GUIDEBOOK

to the

GEOLOGY OF THE ST. FRANCOIS MOUNTAIN AREA

William C. Hayes
Chairman

REPORT OF INVESTIGATIONS NO. 26
October 1961

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Department of Business and Administration
Division of
GEOLOGICAL SURVEY AND WATER RESOURCES
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October 7, 1961

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INTRODUCTION

The area of the St. Francois Mountains and vicinity has been one of the most popular in the Midwest in which to conduct field studies of both Precambrian and Paleozoic rocks. Precambrian felsites, granites, and basic rocks are excellently exposed for such studies, and the mining of Precambrian iron ores and the accessibility of the Lead Belt on the east and northeast flank of the Ozark uplift has encouraged geologic study in an area which is also excellently provided with picturesque scenery.

Many field trips and conferences have been conducted in the area, but previously published guidebooks are now out of print. Plans of the Association of Missouri Geologists to hold their Eighth Annual Meeting in the area offered an opportunity to provide a guidebook that is somewhat different from previous guidebooks.

This guidebook is comprised of road logs for four main routes with supplementary routes branching from the main routes. Cumulative mileage is indicated on each route log, and the primary direction of travel is indicated as being outbound from Ironton. There are no specific stops indicated in the route logs; thus any person referring to the logs may make as many, or as few stops as desirable. It is anticipated that this will provide access and egress to and from the St. Francois Mountains proper and at the same time will call attention to the many interesting geologic features that may be observed in the surrounding area.

Although the field conference of the Association of Missouri Geologists will be particularly concerned with the Precambrian rocks, it is certain that the Paleozoic rock sequence will be of interest to many who may travel some of the routes at a later date. Interesting points of Paleozoic stratigraphy, economic geology, engineering geology, and general geology are included.

A study of the Missouri Precambrian rocks, initiated by the Missouri Geological Survey and Dr. Carl Tolman in 1931 and carried through the manuscript phase by Forbes Robertson, provides several new names for rock units in the Precambrian. Because these names have not yet been published, an explanation of how they are to be used in the forthcoming publication is included in the lead article at the back of this guidebook.

Data for parts of the route logs were taken from logs prepared by various Survey staff members for previous guidebooks. Previously published guidebooks that include the St. Francios Mountain area are:

Bell, A. H., and others, 1949, American Association of Petroleum Geologists Field Trip Guidebook, Thirty-fourth Annual Meeting.

Buehler, H. A., and others, 1933, International Geological Congress, Sixteenth Session, Guidebook 2, Excursion A-2, Mining Districts of the Eastern States.

________________ 1928, Kansas Geological Society, Second Annual Field Trip, Ozark Region of Missouri and Arkansas.

Hinchey, N. L., 1948, American Institute of Mining Engineers Field Trip, Annual Meeting.

Knight, R. D., and Koenig, J. W., 1957, American Association of Petroleum Geologists Field Trip Guidebook, Forty-second Annual Meeting.

Muilenburg, G. A., and Beveridge, T. R., 1954, Kansas Geological Society, Seventeenth Regional Field Conference, Southeastern and South-Central Missouri.

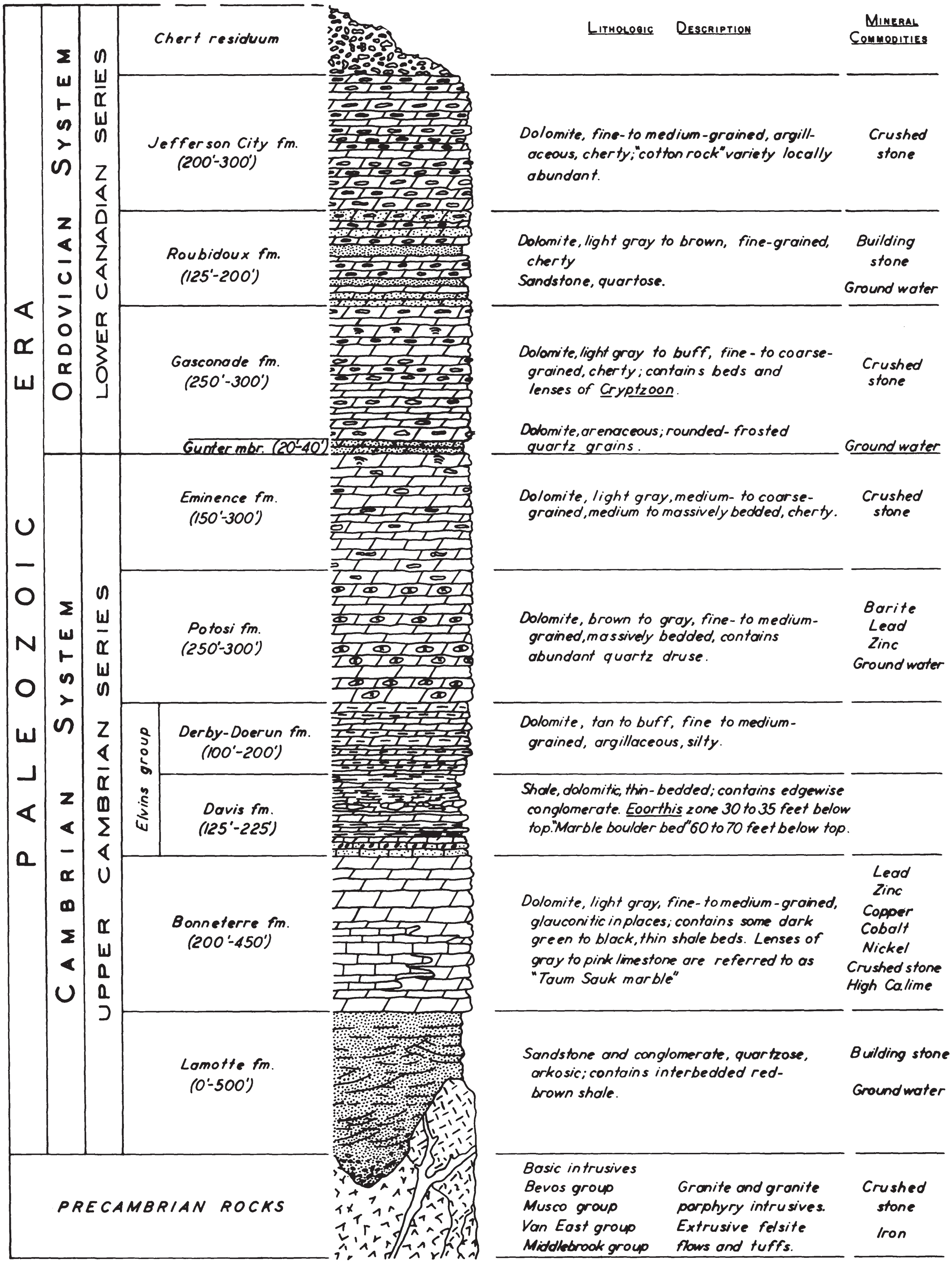
ACKNOWLEDGMENTS

The success of any venture in which several individuals must work together is dependent upon the close cooperation of each participant. The preparation of this guidebook was possible only by the full interest and cooperation of the many authors of the various route logs and supporting articles. Grateful acknowledgment is extended to all of them. Special acknowledgment is extended to Frank G. Snyder and Richard D. Wagner of the St. Joseph Lead Company for preparing the log for the route from Arcadia to Farmington.

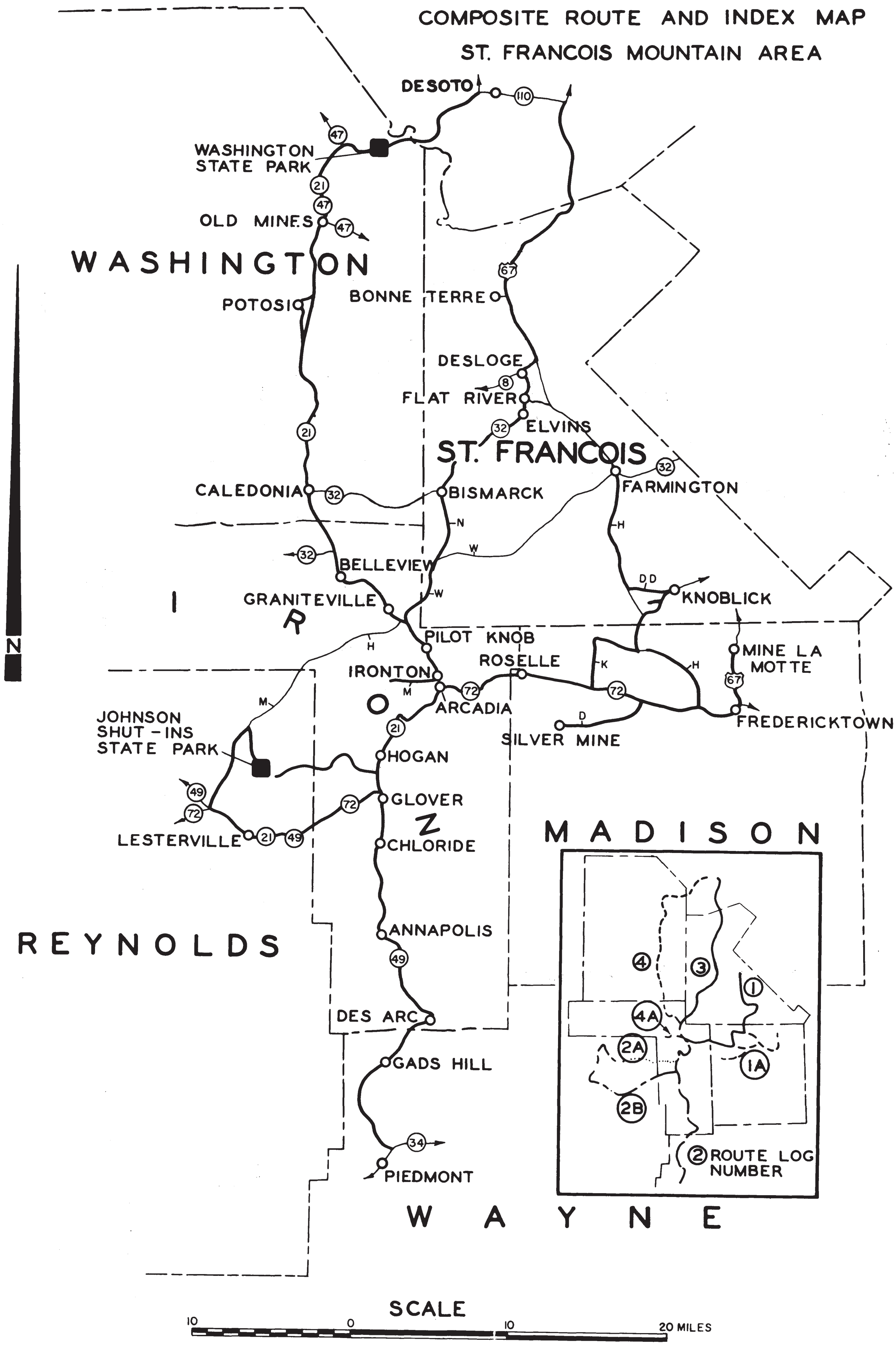
Many thanks are extended to the Midwest Ore Company, the Heyward Granite Company, the Union Electric Company, the Fruin-Colnon Contracting Company, and the Utah Construction Company for not only permitting access to their properties but for their gracious hospitality to the members of the Association of Missouri Geologists.

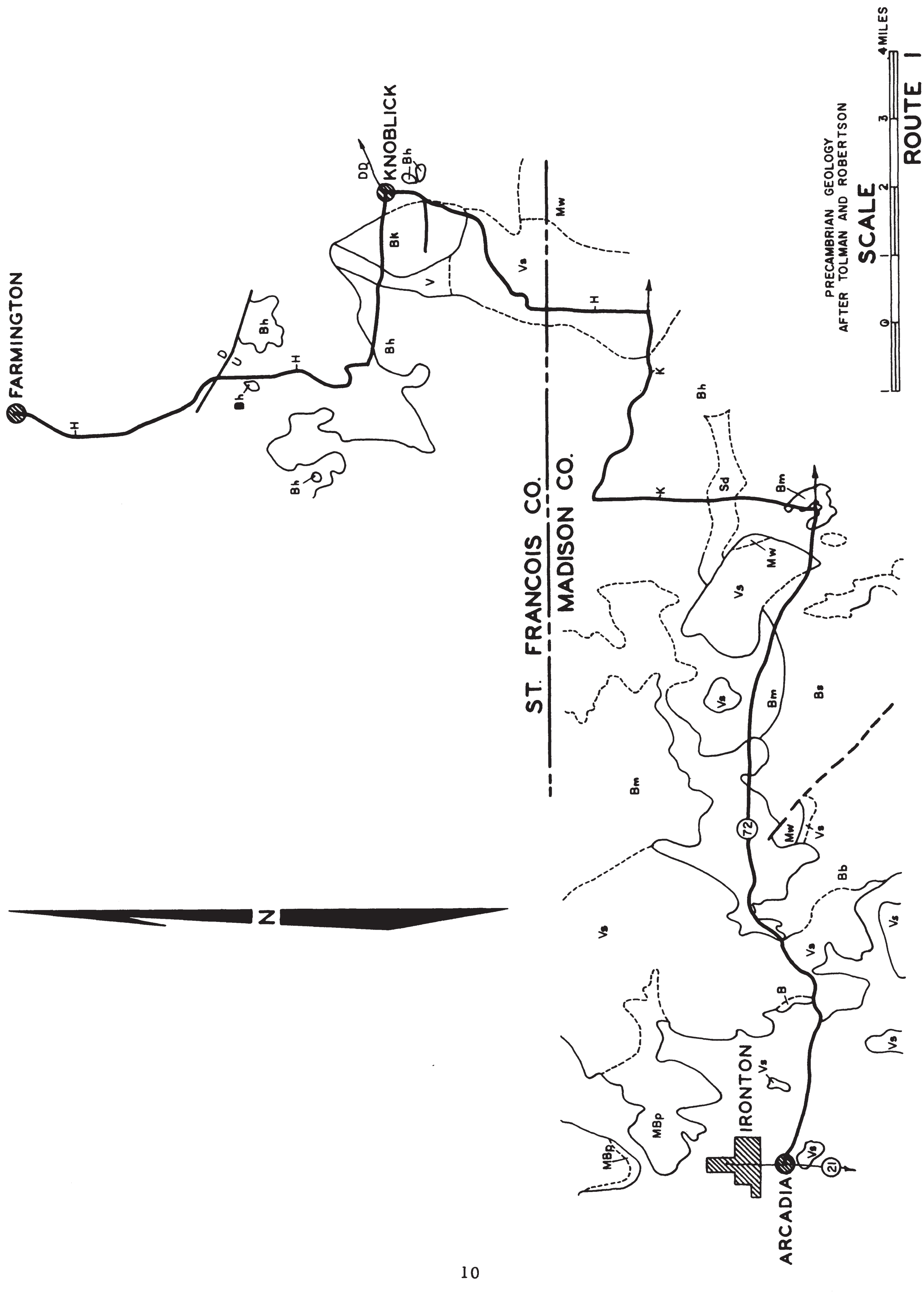
Sincere thanks are extended to the entire staff of the Missouri Geological Survey, especially to those geologists who have worked in the field and who have had office conferences on many of the problems of the area, to the subsurface geologists for their preparation of logs of wells and test holes, to the draftsmen for preparing the final illustrations, to John W. Koenig for final editing of the guidebook, and to Mrs. Mary Huffman and Mrs. Bonnie Happel for typing the manuscript.

The special services rendered by Boyles Brothers Drilling Company, Joy Manufacturing Company, E. J. Longyear Company, and Sprague and Henwood Incorporated, have greatly contributed to the success of the meeting and are gratefully appreciated.



Generalized stratigraphic column of St. Francois Mountain area.


COMPOSITE ROUTE AND INDEX MAP
ST. FRANCOIS MOUNTAIN AREA
DESOTO
110
47
WASHINGTON STATE PARK
21
47
OLD MINES
47
WASHINGTON
67
POTOSI
BONNE TERRE
DESLOGE
8
FLAT RIVER
32
ELVINS
21
ST. FRANCOIS
32
FARMINGTON
CALEDONIA
32
BISMARCK
N
H
W
32
BELLEVIEW
DD
KNOBLICK
W
GRANITEVILLE
I
R
H
PILOT KNOB
ROSELLE
MINE LA MOTTE
K
H
IRONTON
M
67
72
72
O
ARCADIA
FREDERICKTOWN
M
D
JOHNSON SHUT-INS STATE PARK
21
SILVER MINE
HOGAN
49
GLOVER
72
72
Z
LESTERVILLE
21
49
CHLORIDE
MADISON
ANNAPOLIS
REYNOLDS
49
4
3
1
DES ARC
4A
2A
1A
GADS HILL
2B
34
2 ROUTE LOG NUMBER
PIEDMONT
WAYNE
N
SCALE
10
0
10
20 MILES



FARMINGTON
KNOBLICK
IRONTON
ARCADIA
ST. FRANCOIS CO.
MADISON CO.
PRECAMBRIAN GEOLOGY
AFTER TOLMAN AND ROBERTSON
SCALE
0 1 2 3 4 MILES
ROUTE I
N
72
21

ROUTE LOG 1

Arcadia to Farmington

by

Frank G. Snyder and Richard E. Wagner

Directions to Starting Point

To reach the Outbound Starting Point proceed south from the Iron County Courthouse in Ironton to the junction of Missouri Highways 21 and 72 at the north edge of Arcadia (Mileage point 0.45 on Route Log No. 2).

OUTBOUND STARTING POINT: Junction of Missouri Highways 21 and 72 at Arcadia, Iron County.
INBOUND STARTING POINT: Junction of U. S. Highway 67 and State Road D at Farmington, St. Francois County.

(Total driving distance one way - 37.6 miles)

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
00.00		From the Outbound Starting Point at the junction of Missouri Highways 21 and 72 north of Arcadia, proceed east on Missouri Highway 72.	37.6
	2.40		
2.40		Stouts Creek bridge and Stouts Creek Shut-ins. Tong-Ashebran furnace north of bridge.	35.20

The Tong-Ashebran furnace, the first iron furnace west of Ohio and the forerunner of a large number of Missouri charcoal furnaces, was built in 1816 by James F. Tong on Stouts Creek just above the head of Stouts Creek Shut-ins, 2.3 miles east of the present village of Arcadia in Iron County (Figure 1).

Associated with Tong, possibly as a partner, was Corbin Ashebran (var. Sp. Ashabrand, Ashabranner) and a man named Paul De Guiere who was sometimes connected with this enterprise.

James Tong arrived in Missouri about 1813 from Kentucky and left with Austin's "Old Three-Hundred" Colonists for Texas in 1821 or 1822. Tong was a carpenter, and he came from a family with a mining background.

Little is known of Corbin Ashebran. He is usually described as a "hammerman", and because the works was commonly called "Ashebran's Furnace" he must have been the iron master as well. It is probable that Ashebran managed the works during its full period of operation, taking over Tong's share at an early date.

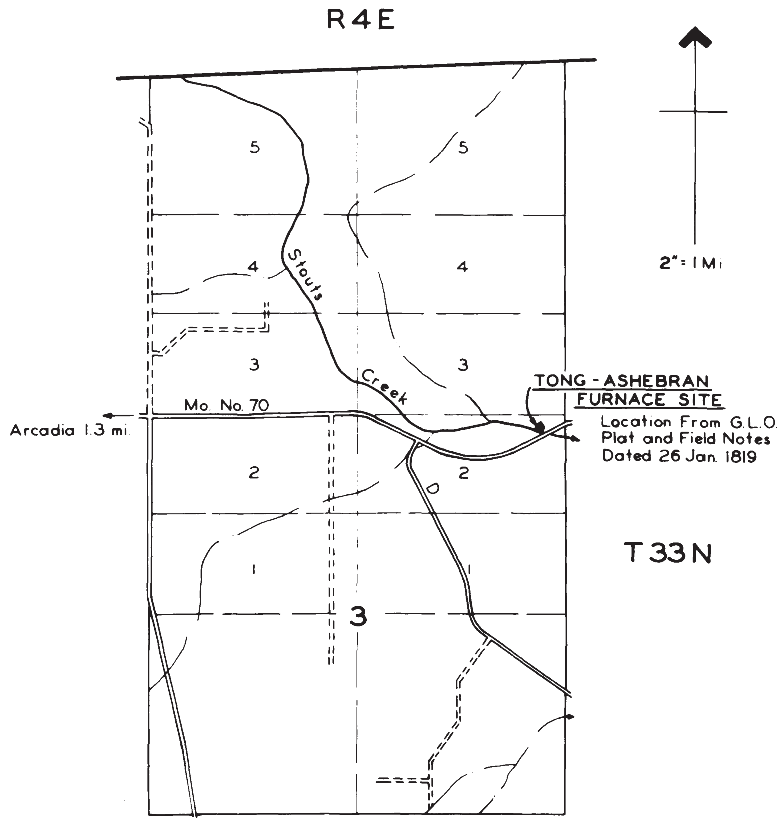


Figure 1
Location of the Tong – Ashebran furnace site, Section 3, T. 33 N., R. 4 E., Iron County, Missouri. Sketch by R. L. Elgin.

Although documentary evidence regarding this early plant is sparse and conflicting, it is fairly certain that the equipment must have consisted of a small, cold blast, charcoal stack, probably "blow'd" by a pair of water driven bellows, and a refinery forge of two fires (a Catalin forge is also suggested) "blow'd" by a trompe and water driven helve hammer, the castings of which came from Pittsburg. A grist mill also was operated in connection with the works.

Ore for the furnace was obtained from a small deposit nearby and from a mine on Shepherd Mountain. The ore was roasted and crushed before being charged into the furnace.

The exact date of "blowing out" is not known, but the Deputy Land Office Surveyor who was subdividing T. 3 N., R. 4E in January of 1819, notes the iron works and Ashebranner mill.

A general business depression is the reason usually given for the closing of the works. If this is true, the works must have closed in 1819 because this was the year of a general business panic, the one which also financially ruined Moses Austin and closed his lead operations at Potosi.

The above account of the Tong-Ashebran furnace was written by Bob Elgin (Representative, James Foundation).

At the shut-ins and for over a mile to the east a complex section of volcanics is exposed. From west to east, the roadcut contains purple rhyolite, agglomerate or flow breccia, and red felsite - often brecciated with hematite cementing the breccia. Several strong fracture zones interrupt the section. The purple rhyolite is mapped as Stouts Creek rhyolite belonging to the younger volcanic series. The position of the red rhyolite is uncertain; it may belong to the older volcanic series.

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	1.60		
4.00		East end of Lake Killarney; red rhyolite is overlain by dolomite of the Bonneterre formation, and basal arkoses and grits from here eastward for next 3 miles except for some small exposures of Precambrian rock.	33.60
	0.60		
4.60		Brown Mountain rhyolite exposure.	33.00
	1.90		
6.50		Silvermine granite exposure.	31.10
	0.60		
7.10		Contact of Magee granite and overlying sediments. Exposures poor.	30.10
	1.00		
8.10		St. Francis River bridge.	29.50
	0.10		
8.20		Good exposures of Magee granite.	29.40
	0.30		
8.50		Approximate position of contact of Silvermine granite and Magee granite. The boundary and relationship of these two granites have not been definitely established.	29.10
	0.40		
8.90		Good outcrops of Silvermine granite.	28.70
	1.00		
9.90		Silvermine granite in contact with Stouts Creek rhyolite, contact poorly exposed.	27.70
	0.30		
10.20		Stouts Creek rhyolite, contact zone with Magee granite poorly exposed.	27.40
	0.30		
10.50		Lamotte sand on Magee granite, sparse outcrops.	27.10
	0.10		
10.60		Junction of Missouri Highway 72 and State Road K. Turn north on State Road K (Starting Point of Route Log 1A).	27.00

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		Near the intersection and for 1/2 mile to the north thin Lamotte sandstone overlies the Magee granite.	
	1.40		
12.00		Approximate south edge of diabase. The contact with the Magee granite is not exposed.	25.60
	0.30		
12.30		Approximate north edge of diabase. The contact with the Butler Hill granite is not exposed.	25.30
	0.30		
12.60		Junction of State Road K and T-road west. Turn west onto country road (C. W. Myers and Ruth Bruning mail boxes mark junction). Road is on Butler Hill granite with numerous good outcrops.	25.00
	1.00		
13.60		Turn south through gate on road to Myer's farm.	24.00
	0.25		
13.85		Park in farm yard.	23.75

A. — Walk east across the pasture to the outcrop of the Skrainka diabase dike or sill. Like most of the diabase bodies in the area, this is deeply weathered and poorly exposed. The dike forms a pronounced topographic ridge at this point that is several hundred feet wide and 25 to 40 feet high, trending slightly north of west. The diabase has been mapped as having a length of over 2 miles. This stop is near the western end of the diabase which here is bordered by Stouts Creek rhyolite on the south and Butler Hill granite on the north.

B. — Approximately 800 feet northeast of the parking area, a small creek has cut into the diabase ridge exposing weathered dike rock with numerous unweathered diabase "boulders". At this point, a 1-foot wide granite dike cuts the diabase. The granite dike can be traced for some distance to the north by means of float.

C. — Continue about 900 feet east to a point where the creek has cut into the north edge of the diabase. The chilled border of the diabase is in contact with the underlying Butler Hill granite. The contact dips about 30 degrees S.S.E. This contact also is exposed across the creek for a short distance upstream and again about 100 feet downstream. At the latter exposure, the top of the granite is seen with remnants of the chilled border phase of the diabase. At one point, the diabase has intruded a fracture in the granite.

There is little doubt that the diabase intruded the Butler Hill granite along the granite-rhyolite contact. The granite dike in the diabase represents a still later phase of granite intrusion.

D. — Several hundred feet downstream and a little to the north,

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		there is an exposure of granite that slopes gently toward the diabase contact which is soil covered at this point. A strong shear zone is present in the granite, striking parallel to the diabase contact and extending northward about 150 feet from the edge of the outcrop. Beyond this, the granite shows a normal joint pattern. Several hundred feet farther north another similar narrow shear zone is exposed. The role of the shear zone is undetermined. It may be related to the diabase intrusion, or it may be part of a regional structural pattern superimposed on the area.	
		From the parking area return to State Road K.	
	1.25		
15.10		Junction of T-road west and State Road K. Turn north. Driving on Butler Hill granite.	22.50
	1.50		
16.60		Junction of State Road K and country road. Follow State Road K to right.	21.00
	2.40		
19.00		Crossing onto Stouts Creek rhyolite.	18.60
	0.60		
19.60		Junction State Roads K and H. Turn north on State Road H.	18.00
	2.40		
22.00		Junction of State Road H and T-road east. Turn east. Stouts Creek rhyolite is exposed on right side of road, and the granite contact is only a few hundred feet to the west.	15.60
	1.10		
23.10		Road Junction, continue to north on T-road.	14.50
	0.80		
23.90		Junction of narrow road to west. Turn west to Knoblick Mountain.	13.70
	1.10		
25.00		Top of Knoblick Mountain	12.60

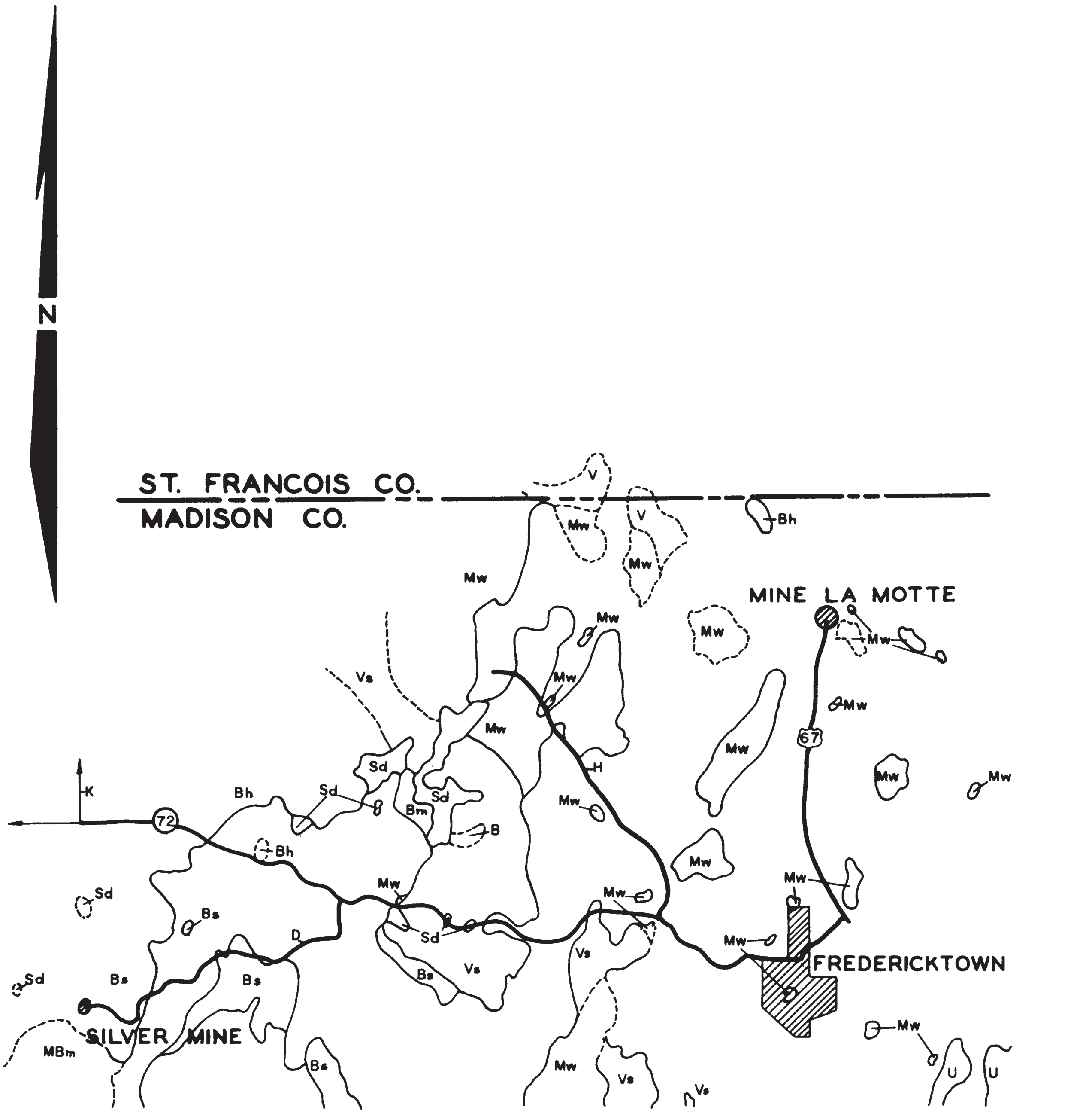
A. — The Stouts Creek rhyolite is exposed at the top of the hill and down the south face. The Stouts Creek rhyolite-Knoblick granite contact angles up the hillside from the southeast to a point about one-half mile north of the fire tower and then continues in a northerly direction where it is crossed by State Road DD. The contact of the Stouts Creek rhyolite with the Butler Hill granite is on the west slope of Knoblick Mountain but is not well exposed.

B. — Walk about one-half mile north along the old ridge road to the abandoned granite quarry. Several hundred feet of rhyolite-granite contact is exposed in the quarry face. The contact is very sharp and shows the intrusive nature of the granite. Granite apophyses extend into the rhyolite. Xenoliths of rhyolite are included in the granite. Thin seams of epidote are common along the contact. The granite shows

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		very little change in grain size toward the contact. The rhyolite above the contact has been altered to a dense, fine-grained, dark rock, sometimes nearly black in color. Above the darkened zone, there is a thick zone of bleached rhyolite. The unaltered rhyolite is not exposed at this point but may be seen as occasional boulders along the crest of the hill.	
		These features are common to many of the felsite-granite contacts observed in outcrop and in subsurface. Other features, quite common in contact zones but not noted here, are miarolitic cavities along the contact, quartz veins extending into the flows at right angles to the contact, and a change in grain size of the granite near the contact.	
		C. — Return to the parking area and continue to the south face of Knoblick Mountain. The rhyolite shows considerable bleaching suggesting that the intrusive granite is not far below. The most interesting feature is a 10- to 20-foot wide "dike" of granite porphyry trending north-south up the face of the hill. This is bordered on each side by a narrow zone of dense black rock similar to that at the granite contact in the quarry. In this case, the contact is gradational rather than sharp. Some epidote is visible in the granite porphyry.	
		No petrographic work has been done on the granite porphyry. It could be entirely unrelated to the nearby intrusive granite. However, it seems more likely that it represents an injection of granite magma, with rapid cooling giving rise to the granite porphyry texture.	
	1.10		
26.10		Junction with gravel road. Turn north to Knoblick. At one time when granite quarrying was active in this area, the town of Knoblick was a thriving community.	11.50
	0.30		
26.40		CAUTION! Railroad crossing.	11.20
	0.20		
26.60		Junction with State Road DD Turn west on State Road DD and cross the railroad tracks.	11.00
	0.70		
27.30		Gray granite quarry north of road in Knoblick granite. The granite contains numerous small inclusions.	10.30
	0.50		
27.80		Contact of rhyolite and Knoblick granite.	9.80
	0.20		
28.00		Felsite-Butler Hill granite contact exposed in ditch on north side of road. Erosion has left a thin shell of felsite which caps the hill. The felsite shows typical rhyolite porphyry jointing and blocky weathering. The felsite is a fine-grained, dark colored rock showing the	9.60

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		effects of contact metamorphism by the underlying intrusive granite.	
	0.30		
28.30		Butler Hill granite. This is an area containing numerous old granite quarries. At this mileage point, Butler Hill granite is a coarse-grained, pink granite, containing numerous small aplite dikes and prominent fracture patterns. North of the highway, there is a "blue" granite quarry. Fragments of gray granite along the road are probably from the gray granite quarry north of the highway 1 mile to the east. As you continue west note the Lamotte sandstone overlapping the granite.	9.30
	0.70		
29.00		Junction of State Roads DD and H. Turn north on State Road H.	8.60
	0.15		
29.15		St. Francis River bridge, continue north on State Road H.	8.45
	0.05		
29.20		Lamotte formation forms low ledges along road.	8.40
	1.70		
30.90		Granite float. The low knob east of the road is a granite outlier. Road is on Lamotte.	6.70
	0.70		
31.60		Crossing Simms Mountain - Mine Lamotte fault zone. Derby-Doerun formation on low hills to left of road and Davis formation on slopes.	6.00
	0.70		
32.30		Junction of State Roads H and AA. Bear right on State Road H.	5.30
	0.70		
34.00		St. Francis River bridge. Bonneterre formation in river bottom.	3.60
	0.30		
34.30		CAUTION! Railroad crossing	3.30
	1.00		
35.30		Crossing fault from Davis onto Bonneterre formation. No outcrops.	2.30
	1.70		
37.00		Junction State Roads H and W. Turn left on State Road W. (East Columbia Street).	0.60
	0.10		
37.10		Junction State Roads W and D. Turn right, pass St. Francois County Courthouse, and continue north on State Road D.	0.50
	0.50		
37.60		Junction State Road D and U. S. Highway 67.	0.00

ROUTE 1A



PRECAMBRIAN GEOLOGY
AFTER TOLMAN AND ROBERTSON

SCALE

1 0 1 2 3 4 MILES

ROUTE LOG 1A

Roselle east to Mine LaMotte

by

William C. Hayes

Directions to Starting Point

To reach the Outbound Starting Point, proceed south 0.5 mile from the Iron County Courthouse in Ironton to the junction of Missouri Highways 21 and 72, then proceed east on Missouri Highway 72 approximately 10 miles to the junction of State Road K and Missouri Highway 72.

OUTBOUND STARTING POINT: Junction of State Road K and Missouri Highway 72, Madison County.
INBOUND STARTING POINT: Mine LaMotte Roadside Park on U. S. Highway 67, Madison County.

(Total driving distance one way - 35.25 miles)

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
00.00		From the Outbound Starting Point proceed east on Missouri Highway 72.	35.25
	0.70		
0.70		Granite exposure on south.	34.55
	1.50		
2.20		Lamotte formation on north for 0.2 mile	33.05
	0.65		
2.85		Top of Lamotte; exposure continues in roadcut on downhill for 0.3 mile.	32.40
	0.70		
3.55		Junction of State Road D and Missouri Highway 72. Turn south on State Road D to Silver Mine.	31.70
	1.25		
4.80		Lamotte on both sides of road.	30.45
	0.60		
5.40		CAUTION! One lane bridge	29.85
	0.30		
5.70		Lamotte formation. Note conglomerate on east side.	29.55
	0.95		
6.65		Cameron's Lake Resort. Entering Silver Mine Picnic Ground, Clark National Forest.	28.60
	0.20		
6.85		St. Francis River bridge.	28.40
		From the bridge about one-half mile upstream, the river	

has formed steep valley walls in the Silvermine granite. According to Tolman and Koch (1936, p. 39), the heavy mineral suite of this granite type is quite distinctive in that titanite is the most abundant accessory, averaging nearly 60 percent, whereas apatite is moderately abundant, averaging 16 percent.

Chemical analysis of Silvermine granite; NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 33 N., R. 5 E.; GSA Rock Analysis Laboratory, L. C. Peck, Chemist, 1947.

SiO_2	69.70	H_2O+	.76
Al_2O_3	14.80	H_2O-	.13
Fe_2O_3	1.26	TiO_2	.40
FeO	1.80	P_2O_5	.14
MgO	.76	MnO	.07
CaO	1.75	F	.07
Na_2O	4.18	Less 0	-.03
K_2O	3.92	Total	99.71

Cum.	Diff.		Cum.
	0.95		
7.80		House on north. Silver Mine area to the north .	27.45

Land in the Silver Mine area was entered as mineral land in 1855, and systematic prospecting began in 1877. Silver was obtained from the argentiferous galena in the quartz veins. Approximately 50 tons of lead and 3,000 ounces of silver were produced up to the time of closing the mines which was about the middle 1880's. In 1916 tungsten was produced during the war years and again for a short time beginning in 1927.

Vein No. 1 (the Einstein) was entered by adit from the west bluff along the river, and several shafts followed along the thread of the vein up on the hill to the west. Inclines were sunk on the crest of the hill some 2,000 feet west of the river at the Apex mine.

The mineralization in the area is distinctive as it is the best known of only a few high temperature pneumatolytic deposits in the Precambrian rocks in the state. The greisenization of the wall rock and the association of minerals such as wolframite, fluorite, topaz, zinnwaldite, cassiterite, and scheelite is of significance (Tolman, 1933). Return to Missouri Highway 72.

Cum.	Diff.		Cum.
	4.25		
12.05		Junction of Missouri Highway 72 and State Road D. Proceed east on Missouri Highway 72.	23.20
	0.45		
12.50		SHARP CURVE! Lamotte on north.	22.75
	0.90		
13.40		Diabase dike exposed along highway for 0.1 mile.	21.85

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.

This exposure of typical Skrainka diabase probably is an oval stock which trends northwest. Note the distinctive soil color and the change from weathered material to fresh appearing diabase that occurs within a very small distance. The diabase typically weathers by exfoliation to rounded, green-colored cobbles and boulders. About $1\frac{1}{2}$ miles north, the now abandoned Skrainka quarry is located where similar material was quarried.

Chemical analysis of Skrainka diabase; $E\frac{1}{2}$ lot 4, $NE\frac{1}{4}$ sec. 3, T. 33 N., R. 6 E; Washington Univ., St. Louis, Missouri, S. S. Goldich, Chemist.

SiO_2	47.27	H_2O+	.52
Al_2O_3	16.31	H_2O-	.08
Fe_2O_3	2.33	TiO_2	2.10
FeO	10.78	P_2O_5	.38
MgO	7.35	MnO	.19
CaO	8.63	CO_2	.08
Na_2O	3.29	S	.10
K_2O	.60	Less O	-.05
		Total	99.96

Outbound Cum.	Diff.		Inbound Cum.
	0.80		
14.20		Stouts Creek rhyolite exposed on south.	21.05
	0.30		
14.50		Kemper Creek Roadside Park	20.75
	0.50		
15.00		SHARP CURVE! Bonneterre exposed in creek bed and along highway for 0.2 mile.	20.25
	0.70		
15.70		SHARP CURVE!	19.55

The Hickory Nut mine is a few hundred feet north of Missouri Highway 72. A 50-foot shaft was sunk in 1870, and about 1902 the Mine LaMotte Lead and Smelting Company erected a 50-ton mill on the tract but moved the mill in 1905 to Mine LaMotte. The mine was worked during 1912-1913 and then was closed until the spring of 1947 when the Mine LaMotte Corporation prospected the area and sank a shaft about one-half mile to the northeast.

Outbound Cum.	Diff.		Inbound Cum.
	0.70		
16.40		Junction of Missouri Highway 72 and State Road H. Turn north to Catherine lead mine.	18.85
	1.45		
17.85		Mine dumps on west of road. Catherine mine.	17.40

Lead was first mined from this tract in the 1860's by a shallow shaft. The Catherine Lead Company was formed in 1899, and mining began in 1901. The operation utilized a 9,125-foot aerial tramway from the mine to the mill on the bank of the

Little St. Francis River. After several years of unprofitable operation by several organizations, the tract was obtained by the Federal Lead Company who operated the mine from 1912 to 1917. There was small intermittent production until the Fredericktown Lead Company leased the property and began operations in 1942.

Galena occurs in the lower part of the Bonneterre and does not extend downward into the Lamotte. The irregular surface of the Precambrian knobs cause the ore horizon to be very undulating, ranging from 15 to 200 feet below the surface. The ore zone is from 6 to 50 feet thick and averages 50. The galena and associated marcasite occur as disseminations and as crystals which line the vugs in the dolomite. Some galena is present along joints, and some is in irregular veins up to an inch in thickness.

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.25		
18.10		Tailings on west side of road. The tailings are now being used by the Missouri Highway Department for road surfacing.	17.15
	0.50		
18.60		Tailings and site of old mill on west.	16.65
	0.20		
18.80		Wills granite exposure on east.	16.45
	0.20		
19.00		Lamotte formation.	16.25
	0.30		
19.30		Wills granite.	15.95
	0.50		
19.80		Lamotte formation.	15.45
	0.20		
20.00		Wills granite on top of hill and Lamotte onlap to the north.	15.25
	0.15		
20.15		Lamotte formation on west side of road.	15.10
	0.60		
20.75		Lamotte formation on both sides of road.	14.50
	0.30		
21.05		Lamotte formation on both sides of road.	14.20
	0.10		
21.15		Wills granite	14.10
	0.40		
21.55		Approximate contact of Wills granite and Stouts Creek rhyolite.	13.70
	0.90		
22.45		Junction of State Roads H and K. Return to Missouri Highway 72 via State Road H, or proceed on to Farmington from this point.	12.80
	6.05		
28.50		Junction of Missouri Highway 72 and State Road H. Turn east onto Missouri Highway 72.	6.75

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	1.00		
29.50		SHARP CURVE! Little St. Francis River bridge.	5.75
	0.35		
29.85		West city limits of Fredericktown.	5.40
	0.70		
30.55		St. Francois County courthouse, a $2\frac{1}{2}$ story red brick building of Romanesque design of the early 1900's.	4.70
		Before Fredericktown was established, the town of St. Michael was founded in 1800 on the bottom land north of Saline Creek, a few hundred yards north of the courthouse, by a dozen or so Creoles. Madison County was organized in 1818, and in the following year Fredericktown, the county seat, was established on the south bank of Saline Creek. The growth of Fredericktown soon encompassed the site of St. Michael.	
		Fredericktown is the locale of the St. Louis Smelting and Refining Division of National Lead Company who mined and tested complex lead-copper-nickel-cobalt ores. In the spring of 1961, the plant was closed, and mining operations in the area some 1.5 miles southeast of the courthouse ceased.	
	0.10		
30.65		Junction of U. S. Highway 67, Missouri Highway 72, and State Road Z. Turn north on 67 and 72.	4.60
	0.30		
30.95		CAUTION! Railroad crossing. East city limits of Fredericktown.	4.30
	0.50		
31.45		Junction U. S. Highway 67 and Missouri Highway 72. Turn north on U. S. Highway 67. The tall smokestack to the south is at the smelter of National Lead Company.	3.80
	0.80		
32.25		Village Creek bridge. The Bonneterre formation is the bedrock in this area.	3.00
	2.65		
34.90		Fenced road to east leads to the mine area of Mine LaMotte.	0.35
		The writings of Schoolcraft (1819, p. 19) state that Philip Francis Renault, Director of the mines of the Company of the West, brought with him to the Louisiana Territory M. de la Motte Caddillac, who, it is reported, was versed in mineralogy. Exploring parties sent out from the base camp near Kaskaskia, Illinois, discovered lead deposits north of what is now Fredericktown. These deposits were worked under the direction of LaMotte.	
		Until the middle 1800's, production was small and erratic. By 1876 production of lead was 2,914 tons, and nickel and cobalt were being recovered. Production was sustained for	

several years, and in 1892 4,403 tons of lead were produced, During the peak production, Keyes (1895) published a report on the Geology of the Mine LaMotte Sheet in which he states (p. 72) that total production from Mine LaMotte was over 100,000 tons of lead.

Considerable rebuilding of the surface plant was done by the Mine LaMotte Lead and Smelting Company after acquiring the property in 1902. The property was operated by several companies with intermittent success and production until the Mine LaMotte Corporation took over the property in 1928. It was closed for a few years in the early 1930's but resumed in 1937. Operations were continuous from World War II until 1958.

The early workings were of surface deposits, and by 1895 shafts had been sunk to reach ore bodies some 100 to 125 feet in depth.

The disseminated galena and the complex nickel and cobalt sulphides occur in the lower 50 feet of the Bonneterre. In the western part of the area, the upper 15 feet of the Lamotte is an important ore horizon. From 1723 to 1947, the property had produced over 325,000 tons of lead.

Outbound Cum.	Outbound Diff.		Inbound Cum.
	0.05		
34.95		South limits of Mine LaMotte.	0.30
	0.25		
35.20		Sweetwater Branch bridge.	0.05
	0.05		
35.25		Mine LaMotte Roadside Park.	00.00

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Keyes, Charles R., 1895, A report on Mine LaMotte sheet, including portions of Madison, St. Francois, and Ste. Genevieve Counties : Missouri Geol. Survey, 1st ser., vol. 9, sheet rept. no. 4, pp. 4-124.

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—————————, and Koch, H. L., 1936, The heavy accessory minerals of the granites of Missouri: Washington Univ. Studies, new ser., no. 9, pp. 11-50 4 pls., 13 figs.

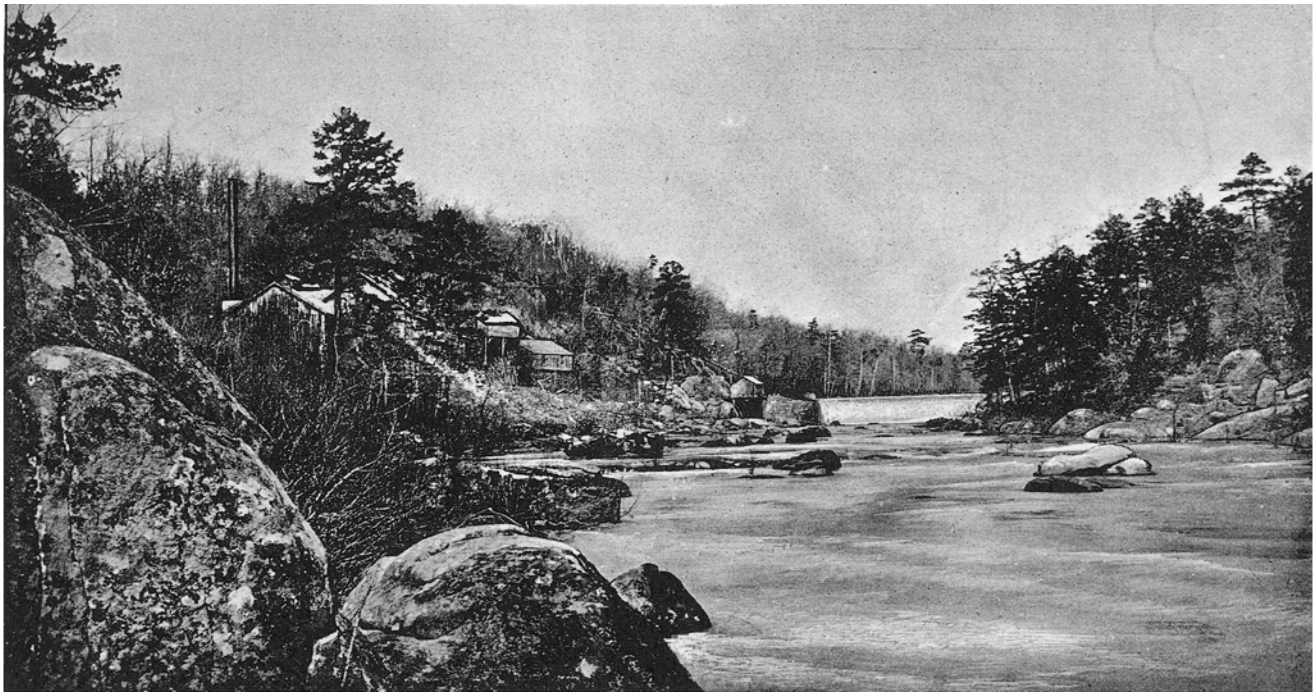
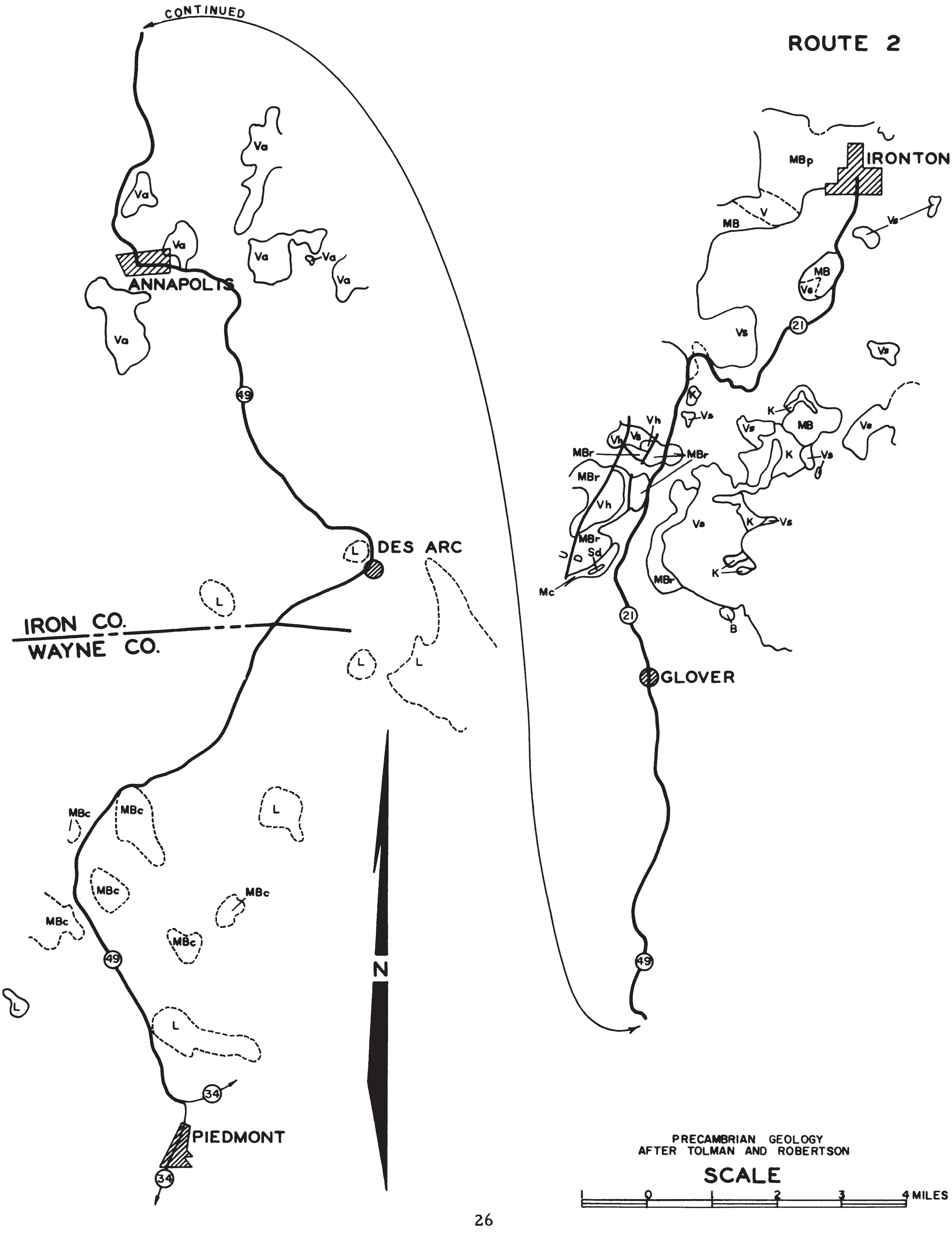


Figure 1.

Silver mines dam and mill as it appears about 1895. Photograph taken from Keyes, C.R., 1895, pl. XIV


ROUTE 2
CONTINUED
IRONTON
ANNAPOLIS
DES ARC
IRON CO.
WAYNE CO.
GLOVER
PIEDMONT
N
49
21
34
Va
MBp
MB
V
Vs
K
Vh
MBr
Sd
Mc
U
D
B
L
MBc
PRECAMBRIAN GEOLOGY
AFTER TOLMAN AND ROBERTSON
SCALE
0
1
2
3
4 MILES

ROUTE LOG 2

Ironton to Piedmont

by

William C. Hayes and James A. Martin

OUTBOUND STARTING POINT: Junction of Missouri Highways 21 and State Road M., Iron County.

INBOUND STARTING POINT: Junction of Missouri Highways 49 and 34, Wayne County.

(Total driving distance one way - 41 miles)

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
00.00		From the Outbound Starting Point at the Iron County Court-house in Ironton, proceed south on Missouri Highway 21.	40.95
		Ironton was founded when Iron County was organized in 1857. During the Civil War, Brigadier General U.S. Grant arrived in August 1861 as commander of the 21st Illinois volunteer regiment to assume command of the area. Some 3,000 troops, mainly infantrymen, were stationed at Ironton. He was soon replaced by General B.M. Prentiss and took command of the District of Southeast Missouri moving his headquarters to Cape Girardeau, and later to Cairo, Illinois. The two-story brick courthouse with Greek Revival cornices and trim was erected in 1858 and used as a refuge for Union soldiers retreating under the Confederate attack led by General Sterling Price in September of 1864. Several scars of the battle are still in evidence on the walls of the building.	
	0.35		
0.35		Stouts Creek bridge. South city limits of Ironton; north city limits of Arcadia.	40.60
	0.10		
0.45		Junction of Missouri Highways 21 and 72. Continue south on Missouri Highways 21 and 72.	40.50
	0.05		
0.50		Unassigned Middlebrook felsite on both sides of road.	40.45
	0.60		
1.10		South city limits of Arcadia.	39.85
	0.30		
1.40		College Hill on west side of road.	39.55
	0.60		
2.00		Junction of Missouri Highways 21 and 72 with State Road E. Continue southwest on Missouri Highways 21 and 72. Railroad cut near State Road E, approximately 0.4 mile from junction, exposes 57 feet of the upper Bonneterre formation.	38.95

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.40		
2.40		Bonneterre formation exposed on both sides of road.	38.55
	2.40		
4.80		Tip Top Mountain Roadside Park. Gasconade formation, chert residuum. Note large boulders of chert. Railroad cut in residuum to south.	36.15
	0.30		
5.10		Junction of Missouri Highways 21 and 72 with State Road CC which leads to the lookout tower on top of Taum Sauk Mountain.	35.85
	0.30		
5.40		Stouts Creek rhyolite units.	35.55

The Stouts Creek rhyolite unit is the most extensive unit mapped by Tolman and Robertson. It was the first unit recognized in the field as an entity and was designated the "purple rhyolite". The salmon colored feldspar and clear quartz phenocrysts in a dark brown, aphanitic groundmass are characteristic. Detailed mapping has provided identifying characteristics whereby the Stouts Creek is divided into much smaller rock units.

The sketch of a thin section from this locality was drawn by P. D. Proctor and is included as the lower half in the illustration below. The top half, also drawn by Proctor, is from a sample along Route Log 2A approximately 2 miles west of Hogan.

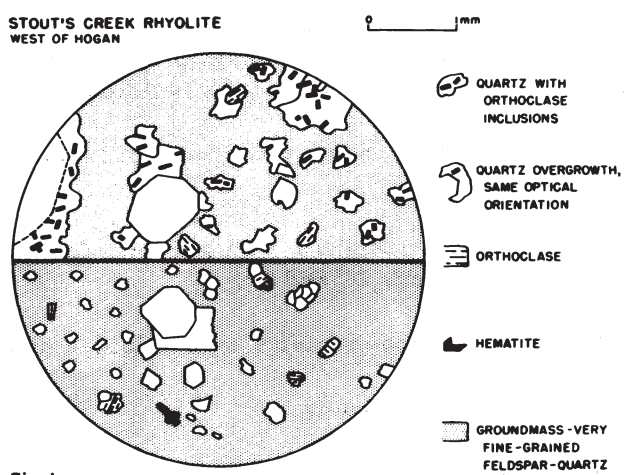


Fig. I
STOUT'S CREEK RHYOLITE
HIGHWAY 21 EAST OF MINOR CREEK
(SKETCH BY P. D. PROCTOR)

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.

Chemical analysis of Stouts Creek rhyolite; SW cor., $W\frac{1}{2}$ lot 3 W., T. 33 N., R. 4E.; GSA Rock Analysis

Laboratory, L. C. Peck, Chemist, 1948.

SiO_2	76.35	H_2O+	.35
Al_2O_3	11.63	H_2O-	.04
Fe_2O_3	1.24	TiO_2	.16
FeO	1.27	P_2O_5	.00
MgO	.12	MnO	.08
CaO	.39	F	.10
Na_2O	3.53	Less O	-.04
K_2O	4.50	Total	99.72

Cum.	Diff.		Cum.
	0.20		
5.60		Stouts Creek rhyolite on west side of road.	35.35
	0.20		
5.80		Bonneterre formation on east side of road; overlaps the Lamotte onto Precambrian.	35.15
	0.10		
5.90		Volcanic ash beds of the Ketcherside tuff. Near the north end of the outcrop a basal conglomerate of the Bonneterre rests on the Precambrian pyroclastics. A shear zone near the center of the exposure displaces the tuff.	35.05

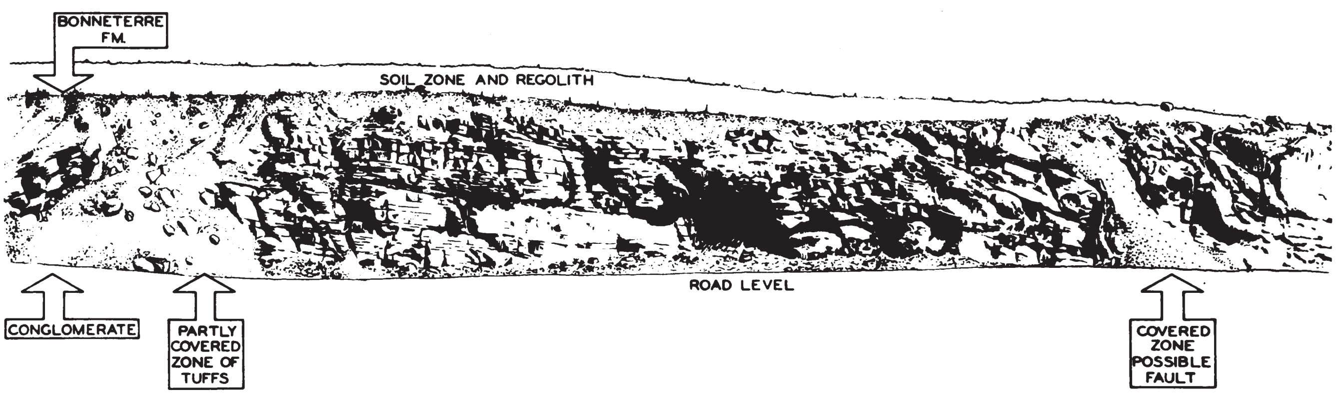


Figure 2

Ketcherside tuff outcrop, SE 1/4 SW 1/4 SE 1/4 sec. 11, T. 33 N., R. 3 E., Iron County. Drawing by Douglas R. Stark from photographs by P. D. Proctor.

Cum.	Diff.		Cum.
	0.30		
6.20		Bonneterre formation on west side of road.	34.75
	0.70		
6.90		Royal Gorge Shut-ins.	34.05

Royal Gorge is one of the most accessable and well developed shut-ins in the area. Where streams flowing on Paleozoic sediments have become superimposed on buried granite or felsite ridges, constricted valleys have developed in the more resistant Precambrian rocks. Bonham (1948) suggests that the shut-ins may be nick points, as advocated in the Treppen concept, rather than being formed from single superimposition.

The dull, light brownish- purple, porphyritic rhyolite with its small, red, feldspar phenocrysts is designated the Royal Gorge rhyolite. A modal analysis of the rock indicates 43 percent quartz and 53 percent potash feldspar of the composition; Or 97.5%, Ab 2.5%. The pseudo perthitic nature of the feldspar phenocrysts should be noted.

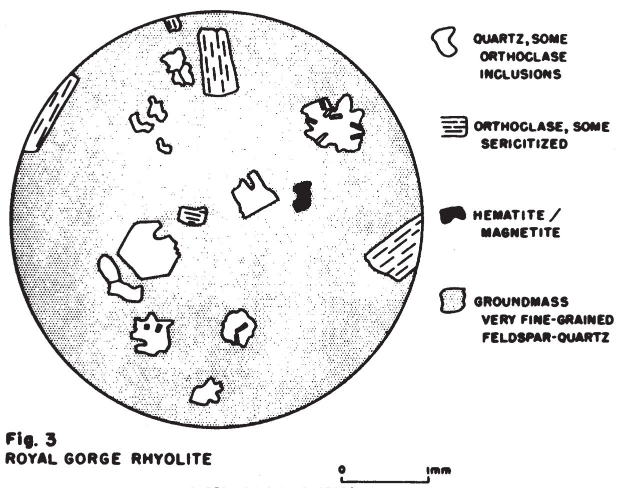


Fig. 3
ROYAL GORGE RHYOLITE

(SKETCH BY P. D. PROCTOR)

Chemical analysis of Royal Gorge rhyolite; C. $E\frac{1}{2}$ $SE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 14, T. 33 N., R. 3 E.; GSA Rock Analysis Laboratory, L. C. Peck, Chemist, 1947.

SiO_2	76.26	H_2O+	.46
Al_2O_3	11.53	H_2O-	.03
Fe_2O_3	2.22	TiO_2	.13
FeO	.31	P_2O_5	.01
MgO	.03	MnO	.03
CaO	.00	F	.02
Na_2O	.13	Less O	-.01
K_2O	8.52	Total	99.67

	0.45		
7.35		Palmer Creek bridge. Hogan Mine, approximately one-half mile upstream to the west.	33.60

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.35		
7.70		Highway parallels the Missouri Pacific Railroad. Hogan Mountains to the west. Ketcherside Mountain to the east.	33.25
	1.55		
9.25		North city limits of Hogan. Junction Missouri Highways 21 and 72 with State Road AA. (Starting Point of Route Log 2A, Hogan to Union Electric Company's Taum Sauk Project.)	31.70
	0.20		
9.45		South city limits of Hogan.	31.50
	0.25		
9.70		Davis formation to the west along gravel road.	31.25
	0.90		
10.60		Junction of Missouri Highways 72 and 21 with Missouri Highway 49. (Starting Point of Route Log 2B, Glover to Johnson Shut-ins). Continue south on Missouri Highway 49.	30.35
	0.50		
11.10		Village of Glover	29.85
	1.10		
12.20		Coarse-grained dolomite, Bonneterre? or Davis? Facies of the Bonneterre, Davis, and Derby-Doerun formations may be similar in lithology, and these formations are distinguished with difficulty in this area (See introduction to Route Log 2B).	28.75
	0.40		
12.60		Coarse-grained dolomite, Bonneterre? or Davis?	28.35
	0.60		
13.20		Village of Chloride	27.75
	1.50		
14.70		Potosi? formation on west in cut. Below the road on the east, there is a bluff of coarse-grained dolomite which probably is upper Davis. Note the calcite.	26.25
	0.10		
14.80		Coarse-grained dolomite; probably the upper part of the Davis formation.	26.15
	0.40		
15.20		Potosi? formation.	25.75
	0.40		
15.60		Potosi? formation.	25.35
	1.20		
16.80		Missouri Pacific Railroad overpass. Big Creek bridge.	24.15
	0.20		
17.00		Large cut in Potosi residuum on east.	23.95
	0.60		
17.60		Village of Sabula.	23.35
	0.80		
18.40		CAUTION! Dangerous curves.	22.55
	0.20		
18.60		Derby-Doerun formation on east.	22.35

Outbound Mileage Cum.	Diff.		Inbound Mileage Cum.
	1.20		
19.80		Annapolis rhyolite on east.	21.15

According to Tolman and Robertson (in preparation), the Annapolis rhyolite consists of at least three facies or individual flows. Near Annapolis, it is a dark gray to black, porphyritic rhyolite with pinkish-gray, feldspar phenocrysts, whereas 2 miles east of Annapolis it is a reddish- to chocolate-brown porphyry with a great many feldspar and quartz phenocrysts. A dark red to reddish-brown, cryptocrystalline porphyry appears to overlie the other two varieties. The presence of dark red, radiating crystals of piedmontite, as described by Haworth (1895, pp. 191-192), is of interest.

Chemical analysis of Annapolis rhyolite; SW$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 14, T. 31 N., R. 3 E.; GAS Rock Analysis Laboratory, L. C. Peck, Chemist, 1947.

SiO_2	72.75	H_2O+	.30
Al_2O_3	13.19	H_2O-	.03
Fe_2O_3	1.39	TiO_2	.31
FeO	1.51	P_2O_5	.06
MgO	.25	MnO	.10
CaO	.55	F	.02
Na_2O	2.40	Less O	-.01
K_2O	6.86	Total	99.71

	1.00		
20.80		CAUTION! Dangerous curves. Potosi formation on east.	20.15
	0.20		
21.00		North city limits of Annapolis.	19.95
	0.25		
21.25		Junction of Missouri Highway 49 and State Road K. Turn south and continue on Missouri Highway 49.	19.70

Along the west side of Big Creek approximately one-half mile to the northwest, the bluffs are capped with massive beds of the Derby-Doerun formation. The section as adapted from Zimmerman (1959, pp. 61, 63, 64), from the top of the bluff downward, is as follows:

Big Creek Section
C. W$\frac{1}{2}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 15, T. 31 N., R. 3 E.

	Feet	Inches
7. Dolomite, slightly calcareous, dark tan with orange and greenish-gray patches, medium-grained, massively bedded with beds 1 to 2 feet thick; protrudes 4 to 6 feet beyond bed 6	4	0

	Feet	Inches
6. Dolomite, calcareous, dark tan with orange to buff and grayish-brown patches, medium- to fine-grained; massive to flaggy bedded; weathers tan to brown . . .	4	0
5. Dolomite, very slightly calcareous, dark tan, fine- to medium-grained, cross-bedded (3/4 inch grooves and $\frac{1}{4}$ to $\frac{1}{2}$ inch siliceous ridges); forms a massive protruding ledge	3-4	0
4. Dolomite, mottled dark tan and gray, medium-grained, massively bedded, bedding planes discontinuous and 4 inches apart in upper $2\frac{1}{2}$ feet; weathers tan to brown	6	11
3. Dolomite, calcareous, gray, medium-grained, porous, cross-bedded in lower 2 feet; contains two zones of 1 mm. aggregates of crystalline quartz, lower zone is $1\frac{1}{2}$ inches thick and 2 feet 8 inches from bottom; weathered surface pitted to slightly grooved horizontally	5	0
2. Dolomite, similar to bed 1	0	5
1. Dolomite, very calcareous, grayish-brown, fine- to medium-grained, porous (pores buff in color and 1 mm. in diameter), massively bedded, bedding planes discontinuous and 4 to 20 inches apart; dolomitic limestone in upper part and cross-bedded in upper 1 foot 4 inches	5	8

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.20		
21.45		Annapolis rhyolite on west in vacant lot.	19.50
	0.30		
21.75		South city limits of Annapolis.	19.20
	0.25		
22.00		Annapolis rhyolite.	18.95
	0.20		
22.20		Derby-Doerun formation; coarse-grained dolomite facies.	18.75
	0.25		
22.45		Road on east leads to the Annapolis Lead mine (0.55 mile east to mine).	18.50

Kidwell (1947) mentions the similarity in this area of certain facies of the Bonneterre, Davis, and Derby-Doerun formations. Results of his studies of their insoluble residues indicate that the Bonneterre is at least 200 feet thick and is not known to crop out. The highly calciferous Davis is 70 feet thick in the subsurface, but a thickness of 105 feet is present in SW$\frac{1}{4}$ SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 10, T. 31 N., R. 3 E. Most

Outbound Mileage			Inbound Mileage
Cum.	Diff.		Cum.

of the surface exposures in the Annapolis Mine area are Derby-Doerun, and the formation may be as much as 150 feet thick.

Park City Consolidated Hole #14
NW$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 13, T. 31 N., R. 3 E.

Curb elevation: 645 feet.

Cambrian	
Derby-Doerun	0 - 140
Davis	140 - 200
Bonneterre	200 - 505
Arkose	505 - 540
Precambrian	540— 565 T.D.

Exploratory drilling by the Annapolis Lead Company around 1920 led to the discovery of a disseminated lead deposit at a depth of some 275-450 feet. By February 1921, as shaft was bottomed at a reported depth of 450 feet. By the end of 1922, a 600 ton-per-day mill was practically completed and underground drifts and crosscuts were prepared for mining the ore body. The ore body is in the Bonneterre and is reported to be 200 to 800 feet wide and some 2,600 feet in length along a N. 35° W. trend, except for the southern 800 feet where the trend is about N. 10° E.

Operation of the mine probably began late in 1922, and in 1923 the reported tonnage mined was 3,485 tons of lead. Mining continued through 1924, but late in that year two toronados hit the area and caused considerable damage. Another toronado struck in 1925, and there was no production recorded for that year.

After the destruction caused by the toronados, the mill was rebuilt in 1926, during which year only 39 days were available for mining operations. Employing an average of 200 men, approximately 30,000 tons of lead valued at slightly less than $2,000,000, had been produced when the company went into receivership in 1931. Most of the ore that was mined was apparently of low grade (in the order of 2 to 3 percent Pb) in comparison to the grade of ore being mined during those years in the Lead Belt.

Considerable exploratory drilling was conducted by Park City Consolidated in the Annapolis area in 1947, but mining has not been resumed.

	0.30		
22.75		Junction of Missouri Highway 49 and State Road C.	18.20

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.40		
23.15		Junction of Missouri Highway 49 with State Road F.	17.80
	0.10		
23.25		Big Creek bridge.	17.70
	0.20		
23.45		Missouri Pacific Railroad overpass.	17.50
	0.10		
23.55		Exposures on the west are near the base of the Potosi formation.	17.40
	1.80		
25.35		Vulcan railroad siding. Stockpiling and loading of agricultural limestone from the Potosi formation.	15.60
	0.10		
25.45		North city limits of Vulcan.	15.50
	0.20		
25.65		On the east in the hillside is Duncan Brothers Quarry in the Potosi formation. At this locality, the Potosi is a coarse-grained, friable dolarenite. It is quarried without blasting.	15.30
	0.40		
26.05		South city limits of Vulcan. Missouri Pacific Railroad underpass.	14.90
	0.35		
26.40		Junction of Missouri Highway 49 and State Road BB.	14.55
	2.15		
28.55		Potosi formation on west.	12.40
	0.30		
28.85		North city limits of Des Arc. Junction of Missouri. Highway 49 and State Road N.	12.10
	0.30		
29.15		Des Arc Mountain, which consists of Mudlick latite is in the distance to the east.	11.80
	0.60		
29.75		South city limits of Des Arc.	11.20
	1.25		
31.00		Iron-Wayne county line.	9.95
	1.55		
32.55		Chert and clay residuum on west.	8.40
	1.40		
33.95		Missouri Pacific Railroad overpass.	7.00
	0.50		
34.45		Gads Hill.	6.50
	0.30		
34.75		Clark Mountain rhyolite in roadcut and in railroad cut to southeast of road.	6.20

The Clark Mountain rhyolite is an aphanitic, reddish-brown to grayish-purple porphyry with phenocrysts of light brown to light red feldspar. The upper part of the unit consists of flow breccia as much as 550 feet thick,

Outbound Mileage Cum.	Diff.		Inbound Mileage Cum.
		and the entire unit may be over 1,000 feet thick (Tolman and Robertson, in preparation).	

Chemical analysis of Clark Mountain rhyolite; SW¼ NW¼ sec. 18, T. 29 N., R. 4 E.; GSA Rock Analysis Laboratory, L. C. Peck, Chemist, 1947.

SiO_2	68.14	H_2O+	.37
Al_2O_3	14.37	H_2O-	.05
Fe_2O_3	2.43	TiO_2	.52
FeO	1.60	P_2O_5	.11
MgO	.19	MnO	.05
CaO	.46	F	.05
Na_2O	1.31	Less 0	-.02
K_2O	9.76	Total	99.39

Cum.	Diff.		Inbound Cum.
	0.05		
34.80		Junction of Missouri Highway 49 and State Road CC.	6.15
	1.05		
35.85		McKenzie Creek bridge.	5.10
	0.80		
36.65		Finley Mountain to the west. The exposures to the southwest are of Clark Mountain rhyolite.	4.30
	1.50		
38.15		Potosi formation. Note its typical color, odor, and crystallinity.	2.80

Chemical analysis of Potosi dolomite from the W. M. Harris Bank, Piedmont, Missouri; R. T. Rolufs, analysist, 1942.

Insol.	1.52
Fe_2O_3	0.23
Al_2O_3	0.05
$CaCO_3$	54.52
$MgCO_3$	43.28
Total	99.60

Cum.	Diff.		Inbound Cum.
	1.90		
40.05		Junction of Missouri Highway 49 and State Road AA.	0.90
	0.70		
40.75		Missouri Pacific Railroad overpass. North City limits of Piedmont.	0.20
	0.10		
40.85		Quarry in Eminence formation on north side of road. Here the Eminence is a coarse-grained friable dolarenite.	0.10
	0.10		
40.95		End of Missouri Highway 49 at junction with Missouri Highway 34.	00.00

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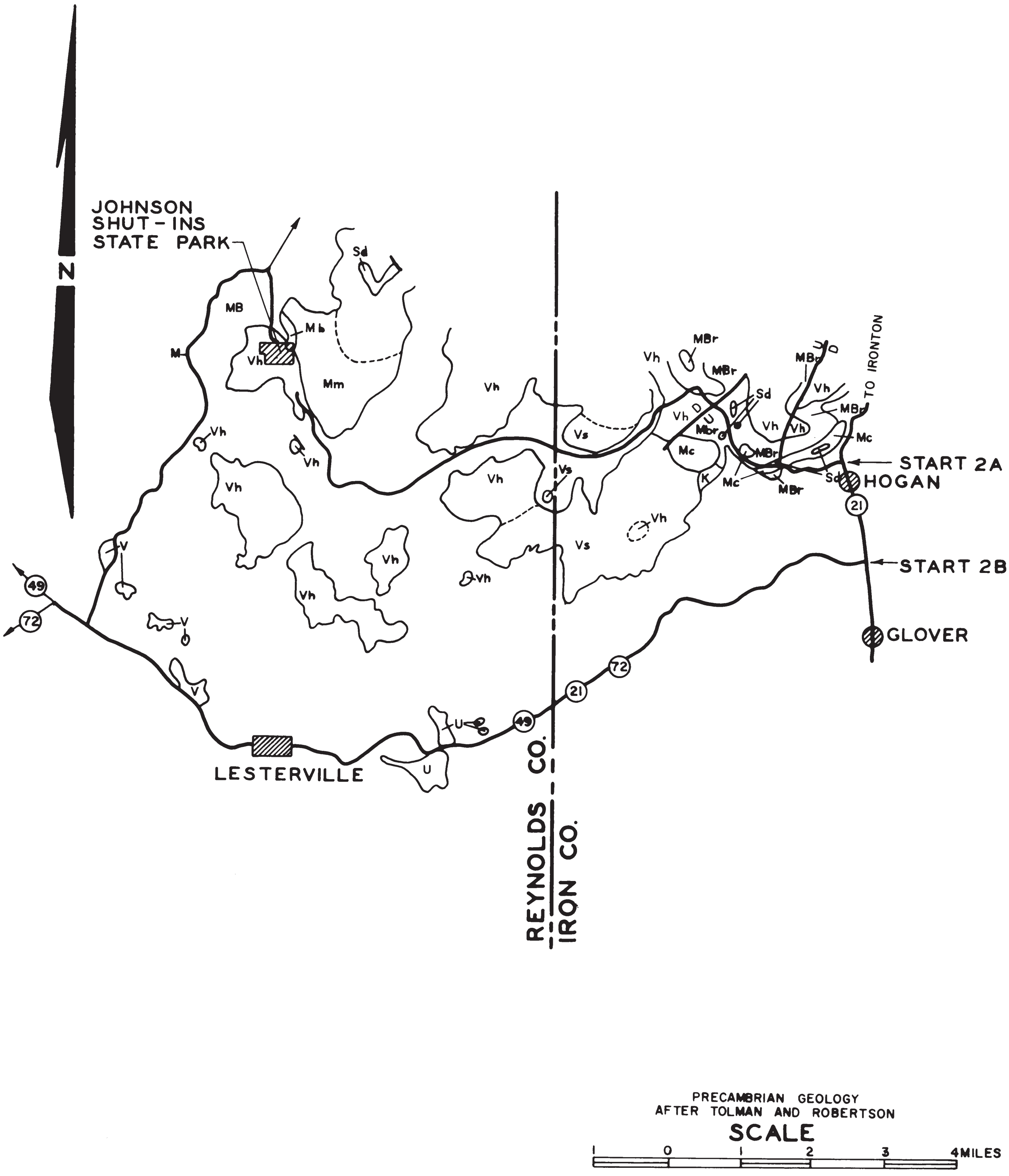
Zimmerman, Richard A., Geology of the Annapolis area, Iron County, Missouri: unpublished Masters thesis, Univ. of Missouri School of Mines and Met., Rolla Missouri.

Figure 4.

Jointing of granite porphyry, east bank of East Fork of Black River. Photograph taken from Haworth, Erasmus, 1896, The crystalline rocks of Missouri: Missouri Geol. Survey, vol. IX, pl. VI, Jefferson City.

ROUTES 2A AND 2B



ROUTE LOG 2A

Hogan to Taum Sauk Project

by

William C. Hayes, Paul D. Proctor, and James A. Martin

Directions to Starting Point

To reach the Starting Point proceed south from the Iron County Courthouse in Ironton on Missouri Highways 21 and 72 to the north city limits of Hogan at the junction of Missouri Highways 21 and 72 with State Road AA (mileage point 9.25 on Route Log No. 2)

STARTING POINT: Junction of Missouri Highways 21 and 72 with State Road AA, Iron County.

(Total driving distance 10.1 miles)

Mileage Cum.	Mileage Diff.	
00.00		From the Starting Point proceed west on State Road AA.
	0.65	
0.65		Bonneterre dolomite with Lamotte sandstone inter-fingered in the dolomite.
	0.30	
0.95		Diabase instrusive in Carver Creek granite porphyry and fault zone.

The Carver Creek granite porphyry is a sill-like mass which has been intruded into Stouts Creek rhyolite. It is a very fine-grained granite porphyry with a green and purple mottled groundmass. Phenocrysts of pink orthoclase are large, being as much as 10 mm. in length (Figure 1).

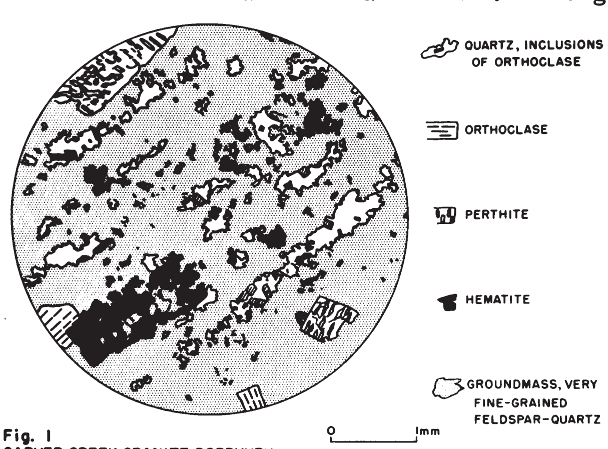


Fig. 1
CARVER CREEK GRANITE PORPHYRY

(SKETCH BY P. D. PROCTOR)

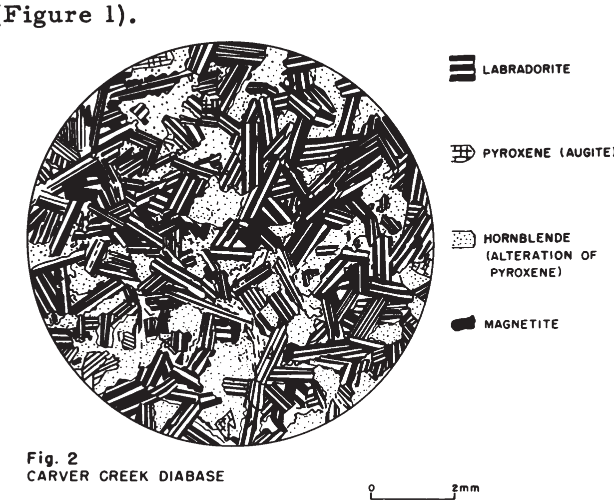


Fig. 2
CARVER CREEK DIABASE

(SKETCH BY P. D. PROCTOR)

Mileage Cum.	Mileage Diff.	
		West of the exposure of Carver Creek granite porphyry, there is a diabase intrusion. The rock consists of labradorite, hornblende altered from augite, augite, and magnetite (Figure 2).
	0.45	
1.40		Victory Baptist Church. Felsite on north. About 0.2 mile on the road to southwest, Taum Sauk marble beds are exposed along the north side of the road. Bear northwest on State Road AA.
	0.30	
1.70		Carver Creek granite porphyry on east side of road.
	0.60	
2.30		Small shut-ins on west side of road in Stouts Creek rhyolite. Exposures on east of road.
	0.10	
2.40		Carver Creek bridge.
	0.20	
2.60		Crossing fault zone.
	0.15	
2.75		Exposure of Hogan Mountain rhyolite.

Several flows and ignimbrites have been mapped together as the Hogan Mountain rhyolite. From 20 to 30 percent of the rock consists of salmon-red feldspar and glassy quartz phenocrysts. Flow layers are consistent and dip at low angles to the north and west. Corrosion of the quartz and quartz overgrowths are characteristic (Figure 3). The rock is probably a devitrified welded tuff (Tolman and Robertson, in preparation).

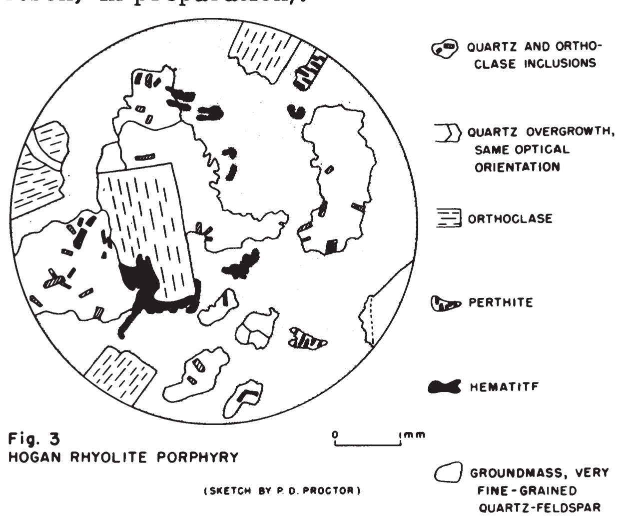


Fig. 3
HOGAN RHYOLITE PORPHYRY
(SKETCH BY P. D. PROCTOR)

	0.25	
3.00		End of State Road AA. Bear southwest to Union Electric Project. Road straight ahead leads to Devil's Toll Gate and becomes rough and impassable for passenger cars.

Mileage Cum.	Diff.	
	0.30	
3.30		Roadcut in residuum.
	0.20	
3.50		Slide problem in construction of road in residuum.
	0.20	
3.70		Precambrian boulder conglomerate.
	0.25	
3.95		Junction with old road on north.
	0.25	
4.20		Little Taum Sauk Creek, low-water bridge.
	0.10	
4.30		Bonneterre formation on north side of road. Fine-grained, dark gray, medium-bedded dolomite with intercalated siltstone and shale. Exposure becomes more shaly above.
	1.10	
5.40		Type Saum Sauk marble on south bank of Little Taum Sauk Creek south of road.
	2.50	
7.90		Road on south leads to Lesterville. Continue straight ahead to Union Electric Project.
	0.25	
8.15		Taum Sauk Creek, low-water bridge.
	1.35	
9.50		Gasconade chert residuum with felsite and sandstone float.
	0.10	
9.60		Roubidoux sandstone float.
	0.30	
9.90		Pit in Gasconade residuum. The residuum has been used for road metal in the Project area.
	0.20	
10.10		Gate - Entrance to Union Electric Taum Sauk Project. Note the relic bedding in the residuum in the cut to the east.

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Bonham, Lawrence C., 1945, The geology of the southwest part of the Ironton Quadrangle, Missouri: unpublished Masters thesis, Washington Univ., St. Louis, Missouri.

Tolman, Carl, and Robertson, Forbes, 1960, Precambrian geologic map of Missouri: unpublished manuscript, Missouri Geol. Survey and Water Resources, Rolla, Missouri.

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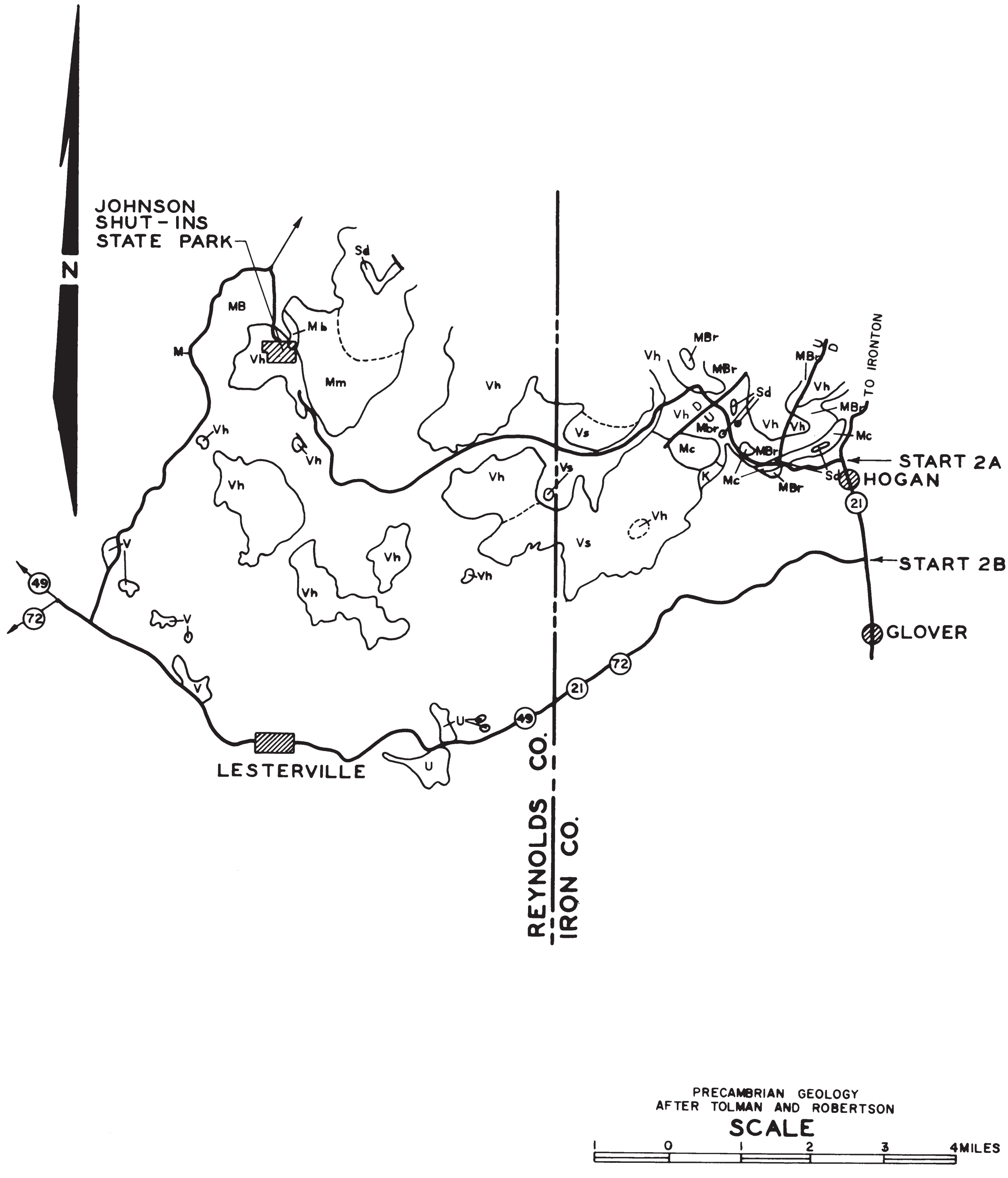
ROUTES 2A AND 2B



ROUTE LOG 2B

Glover to Johbson Shut-ins

by

Wallace B. Howe

INTRODUCTION

The region covered by this Route Log, Route Log 2A, and part of Route Log 2 lies within one of the more important problem areas of Upper Cambrian stratigraphy in Missouri. Geologic mapping is difficult because the variability of facies and stratigraphic relationships are such that differentiation of even the major formational units is problematic. For example, similar lithologies may be observed in the Bonneterre, Davis, Derby-Doerun, and Potosi formations. Because a lithology in the upper part of the Derby-Doerun is very similar to that of the Bonneterre, Dake (1930) described the Potosi formation as unconformable on the Bonneterre formation.

Detailed paleontological and stratigraphic studies by Kurtz (1960) have suggested several modifications in stratigraphic thought and nomenclature in the area. The Missouri Geological Survey is continuing the investigation of the stratigraphy of the area. At intervals during the past two years, Thor Kiilsgaard of the U. S. Geological Survey has been engaged in geologic mapping of the Lesterville Quadrangle.

Directions to Starting Point

To reach the Outbound Starting Point proceed south from Iron County Courthouse in Ironton on Missouri Highways 21 and 72 to the junction of Missouri Highway 49 north of Glover (mileage point 10.6 on Route Log 2).

OUTBOUND STARTING POINT: Junction of Mo. Highways 21 and 72 with Missouri Highway 49, Iron County.

INBOUND STARTING POINT: Parking area, Johnson Shut-ins State Park, Reynolds County.

(Total driving distance one-way - 19.9 miles)

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
00.00		Proceed from Starting Point west on Missouri Highways 21, 49 and 72.	19.90
	0.20		
0.20		The massive to thin-bedded dolomite exposed along the south side of the road is typical of the Davis in this area where the formation includes mostly thin- to medium-bedded	19.70

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		glauconitic and slightly quartzose or arkosic dolomite and a few shaly beds. An extremely massive, coarse- to very coarse-grained dolomite facies of the Davis formation also occurs in this series of exposures.	
	0.25		
0.45		Bedrock is not exposed for some distance. Thick residuum mantles essentially all of the upland area. Residual chert from the Gasconade formation is present in most of the residuum, and the massive sandstone often seen associated with it is generally believed to be Roubidoux.	19.45
	0.45		
0.90		Railroad tie mill to the left.	19.00
	0.35		
1.25		Picnic tables in turnout at summit of hill.	18.65
	0.95		
2.20		Carver Creek bridge.	17.70
		The valley of Carver Creek provides many good exposures of beds referable to the Davis, Derby-Doerun, and Potosi formations. Both Herbst (1952) and Kurtz (1960) have prepared detailed descriptions of these strata. The _Eoorthis_ zone is well defined here, and the base of the Davis is not exposed. This coarse-grained dolomite facies evidently has been identified as Bonneterre and possibly also as Potosi in earlier work. Approximately $1\frac{1}{2}$ miles south of the bridge the Potosi is faulted against the lower Davis.	
	0.80		
3.00		Begin descent of long hill.	16.90
	0.80		
3.80		Leave Des Arc Quadrangle - Enter Lesterville Quadrangle.	16.10
	1.50		
5.30		Leave Iron County - Enter Reynolds County.	14.60
		The low-lying area ahead is underlain by Bonneterre.	
	1.40		
6.70		Enter Lake Springs area. Here Mill Creek becomes sluggish, and one or more small lakes are formed east and upstream from a small shut-ins where the valley is constricted and base-level is locally controlled.	13.20
	0.10		
6.80		Exposures of upper Bonneterre and lower Davis formations.	13.10
		Lowermost beds, here, are rubbly to massive but generally dense limestone and dolomitic limestone. This rock type is commonly referred to as the "Taum Sauk marble". In the rock at this locality and in similar limestone along Marble Creek in Iron and Madison Counties, extremely large crystals of dolomite occur as discrete or connected masses in a very finely crystalline or dense limestone matrix. The stratigraphic distribution of this rock type is not well understood.	

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		At this locality, it would be included in the Bonneterre. In this area, the Bonneterre-Davis contract is enigmatic. A regionally important silty dolomite zone, long recognized and used as an upper Bonneterre marker in subsurface work at the Missouri Geological Survey, occurs in outcrops in this area. In recent mapping it is being used effectively in the Lesterville area, where it serves as a reference bed in distinguishing between massive coarsely crystalline dolomite of the Bonneterre and similar massive, coarsely crystalline dolomite of the Davis formation. The silty dolomite zone, which is characterized by a finely to medium crystalline texture and a thinly laminated though massive nature, is exposed at mile 6.85 and at a number of points between here and Lesterville. It is from 5 to 10 feet thick and is finely cross bedded. Coarsely crystalline dolomite assigned to the Davis is present above the silty dolomite zone. The beds dip to the east at this point owing to the influence of Precambrian knobs just to the west. The Lamotte does not crop out in this area.	
	0.25		
7.05		Exposures of Precambrian acidic extrusives, including vitrified tuffs, ash, and a dark variety of rhyolite porphyry. These rocks are a part of a mass forming a series of knobs that comprise shut-ins along Mill Creek and Clay Creek Hollow to the north.	12.85
	0.15		
7.20		Leaving Precambrian exposures.	12.70
	0.60		
7.80		Coarsely crystalline dolomite of the lower Davis formation. Excellent exposures of the silty dolomite zone are uphill to the west along the north side of the road. A small knob is located to the south.	12.10
	0.10		
7.90		Summit of ridge at the Dix place. Upper Bonneterre and lower Davis beds exposed on right.	11.90
	0.30		
8.30		Black fault zone. The shattered coarsely crystalline dolomite on the south side of the road is tentatively referred to the Davis and is on the upthrown side of the Black fault as extended from the Edgehill Quadrangle and traced through this area by Kiilsgaard. The hill straight ahead and to the right of the highway is capped with dolomite of the Potosi formation and is on the south and downthrown side of the fault.	11.60
	0.15		
8.45		Intersection of Missouri Highways 21, 49, and 72 with State Road U (north). Much of this road to the north is newly constructed, and many fine exposures of the Davis formation occur along it.	11.45
	0.25		
8.70		Intersection of Missouri Highways 21, 49, and 72 and State	11.20

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
		Road U (south). Between this point and East Fork of Black River, a few hundred feet to the west, there are exposures of dolomite which have been referred to the upper Derby-Doerun and lower Potosi formations. The position of the contact has not been definitely established at this locality, but the top of the massive bed just above road level is suggested as being at the position of the contact.	
	0.15		
8.85		East Fork of Black River.	11.05
	0.50		
9.35		East city limits of Lesterville.	10.55
	0.85		
10.20		West city limits of Lesterville. Middle Fork of Black River on the south.	9.70
	0.30		
10.50		Exposures of tan to gray, medium crystalline dolomite referred to Derby-Doerun.	9.40
	0.10		
10.60		Exposures at this point and those to the west, including ones along the slopes north of the road at mile 10.9, are referred to the Derby-Doerun formation. Middle Fork of Black River to the south.	9.30
	0.50		
11.10		Precambrian acidic extrusives, principally flow breccia. Exposure is on south flank of small knob.	8.80
	0.45		
11.55		Exposure of massive, finely to medium crystalline dolomite tentatively referred to the upper Derby-Doerun. The coarse brecciation and locally conglomeratic character of the rock at this exposure is not explained. Much of the dolomite is of the massive type that often can be seen to have relic cross-bedding structures and sometimes retains oolitic texture.	8.35
	1.35		
12.90		Intersection Missouri Highways 21, 49, and 72, and State Road M. Turn north on State Road M. Residuum is quite thick in this area, and there are not many exposures of bedrock.	7.00
	1.10		
14.00		Prominent exposure of Precambrian extrusives in roadcut which is the flank of a small knob. Like many of the other knobs, this one consists mostly of a complex array of acidic extrusive rocks, including rhyolite porphyry, vitrified ash, and tuffs and flow breccia. Some of the rock at this locality has granophyric texture.	5.90
	0.30		
14.30		Baker Branch bridge.	5.60
	0.50		
14.80		Leave Lesterville Quadrangle - Enter Edgehill Quadrangle.	5.10

Outbound Mileage Cum.	Outbound Mileage Diff.		Inbound Mileage Cum.
	0.10		
14.90		Potosi residuum in blackslope along east side of road.	5.00
	0.20		
15.10		Potosi residuum.	4.80
	0.15		
15.25		Thick residuum exposed in cuts to the west.	4.65
	0.10		
15.35		Summit of ridge.	4.55
	0.75		
16.10		Prominent exposures of massive arkosic dolomite which is probably upper Davis. The rock would be classed as a massively bedded dolarenite.	3.80
	0.20		
16.30		Walker Branch Baptist Church to the west.	3.60
	0.20		
16.50		Walker Branch bridge.	3.40
	0.20		
16.70		Davis formation. Massive dolarenite, like that at last exposure, displays well defined cross-bedding at one point.	3.20
	1.10		
17.80		Roadcuts in thick residuum.	2.10
	0.90		
18.70		Junction of State Roads M and MM. Continue northeast on M.	1.20
	0.25		
18.95		Exposures of coarse arkosic dolarenite of the Davis to the right. Note locally abundant specimens of *Eoorthis*.	0.95
	0.05		
19.00		Entrance to Johnson Shut-ins State Park. Leave State Road M and turn south and follow gravel road. The dolomite beds seen along the entrance road seem best assigned to the upper Davis and lower Derby-Doerun formations. At one point, some of the outlines of massive stromatolitic structure are preserved.	0.90
	0.90		
19.90		Parking area. Follow foot trails to shut-ins.	00.00

Johnson Shut-ins is typical of this unique type of geomorphic feature of the St. Francois Mountain area.
(See paper on Physiographic Features by Hayes in back of guidebook).

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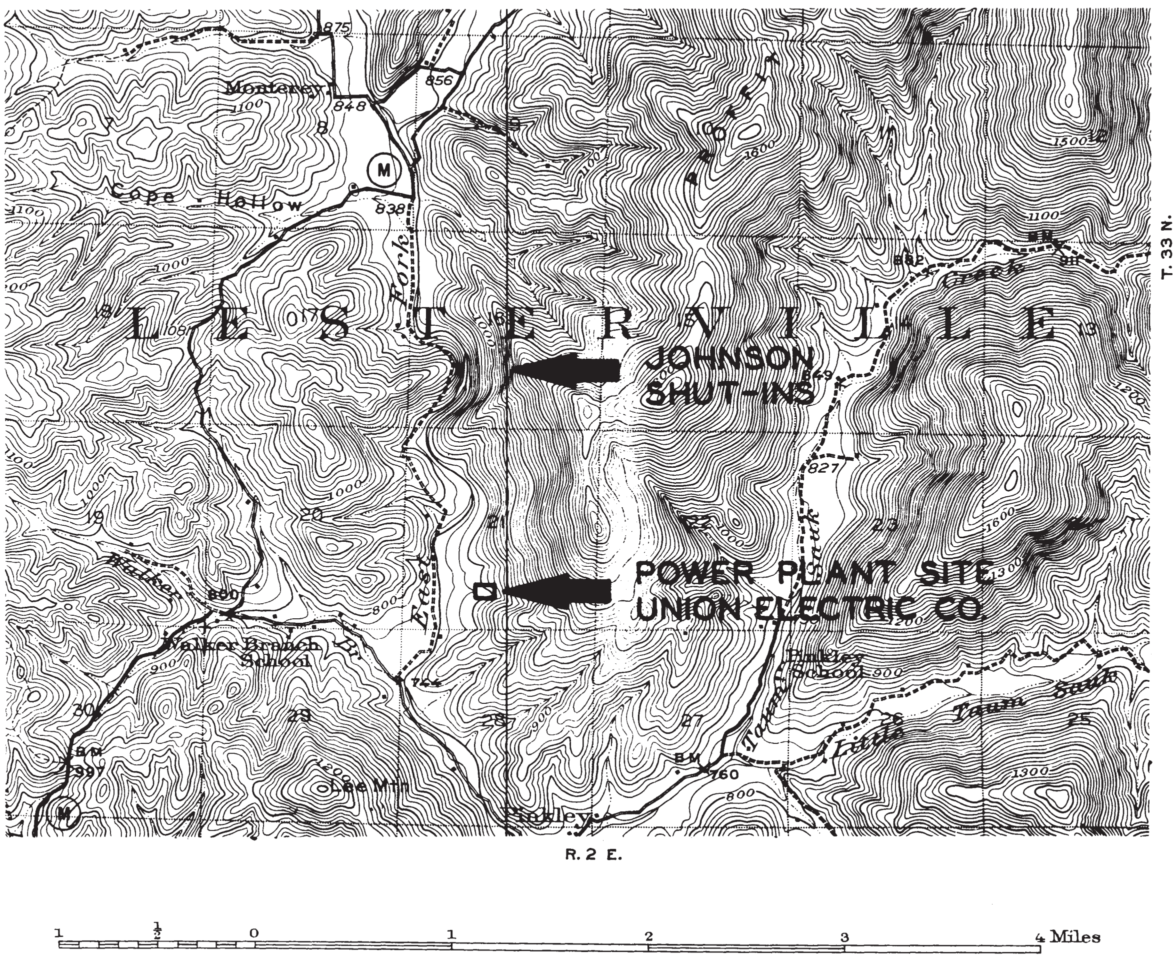

Contour interval 20 feet

Figure 1.
Map showing the topographic expression of Johnson Shut-ins and the location of the Union Electric Company, Taum Sauk project.

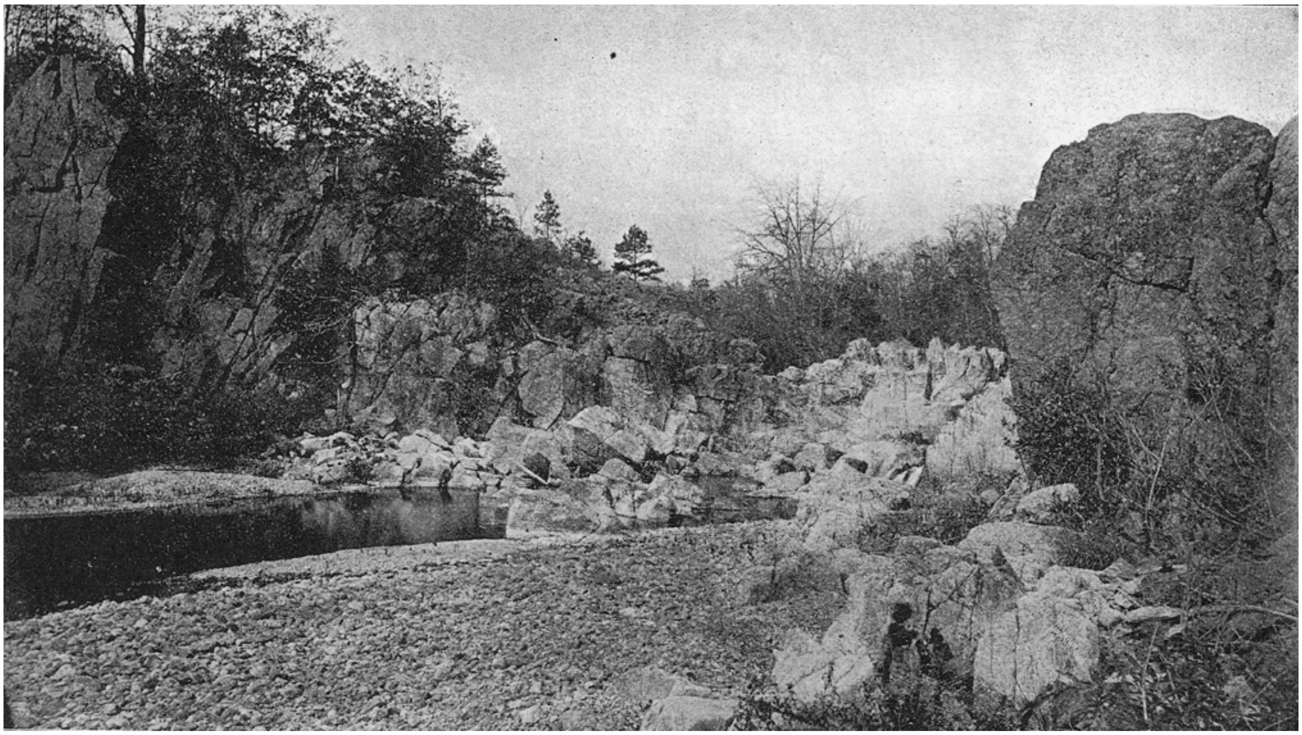

Figure 2.

Johnson Shut-ins. Photograph taken from Gallaher, Jno. A., 1900, Preliminary report on the structural and economic geology of Missouri: Missouri Bur. Geology and Mines, vol. XIII, pl. III, Jefferson City.