadrangle: Frankfort, Ky., Kentucky Geological Survey.

Shaler, N. S., 1899, Formation of dikes and veins: Geological Society of America Bulletin, v. 10, p. 253-262.

Shawe, F. R., and Wigley, P. B., 1974, Geologic map of the Stanford Quadrangle, Boyle and Lincoln Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1137.

Simmons, G. C., 1967, Geologic map of the Union City Quadrangle, Madison and Clark Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-585.

Starnes, X. B., 1947, Fluorite and zinc on the Eva Tanguay property, Crittenden County, Kentucky: U.S. Bureau of Mines Report of Investigations 4055, 16 p.

Swanson, A. S., 1949, Investigation of the Klondike fluorspar deposit, Livingston County, Kentucky: U.S. Bureau of Mines Report of Investigations 4603, 19 p.

Taylor, A. R., 1962, Geologic map of the Amandaville Quadrangle, southern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-186.

Thurston, W. R., 1944, Notes on the geology of the Eva Tanguay fluorspar property, Tabb Fault System, Crittenden County, Kentucky: U.S. Geological Survey Open-File Report, 2 p.

Tibbs, J. S., 1974, Geology and history of Penwalt Corporation's Dyers Hill Mine, Livingston County, Kentucky, *in* Hutcheson, D. W., ed., A symposium on the geology of fluorspar: Kentucky Geological Survey, ser. 10, Special Publication 22, p. 87-95.

Trace, R. D., 1954, Fluorspar deposits of western Kentucky: Part 2, Mineral Ridge area, Livingston and Crittenden Counties: U.S. Geological Survey Bulletin 1012-D, p. 59-79.

Trace, R. D., 1962a, Geology of the Salem Quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-206.

Trace, R. D., 1962b, Geology and fluorspar deposits of the Levias-Keystone and Dike-Eaton areas, Crittenden County, Kentucky: U.S. Geological Survey Bulletin 1122-E, 26 p.

Trace, R. D., 1974a, Geologic map of part of the Cave in Rock Quadrangle, Crittenden County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1201.

Trace, R. D., 1974b, Illinois-Kentucky fluorspar district, *in* Hutcheson, D. W., ed., A symposium on the geology of fluorspar: Kentucky Geological Survey, ser. 10, Special Publication 22, p. 58-76.

Trace, R. D., 1976, Geologic map of the Lola Quadrangle, Livingston and Crittenden Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1288.

Ulrich, E. O., and Smith, W. S. T., 1905, The lead, zinc, and fluorspar deposits of western Kentucky: U.S. Geological Survey Professional Paper 36, 218 p.

Weir, G. W., 1969, Geologic map of the Paint Lick Quadrangle, east-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-800.

Weir, G. W., and Richards, P. W., 1974, Geologic map of the Pomeroyton Quadrangle, east-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1184.

Weller, Stuart, and Sutton, A. H., 1929, Map of the areal and structural geology (fault pattern) of Crittenden County, Kentucky, with regional stratigraphic section: Kentucky Geological Survey, ser. 6, Scale 1:62,500.

Wolcott, D. E., 1969, Geologic map of the Little Hickman Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-792.

Wolcott, D. E., and Cressman, E. R., 1971, Geologic map of the Bryantsville Quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-945.

Wolford, J. J., 1932, The geology of Owen County, north-central Kentucky: Baltimore, Johns Hopkins University, Ph.D. Thesis, 209 p.

Wolford, J. J., Chappars, M. S., and Withers, F. S., 1931, Areal and structural geology of Owen County, Kentucky: Kentucky Geological Survey, ser. 6.

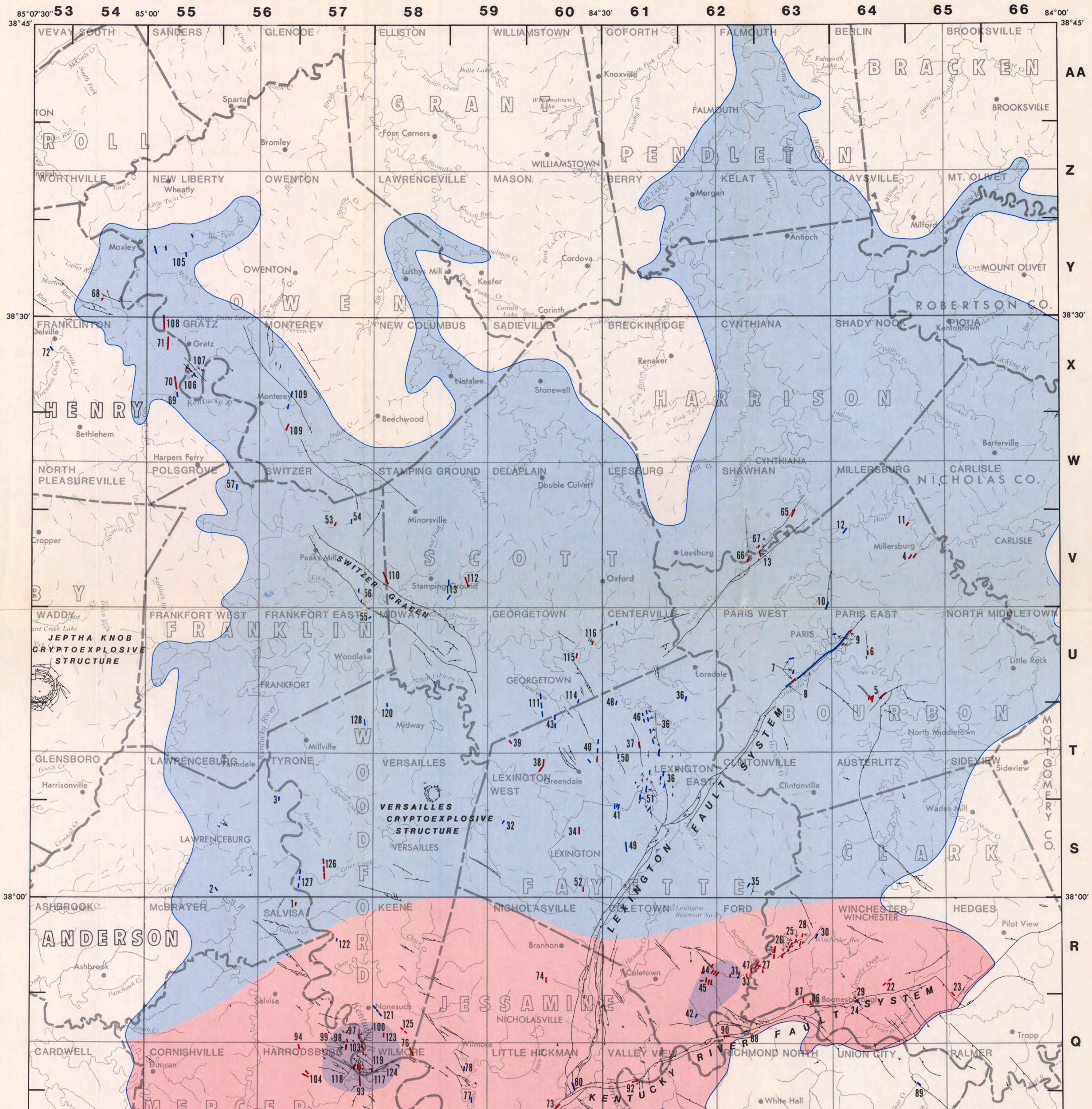
Zartman, R. E., Brock, M. R., Heyl, A. V., and Thomas, H. H., 1967, K-Ar and Rb-Sr ages of some alkalic intrusive rocks from central and eastern United States: American Journal of Science, v. 265, no. 10, p. 848-870.

KENTUCKY GEOLOGICAL SURVEY
Donald C. Haney, Director and State Geologist

PLATE 1
BULLETIN 1

BARITE OCCURRENCES

Map Number	Robinson (1931) Numerical Designation	Name	County	Carter Coord. Location	Geologic Quadrangle
1	5	Bear Branch Creek (Routt) Vein	Anderson	1-R-56	Salvisa
2	1	Hammonds Creek Vein	Anderson		Lawrenceburg
3	2	Watts Vein	Anderson		Tyrone
4	11	Caldwell Veins	Bourbon	15-V-15	Millersburg
5	7	Cassius Clay Veins	Bourbon	22, 23-U-64	Paris East
6	—	Clay Vein	Bourbon	13-U-64	Paris East
7	—	Houston Creek Veins	Bourbon	13, 18-U-63	Paris West
8	6, 12	Paris Vein	Bourbon	11-U-63 18-U-63 19-U-63 6, 7, 15-U-64	Paris East and Paris West
9	—	Paris (Marsh) Vein	Bourbon	7-U-64	Paris East
10	—	Peacock Road Vein	Bourbon	21-V-63 1-U-63	Paris West, Shawhan
11	10	Purdy Vein	Bourbon	5-V-65	Millersburg
12	—	Ruddels Mill Vein	Bourbon	6-V-64	Millersburg
13	—	Silas Creek Vein	Bourbon	15-V-63	Shawhan
14	18	Baughman Vein	Boyle		Danville
15	13	Faulconer Vein	Boyle	13-0-57	Danville
16	19	Gunn Vein	Boyle		Bryantsville
17	15	Hayden Vein	Boyle	13-N-57	Junction City
18	29	Hubble Vein	Boyle		Stanford
19	17	Sandidge Vein	Boyle	8-N-58	Bryantsville
20	16	Walker Vein (Caldwell Stone Company Quarry)	Boyle	15-N-58	Bryantsville, Stanford
21	—	Walker West Vein	Boyle	14-N-58	Bryantsville
22	30	Doctor Cole Prospect	Clark	22-R-64	Winchester
23	—	Dry Fork Vein	Clark	2, 3-Q-65	Hedges
24	32	Hampton Vein	Clark		Winchester
25	—	Jones Nursery Road Vein	Clark	13, 14, 17-R-63	Ford
26	—	Rice Vein	Clark	14-R-63	Ford
27	35, 60	Smith-Dugan Vein	Clark	16-R-63	Ford
28	34	Stevenson Vein	Clark	12, 13-R-63	Ford
29	31	Thomas-Stevenson Vein	Clark		Ford
30	—	Waterworks Road Vein	Clark	9-R-63	Ford
31	—	Boggs Fork Creek Veins	Fayette	19, 22-R-62	Ford
32	40	Bosworth Vein	Fayette		Lexington West
33	—	Blue Grass Christian Camp Vein	Fayette	20, 21-R-62	Ford
34	—	Central Rock Company Quarry	Fayette	9-S-60	Lexington West
35	—	Chilesburg Railroad Vein	Fayette	21-S-62	Clintonville
36	53, 54	Cole and Russell Cave Veins	Fayette	S, T-61	Centerville Lexington East
37	49	Craig Vein	Fayette	13-T-61	Lexington East
38	42	Crenshaw Vein	Fayette	14, 17-T-60	Lexington West
39	41	Dolan Vein	Fayette	9-T-59	Georgetown
40	45, 44	Downing and Pettit Veins	Fayette	11-T-60	Lexington West
41	38	Erdman Vein	Fayette		Lexington East
42	63	Goff Vein	Fayette		Coletown
43	43	S. Haggins Vein	Fayette		Georgetown
44	—	I-75 Veins	Fayette	18-R-62	Ford and Coletown
45	61, 65	McChord & McChord Schoolhouse Veins	Fayette	23, 24-R-62	Coletown
46	52	Moore Vein	Fayette		Centerville
47	59	Mortons Mill Vein	Fayette	20-R-62	Ford
48	47	Peter Vein	Fayette		Georgetown
49	37	Potters Field (Stoll) Vein	Fayette		Lexington West
50	46	Ware Vein	Fayette		Lexington East
51	51	Yarington Vein	Fayette	S, T-61	Centerville Lexington East
52	—	Yawl Vein	Fayette	22-S-60	Nicholasville
53	—	Abandoned adit on Camp Pleasant Branch	Franklin	3-V-57	Switzer
54	73	Camp Pleasant Branch Lead Mine	Franklin	2-V-57	Switzer
55	70	Jones Vein	Franklin		Frankfort East
56	—	Switzer Prospect Pits	Franklin	21, 22-V-57	Switzer
57	72	Wait Vein	Franklin		Polsgrove
58	76	Burdette (Boone Creek) Vein	Garrard	4, 7-N-59	Bryantsville
59	81	Campbell Veins	Garrard	22-P-59	Little Hickman
60	79	Dunn Vein	Garrard	6-0-59	Bryantsville
61	86	Fox Vein	Garrard		Bryantsville
62	78	Hogg Vein	Garrard		Bryantsville
63	—	Microwave Tower Vein	Garrard	6-N-59	Bryantsville
64	85	Tuggle Vein	Garrard		Bryantsville
65	91	Hoggins Vein	Harrison	3-V-63	Shawhan
66	89	Lail Vein	Harrison	11-V-62	Shawhan
67	—	Silas Creek Barite Occurrence	Harrison	6-V-63	Shawhan
68	100, 99	Drennon Springs and Green Vein	Henry	23-Y-54	Worthville
69	93, 94	James and Montgomery Veins	Henry		Gratz
70	95	Lockport Vein	Henry	17-X-55	Gratz
71	95	Union Mine (Gratz) Vein	Henry	7-X-55	Gratz
72	101	White Sulfur Springs Vein	Henry		Franklinton
73	104	Ambrose and Horine Vein	Jessamine	3, 4-P-60	Little Hickman
74	—	Catnip Hill Quarry	Jessamine	24-R-60	Nicholasville
75		McKenzie Moss Veins	Jessamine		Wilmore
76	112	Noel Vein	Jessamine	13, 18-Q-58	Wilmore
77	109	Overstreet Vein	Jessamine		Wilmore
78	110	Prentiss Vein	Jessamine		Wilmore
79		Trinity Church Vein	Jessamine	7-P-61	Valley View
80	105	J. West Fault Vein	Jessamine		Little Hickman
81	—	Brassfield Dolomite Occurrence	Lincoln	7-L-60	Crab Orchard
82	129	Givens Vein	Lincoln	15-N-59	Stanford
83	—	Hanging Fork Creek Vein	Lincoln	20-N-58	Stanford
84	128	Kentucky 590 (Engleman Fault) Vein	Lincoln	20-N-58	Stanford
85	123, 124, 125	Swinebroad, White, & Kenton Veins	Lincoln		Stanford
86	—	Boonesboro Quarry Vein	Madison	2-Q-63	Ford
87	—	Boonesboro Vein	Madison	2-Q-63	Ford
88	—	Clays Ferry at I-75 Vein	Madison	10-Q-62	Ford
89	133	Clear Creek Fault	Madison		Union City
90	—	Hines Creek Vein	Madison	12-Q-62	Ford
91	107	Reynolds Vein	Madison		Little Hickman
92		Y.M.C.A. Occurrence	Madison	23-Q-61	Valley View
93	143, 144	Chinn Mine	Mercer	21-Q-57	Harrodsburg
94	—	Cummins Ferry Road Vein	Mercer	15-Q-57	Harrodsburg
95	138	Currey Lane Vein	Mercer	7-P-57	Harrodsburg
96	139, 140	Faulconer Vein	Mercer	18, 2, 3-P-57	Harrodsburg
97	—	Gate Vein	Mercer	12-Q-57	Salvisa
98	Jolly & Heyl 1964, é147b	Gloebbel Dean Mine	Mercer	12-Q-57	Salvisa
99	142	Kentron Mine	Mercer	12-Q-57	Harrodsburg
100	Jolly & Heyl 1964, é147c	Old Dean (James Britton) Mine	Mercer	11, 12-Q-57	Salvisa
101	136	Riker Vein	Mercer	25-P-57	Harrodsburg
102	137	Thompson Vein	Mercer	10-P-56	Harrodsburg
103	Jolly & Heyl 1964, é143	Twin Chimney Mine	Mercer	11-Q-57	Harrodsburg
104	—	Unity Road Veins	Mercer	16, 25-Q-57	Harrodsburg
105	149, 150	Big Twin Creek Prospects	Owen		New Liberty
106	154	Browns Bottom Fault Occurrence	Owen	13, 19-X-55	Gratz
107	—	Browns Bottom Prospect	Owen	12-X-55	Gratz
108	148	Gratz Vein	Owen	4-X-55	Gratz
109	—	Sandridge Creek Prospects	Owen	21-X-56, 1-W-56	Monterey
110	71	Clark (Kissinger) Vein	Scott	16-V-58	Stamping Ground
111	160	Coleman Vein	Scott		Georgetown
112	161	Davis Vein	Scott	17-V-59	Georgetown
113	162, 163	Johnson-Hooke Vein	Scott		Stamping Ground
114	159	J. L. Lisle Vein	Scott		Georgetown
115	159	Nally-Gibson Quarry (Thomas Vein)	Scott	12-U-60	Georgetown
116	—	North Elkhorn Creek (Crumbaugh) Vein	Scott	10-U-60	Georgetown
117	177 Jolly & Heyl 1964, é144a	East Faircloth Veins (Hayden Mine)	Woodford	20-Q-57	Harrodsburg
118	177 Jolly & Heyl 1964, é144a	West Faircloth Vein (Moore Mine)	Woodford	19-Q-57	Harrodsburg
119	176	Hanna-Morgan (Chinn) Vein	Woodford	20-Q-57	Harrodsburg
120	169	I-64 Vein	Woodford	5-T-58	Midway
121	172	Nonesuch (Allender) Vein	Woodford		Keene
122	169	Orr Vein	Woodford		Salvisa
123	—	Prather (Troy) Vein	Woodford	15-Q-58	Keene
124	175	Prewitt Vein	Woodford	20-Q-57	Wilmore
125	173	Shropeshire Vein	Woodford	7, 8-Q-57	Keene
126	—	Shyrock Ferry Road Vein	Woodford	17-S-57	Tyrone
127	168, 166	Shyrock Ferry (Cotton) Vein	Woodford		Tyrone
128	165	Withrow Vein	Woodford		Frankfort East



EXPLANATION

Barite vein observed during field investigation for this report

Barite vein reported in previous literature

Fault. Ball on downthrown side. Faults compiled from 7.5-minute Geologic Quadrangle Maps published by U.S. Geological Survey

Boundary of Central Kentucky Mineral District. (Middle Ordovician limestones are exposed at the surface within the district)

Zone 1. Abundant fluorite and calcite, with minor barite

Zone 2. Abundant fluorite, barite, and calcite, with minor sphalerite

Zone 3. Abundant barite, galena, and sphalerite

LOCATION OF BARITE VEINS IN CENTRAL KENTUCKY

Warren H. Anderson

1982