GUIDE BOOK

FIELD TRIP

Second Annual Meeting
Association of Missouri Geologists

by
Walter V. Searight

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Field Trip
Second Annual Meeting
Association of Missouri Geologists

STATE OF MISSOURI
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Division of
GEOLOGICAL SURVEY AND WATER RESOURCES
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INTRODUCTION

Western Missouri has a Desmoinesian section which is the standard for the state and is typical of this portion of the Pennsylvanian in the northern midcontinent. The midcontinent contains Middle Pennsylvanian deposits of two general facies; a basin facies as in the McAlester basin of Oklahoma and a platform facies as in western Missouri. The area is an excellent one in which to observe the characteristics of platform deposits, to demonstrate the continuity of thin beds, and to point out the methods used in classifying Pennsylvanian deposits.

A prominent feature of these beds is their cyclic or repetitive type of sedimentation which is so conspicuous that in some states it forms a basis for classification. In Illinois, Kansas, and Missouri these cyclic successions are called cyclothsems and are used as an important basis for the classification of Pennsylvania deposits. In the pre-Marmaton of Missouri and Kansas cyclothsems are employed as formational subdivisions. The presence of cyclical sedimentation, as exemplified by the Pennsylvania cyclothem, is widely recognized in the platform deposits of North America, Britain, and Europe, and its importance is no longer questioned. However, the lithologic units composing the cyclothem vary greatly from area to area and from one stratigraphic position to another, thus causing a divergence of opinions concerning the interpretation and genesis of the phenomenon.

The original concept of the cyclothem proposed by Weller (1930, pp. 97-135) assumes that the cycle begins with sandstone deposition on an erosion surface and culminates in a marine inundation which succeeds a transitional phase of lowland, swamp environments. Following the marine deposition a return to erosion terminates the cycle. This succession from sand, to underclay, to coal, to limestone, to sandstone is readily observed in Missouri. Since the sandstone deposits are discontinuous at most positions, the boundaries between cyclothsems are commonly obscure in western Missouri, southeastern Kansas, and northern Oklahoma. Furthermore, evidence for a significant unconformity at the base of the sandstone is rarely convincing. For these and other reasons, the top of the coal bed has been chosen in Kansas and Missouri as the boundary of the cycle in pre-Marmaton deposits. The position of this plane is easily determined in outcrops and in the subsurface and is readily mappable. A succession of deposits, from the top of a coal bed to the next stratigraphically higher, is treated as a formation and bears a formational name. Lithologic units corresponding to members within the formation are not named unless they already bear names of long usage. In numerous cases such names are now applied to the formation, thus obviating the introduction of a number of new names. Interstate studies and cooperation have also aided greatly in the reduction and simplification of nomenclature by using the same name across state boundaries.
ACKNOWLEDGMENTS

This is the second field trip and meeting of the Association of Missouri Geologists. The Association wishes to thank the staff of the Missouri Geological Survey for organizing this trip and for the preparation of this guidebook.

Association of Missouri Geologists

The Committee on Arrangements appreciates the assistance of the staff of the Missouri Geological Survey in the preparation of the guidebook. G. A. Muilenburg and R. D. Knight assisted in making the road log. J. D. Stewart photographed the exposures illustrated, printed the pictures, and retouched the plates. He and E. H. Woolrych drafted the graphic sections. Survey staff members are also responsible for identification, classification, and correlation of the drilling logs included. The guidebook was read critically by J. W. Koenig and many of his suggestions followed. Sections were made by the author unless otherwise stated.

The committee appreciates the courtesy of Potter and Sims, Inc., Ellis Coal Company, and Crowe Coal Company, in permitting their properties to be included on the itinerary.

Committee on Arrangements
FIG. 1. CLASSIFICATION OF DESMOINESIAN (PENNSYLVANIAN) OF NORTHERN MID-CONTINENT (ADAPTED FROM BULL. A.A.P.G. VOL. 37, p. 2748, 1953). STRATA EXPOSED AT EACH STOP OF 2ND A.M.G. FIELD TRIP INDICATED BY NUMBERED BRACKETS.
At the morning stops a sequence of sandstone, siltstones, shales, and coal will be studied. This succession of sediments contains limestone only locally, yet it lies below the persistent, but rather patchy Seville limestone. This sedimentary series has been referred to in the older literature as the Dederick and Clear Creek in western Missouri (Greene and Pond, 1926), and as the Columbus sandstone (Haworth and Kirk, 1894, p. 106) in southeastern Kansas. The Graydon sandstone and conglomerate appears also to include the same stratigraphic succession. In this general area, the widely recognized fossil break between the Pottsville and Allegheny formations of Ohio lies at the top of the Seville limestone. The Oklahoma group name, Krebs, (Oakes, 1953) is provisionally used for this succession of beds in Missouri and the time term Venteran (Searight and others, 1953) (Figure 1) is applied to it. This time term is derived from the type locality of Venter Bluff along U. S. Highway 54 in Cedar County, Missouri, (See Lexicon).

Between the Warner sandstone and pre-Desmoinesian there is a rock series which contains black shales, underclay, and as many as three coal beds. This succession is known in Missouri as the Riverton formation (Figure 1), (Stop 1), from the Riverton coal of Cherokee County, Kansas. Inasmuch as key beds other than coals have not been found in the Riverton, parts of it, therefore, are not readily identified and the formation has not been divided into smaller units. It is obvious, however, that the unit contains several cyclic successions.

The coal bed of the Warner formation is rarely seen. The Rowe and Drywood coal beds are widespread. They extend from the Kansas-Missouri boundary into Henry County, Missouri, and northward probably into the Forest City basin. These coals are typically developed in the Lamar area (Stop 2), but in the Deerfield area (Stops 3 and 4) the Drywood appears to be absent. On the surface and in the subsurface of the Nevada area and the Camp Crowder area to the southeast, the Warner and Bluejacket sandstones thicken and coalesce to form a nearly continuous sandstone succession in which coal beds have not been recognized.

The type locality of the Seville limestone is along the Spoon River near Seville, Fulton County, Illinois. It correlates with the Minshall limestone of Indiana and the Lower Mercer limestone of Pennsylvania. It is also correlated with the Inola limestone of Oklahoma.
FIG. 3. STOP 1. SECTION EXPOSED IN THE SNAPP MINE, POTTER AND SIMS, INC., IN THE NW 1/4 SE 1/4 SEC. 23, T. 29 N., R. 33 W., JASPER COUNTY, MISSOURI. THE SANDSTONE TO THE LEFT OF THE FAULT IS THE UPPER PART OF THE TOP SANDSTONE TO THE RIGHT.
Fig. 4. STOP 1.
Lower Venteran beds exposed in the west wall of the Snapp Mine, Potter and Sims, Inc., in the NW-1/4 SE-1/4 sec. 23, T. 29 N., R. 33 W., Jasper County, Missouri.

ROAD LOG - MORNING
Meeting time and place: 7:30 a.m. October 8, 1955. Assembly point on Highway 43 just south of junction of Missouri Highways 96 and 43. Cars head north. Check odometers at junction.

Mileage

0.0 Straight ahead on Missouri Highway 43.
0.2 Early Krebs ("Cherokee"), probably Warner, both sides of road; stigmatic sandstone below underclay, under chert gravel. The sandstone is almost a ganister of the type common under coal beds; the underclay contains carbonized root impressions.
1.0 Turn right (east) on country road.
1.1 Early Krebs sandstone in road cuts.
2.0 Turn left (north) at cross roads.

2.35 Turn left into Potter and Sims Mine.
STOP 1.

STOP 1. Snapp Mine, Potter and Sims, Inc. The mine was in production from 1951 through May, 1953. During this period the mine produced over 10,000 tons of zinc concentrate which was valued at more than $1,000,000, and over 2000 tons of lead concentrate which was valued at more than $450,000. The estimated, total value of the zinc and lead concentrates was more than $1,500,000. In 1951 this mine was the largest producer of zinc in Missouri. The production of the two metals averaged roughly one ton of lead to five tons of zinc. At the present time the mine is not in operation. It is reported that the water depth in the pit is 150 feet.
The stratigraphic section at this locality was made while the mine was in operation and it shows basal Pennsylvanian (Desmoinesian) beds resting on Mississippian. It also shows the Riverton formation and the entire Warner formation. A very similar succession is exposed in the wall of a recent sink hole west of Cow Creek, Cherokee County, Kansas, (Pierce and Courtier, 1937, p. 25) which is about 10 miles northwest of this location.

Through the kindness of Potter and Sims, Inc., Joplin, Missouri, permission has been given to visit this mine.

2.35 Leaving Potter and Sims, Inc., mine, turn left (north) on country road we came in on.

3.0 Turn left on T road (west).

4.0 STOP! MISSOURI HIGHWAY 43. Turn right (north) on Highway 43.

4.9 Curve right.

5.0 Early Krebs shale in ditch.

5.2 Boone limestone in ditches.

6.4 Curve left.

7.0 Bridge, Spring Creek.

7.15 Boone limestone in cuts.

7.8 Boone cherts in ditch, left.

8.15 Abandoned coal shaft; pieces of Mississippian limestone, chert, black shale, gray shale on dump. Coal mined apparently near bottom of Pennsylvanian.

8.2 Bridge, North Fork Creek.

8.35 Bridge.

9.3 Curve right.

9.45 Curve left.

10.1 Strip coal mine right, probably Rowe coal. Overburden largely sandstone.

10.3 Strip coal mine, left, probably Rowe coal.

11.0 Sandstone in cuts (Bluejacket?).

11.3 Sandstone in cuts (Bluejacket?).

12.15 Sandstone in cuts (Bluejacket?).

12.4 Massive sandstone in cuts (Bluejacket?).

12.5 SLOW! JUNCTION MISSOURI HIGHWAY 43 WITH JASPER COUNTY HIGHWAY H. Turn right on H.

12.8 Prairie Star School, 1898, left.

14.4 Krebs sandstone in ditches, both sides of road.

14.6 Krebs sandstone in ditches, both sides of road.

14.9 Bridge.

15.2 Krebs sandstone in ditches, both sides of road at intervals to junction with Jasper County Highway O.

15.45 Junction Jasper County Highways H and O.

15.7 Krebs sandstone in ditches at intervals for next 2 miles.

19.6 Junction Jasper County Highways H and O.

20.35 Curve right.

20.6 Bridge, North Fork Creek.

20.7 Curve left.

21.25 Boone limestone in gulley at right. Curve right.

22.5 SPEED ZONE! 35 MILES PER HOUR.

22.6 Jasper, Missouri.

22.7 Railroad crossing.

22.75 High School, left.

23.0 SLOW! Junction ahead.


23.2 Curve right.

23.35 Curve left.

23.7 Boone limestone on right.

23.9 Bridge, Coon Creek.

24.0 Curve left over viaduct.
FIG. 5. STOP 2. SECTION FORMERLY EXPOSED IN STRIP
MINE AND SHAFT WEST OF U.S. HIGHWAY 71 IN THE NE ¼ SE ¼
SEC. 14, T. 31 N., R. 31 W., BARTON COUNTY, MISSOURI.

24.1 Leaving Jasper County, entering Barton County.

24.3 Curve right.

27.2 Junction U.S. Highway 71 and Missouri 126.

28.8 Bridge. A mile west, the Warner sandstone is exposed along a small creek.

29.75 STOP 2.

Between STOP 2 and Lamar, a distance of a little more than four miles, the Bluejacket sandstone is exposed at intervals in the road ditches.

33.4 SPEED ZONE! 40 MILES PER HOUR.

33.6 Viaduct.

33.7 CAUTION! STOP AHEAD.

33.9 4 WAY STOP! JUNCTION U.S. HIGHWAYS 71 AND 60. Straight ahead on Highway 71; City of Lamar, right.

Lamar, the county seat of Barton County, was named from Mirabeau B. Lamar, President of the Republic of Texas from 1838 to 1841. This city is the birthplace of ex-President Harry S. Truman.

The City of Lamar, Well #2, drilled in 1954, penetrates 981 feet of Pennsylvanian, Mississippian, and Ordovician beds. The bottom of the well is in the Gasconade.
The log of this well, made from a study of samples by R. D. Knight of the Missouri Geological Survey, follows:

City of Lamar, Well #2
Missouri Survey, Log #12618
SE SE NW sec. 18, T. 32 N., R. 30 W., Barton County
Pennsylvanian System
Mississippian System
    Meramecian Series
    Warsaw
    Short Creek
    Osaganian Series
    Keokuk-Burlington
    Grand Falls-Reeds Springs-Fern Glen
Kinderhookian Series
    Sedalia*
    Northview
    Compton
Ordovician System
    Cotter
    Jefferson City
    Roubidoux
    Upper Gasconade
    Total depth

* Beveridge and Clark (1952, pp. 71-77) and Spreng (1952, pp. 81-86) consider that the Sedalia as used in the subsurface to be the Pierson formation and place the Kinderhookian-Osaganian boundary at the Northview-Pierson contact.

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Fig. 6. STOP 2.
Upper portion of the Drywood formation under the lower Bluejacket formation exposed east of U. S. Highway 71, in the NW-1/4 SW-1/4 sec. 13, T. 31 N., R. 31 W. The coal bed is the Drywood and the sandstone above it is the Bluejacket.
The Bar-Co-Rock plant is five and one-half miles west and one and one-half miles north, at Iantha. Paving and surfacing material is made by processing oil-bearing sandstone. The rock is crushed, heated, and asphalt added for a binder. The sandstone, unusually thick for this area, is thought to be Bluejacket.

34.1 Old mines, both drift and strip in Rowe coal.

34.9 Resume speed.

35.2 Bluejacket sandstone in ditch, right.

39.3 Bluejacket sandstone in ditch, right.

40.5 Junctions U. S. Highway 71 with Barton County Highways V and C.

42.5 Curve left.

43.9 Curve right.

44.7 Leaving Barton County, entering Vernon County.

45.1 SPEED ZONE! 35 MILES PER HOUR.

45.2 Sheldon.

In Vernon County, east and northeast of Sheldon, in the vicinity of Bellamy, both the Rowe and Drywood coal beds have been mined in small stripping operations which date back as far as the beginning of the century. The Bluejacket sandstone in this same area is locally petrotiferous and for many years has sporadically aroused considerable interest.

45.5 Curve left.

45.9 Resume speed.

46.6 Curve right, Krebs shales in ditch on right.

47.5 Krebs shales and sandstones, ditches right and left.

50.0 Krebs shales and sandstones in ditch, right.

51.1 Curve left.

Approximately a mile west of the highway a well was drilled in 1954 to a depth of 530 feet through rocks of Pennsylvanian, Mississippian, and Ordovician age. A log of the well was prepared by L.C. Martin and K. H. Anderson formerly of the Survey staff.

Kim Oil Company, Missouri Survey, Mayes #1 Log #12681
Sec. 22, T. 35 N., R. 31 W., Vernon County
Pennsylvanian System 20-104 feet
Mississippian System
Meramecian Series
Warsaw 104-211
Short Creek 211-230
Osagian Series
Keokuk-Burlington 230-370
Fern Glen 370-425
Kinderhookian Series
Pierson-Chouteau 425-495
Compton 495-515
Ordovician System
Jefferson City 515
Total Depth 530

51.35 Bridge.

51.9 Curve right.

52.4 Milo, right.

52.8 Junction Vernon County Highway E, right.

55.2 SPEED ZONE! 45 MILES PER HOUR.
S curve left over viaduct.

55.8 Viaduct.

56.5 Camp Clark, right; Missouri National Guard.

56.8 Railroad crossing.

57.8 Curve left, Motel Tolle.

59.3 SPEED ZONE! 30 MILES PER HOUR.

59.4 Nevada.

During the early days of the Civil War, Nevada was used as a headquarters by Confederate troops and was known as the "Bushwhackers Capitol". It was captured by a company of Federal militia from Kansas, May 26, 1863. The town was burned to the ground except for two log cabins which were apparently overlooked. The city is the county seat for Vernon County. The court house with its corner turrets and clock tower, is located in the middle of the city square and is built of Carthage limestone. The
business district is concentrated about the square. Radio Springs Park, at the foot of South College Street, is a recreation center which has two lakes and a golf course. A little more than a mile north of Nevada is a State Hospital for the treatment of mental diseases. Nevada celebrated its centennial in July of this year.

Ten miles north of Nevada, adjacent to U.S. Highway 71, a well was drilled in 1954 through Pennsylvanian and Mississippian rocks into the Ordovician to a depth of 852 feet. Drill cuttings from this well were studied by J. W. Koenig and R. D. Knight of the Survey staff, and the log is inserted here for comparison with the subsurface succession near Nevada and Lamar.

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<th>McDowell Rendering Plant, Well #1</th>
<th>Missouri Survey, Log #13067</th>
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<td>NW NE SW sec. 17, T. 37 N., R. 31 W., Vernon County</td>
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Pennsylvanian System 0-155 feet
Mississippian System
Meramecian Series
Warsaw 155-260
Short Creek 260-265
Osagian Series
Keokuk-Burlington 265-475
Kinderhookian Series
Sedalia 475-485
Northview 485-495
Chouteau 495-560
Ordovician System
Jefferson City 560-735
Roubidoux 735
Total Depth 852

60.8 TRAFFIC SIGNALS!! Watch for dips in pavement next several blocks.

61.4 Cottey College, right.

Cottey College is a privately endowed junior college for girls. It was established as the Vernon Seminary by Virginia Alice Cottey in 1884 and was chartered as Cottey College in 1887. Since 1927 the school has been owned and operated by the P. E. O. Sisterhood.

61.75 Krebs sandstone in ravine, left, and road cuts, right.

Nevada is on a structural high. Mississippian rocks crop out in a window northwest of Nevada, NE-1/4 sec. 20, T. 36 N., R. 31 W. In the vicinity of Nevada and Camp Clark the Krebs succession is mostly micaceous sandstone. The Warner, Rowe, and Drywood coal beds commonly present in this sandstone series have not been observed either in the outcrops or in the drilling records of this vicinity. However, beds of dark brittle shale have been observed within the succession. The sandstones may be considered as containing the Warner sandstone at the bottom and Bluejacket sandstone at the top. A few miles to the southwest drilling records indicate that the coal beds are present and are situated between the sandstones. The Riverton formation, with its two coal beds, is exposed below the sandstones along Birch Creek in the NW-1/4 sec. 8, T. 35 N., R. 31 W., about a mile south of the present position.

62.8 Hatton slough. Lower Krebs sandstone, probably Warner sandstone. The black shales of the Riverton are not exposed below the sandstone. The Riverton is exposed farther to the north near outcrops of Mississippian age.

63.1 Sandstone in west bank of creek and in road cuts.

63.9 Shale in Krebs group, probably between Bluejacket and Warner.

64.0 Shale in road cuts, right, in Krebs group.

65.2 JUNCTION U.S. HIGHWAY 54 AND MISSOURI HIGHWAY 43. NOTE THIS POINT!! IT IS THE ASSEMBLY POINT FOR THE AFTERNOON TRIP.

65.4 Shale in Krebs.
FIG. 7. STOP 3. SECTION NEAR THE BRIDGE ACROSS DRYWOOD CREEK, NORTH OF U.S. HIGHWAY 54 IN THE NE 1/4 SW 1/4 SEC. 5, T.35 N., R.32 W., VERNON COUNTY, MISSOURI.
Venteran beds exposed in the NE-1/4 SW-1/4 sec. 5, T. 35 N., R. 32 W., Vernon County, Missouri. The massive bed at the left of the old bridge abutment is at the top of the Warner sandstone. The dark streak in the upper right background indicates the position of the Rowe coal bed immediately below it.

65.5 Massive Krebs sandstone in road cuts.

65.6 Massive Krebs sandstone in road cuts.

66.9 Shale and sandstone (Krebs) in road cut on right.

67.2 Sandstone above shale in road cut, all Krebs.

67.25 Shale in road cut, left.

67.4 Shale in road cut, left.

67.65 Bluejacket sandstone over shale in road cut, right. Coal streak about 10 feet below sandstone is probably Drywood.

67.9 STOP 3.

STOP 3. The stratigraphic sequence at this location exhibits beds of the Krebs group, from the base of the Warner sandstone up to and including the Bluejacket sandstone. The Riverton coal bed was exposed here, below the Warner sandstone, in the 1870's. It was again exposed during the recent drought and was measured in 1953. It is now below the water level of Dry Wood Creek. In this section and the next, at STOP 4, the Drywood coal is absent. It appears to be cut out by the uneven base of the Bluejacket sandstone.

67.95 Bridge, Dry Wood Creek.

68.25 Bridge.
FIG. 9. STOP 4. SECTION SOUTH OF MARMATON RIVER EAST OF VERNON COUNTY HIGHWAY H IN THE NW¼ SW¼, SEC. 6, T. 35 N., R. 32 W., VERNON COUNTY, MISSOURI.
Fig. 10. STOP 4.

Late Venteran beds exposed at the bridge across the Marmaton River in the NW-1/4 SW-1/4 sec. 6, T. 35 N., R. 32 W., Vernon County, Missouri. The sandstone at the top is the Bluejacket. The lower sandstone is in the Drywood formation. Slumped blocks of sandstone cover the Rowe coal bed which is exposed less than 100 yards east.

68.6 Curve left.
68.8 SPEED ZONE! 40 MILES PER HOUR.
69.0 Deerfield.

Deerfield was formerly the site of an "asphalt" plant which was situated on the south side of the town. The product of this plant was used for road surfacing and roofing. In the 1870's pottery was manufactured at the now, long deceased Deerfield Pottery. A saw mill at the west edge of town cuts oak, pecan, and other hardwoods. Pecan wood is used in this area for truck beds.

69.4 Junction U. S. Highway 54 and Vernon County H. Turn right on H (north).
69.7 SLOW! Curve and bridge ahead. Turn cars around. STOP 4.

STOP 4 is one of the sites at which "asphalt" rock was mined. The raw material was processed at Deerfield. The Bluejacket sandstone at this location is saturated or nearly saturated with black "asphalt". The "asphalt", however, is crude oil containing but little asphaltic material. True asphalt must be used as a binder to permit its use as a satisfactory road material. As at this place, the Bluejacket sandstone is petroliferous in many places in Vernon County. Several hundred holes have been drilled in unsuccessful attempts at production since 1900. Return to Highway H and turn left on U. S. Highway 54 back to Nevada. Lunch wherever you wish in Nevada. After lunch, return to the Junction of U. S. Highway 54 and Missouri Highway 43 for the afternoon trip. Check odometers at the junction where the afternoon log begins.
Fig. 11. Stop 5. Section at abandoned strip coal mine 1/2 mile southwest of Moundville Cemetery in Lot 4 W. Sec. 5, T. 34 N., R. 32 W., Vernon County, Missouri.

Afternoon Stops (5,6,7,8,9)

The afternoon stops will be devoted to a review of the significant beds which make up the group provisionally referred to as the Cabaniss group, which, with the Marmaton group, represents Cygnian time (Figure 1). The type area in which strata of Cygian age may be observed is located along the Marais des Cygnes River (Little Osage) in Vernon County, Missouri, and to the west in Bourbon and Lynn Counties, Kansas, (Searight and others, 1953). At Moundville, Stop 5, the lower portion of the succession extending from the lower Cabaniss beds to the top of the Tiawah limestone will be seen. Near Bronaugh, at Stops 6, 7, 8, and 9, the remainder of the group and the basal Marmaton will be observed.

Road Log - Afternoon

Assembly point, on Missouri Highway 43 at junction of U.S. Highway 54 and Missouri Highway 43, 4 miles west of Nevada. Cars head south on 43. Check odometers at junction.

Mileage

0.0 Junction.
0.1 Undifferentiated Krebs in road cuts.
1.0 Railroad crossing.
1.1 Sandstone in road cuts, probably Bluejacket.
3.4 Ridge to west and southwest capped by Marmaton.
4.0 Curve right.
4.4 Curve left.
4.8 Bridge. Strip mine to right of road in Weir-Pittsburg coal bed. The north crop-line of the minable coal of this bed is in Vernon County. It is not mined between this locality and Montrose in southwestern Henry County, Missouri.
5.4 SPEED ZONE! 30 MILES PER HOUR.

5.45 Moundville. The thin Tiawah limestone, the caprock of the Tebo coal, lies below the surface at this locality. The Tebo is very thin here and the Weir-Pittsburg lies about 15 to 20 feet below the Tiawah. A dozen or more small operators formerly had mined the Weir-Pittsburg in this area. One of these operators had excavated a shaft behind the old mill to the left of this curve. Another shaft is situated south of this point, around the next curve behind the church. As the old miners put it "Moundville sets on props and pillars"; the coal having been mined out from beneath it. The Weir-Pittsburg bed is approximately 30 inches thick, but two thinner beds separated by thin clay seams lie immediately below it. The lower coal bed is 16 inches to 36 inches thick. The middle bed is commonly a foot or less thick.

5.7 JUNCTION MISSOURI HIGHWAY 43 AND VERNON COUNTY F. Straight ahead, west on F. SLOW THROUGH TOWN! WATCH STREET INTERSECTION!

5.9 Moundville High School, 1893, left.

6.1 Stripping in Weir-Pittsburg coal, right.

6.3 Curve left.

6.4 Turn right, SLOW!

6.5 NO DUMPING SIGN. Turn left on black mine road.

6.6 Turn cars around. STOP 5.

STOP 5. The abandoned strip mine at this stop exhibits the Weir-Pittsburg coal. The coal has not been exposed for many years, but is recorded as being 30 inches thick. The mudstone which rests on the coal is the characteristic
Fig. 13
Chelsea sandstone north of Missouri Highway 43 in road cut in the SE-1/4 SE-1/4 sec. 17, T. 34 N., R. 32 W., Vernon County, Missouri.

overburden of the bed in this area and may be seen on the spoil banks. It is reported by Broadhead to be 17 feet thick at Moundville. The area below the ground on which the cars were turned has probably been mined out through a shaft.

Turn back to Vernon County F. Turn right to Moundville and Missouri Highway 43.

7.5 STOP! JUNCTION VERNON COUNTY HIGHWAY F AND MISSOURI HIGHWAY 43. Turn right (south) on 43.

7.7 Leaving Moundville.

7.8 Tiawah limestone (Tebo caprock) to left in road cut, just south of driveway to house - look sharp.

7.9 Shales (mudstones) over Weir-Pittsburg coal, both sides of road. There was formerly an old drift in Weir-Pittsburg coal to left. The mine was reported as unsuccessful and was abandoned without production.

7.95 Railroad crossing.

11.5 Chelsea sandstone, Scammon formation, both sides of road.

11.9 Chelsea sandstone.

In this general area the Scammon sandstone (Chelsea) locally cuts through the lower beds of the Scammon and Tebo formations. In the NW-1/4 of sec. 20 and the SE-1/4 of sec. 19, T. 32 N., R. 33 W., Barton County, Missouri, about 14 miles southwest of this point, the sandstone rests on mudstones at the bottom of the Tebo formation which lies above the Weir-Pittsburg coal bed. Both the Tiawah limestone and Tebo coal are absent. At Liberal, about 11 miles southwest in Barton County, Missouri, the Chelsea also lies within a few feet of the Weir-Pittsburg coal on mudstones of the Tebo formation.

12.1 Curve right. Look closely at cut to right for Tiawah limestone.

12.2 Tiawah limestone (Tebo caprock).
FIG. 14. STOP 6. SECTION EXPOSED IN THE HIGHWALL OF THE ELLIS MINE IN SW₁/₄ SW₁/₄ SEC. 18, T. 34 N., R. 32 W., VERNON COUNTY, MISSOURI.

12.3 Top of hill, Chelsea sandstone in cuts (Figure 13).

12.5 SPEED ZONE! 30 MILES PER HOUR.

12.6 Bronaugh.

12.9 JUNCTION MISSOURI HIGHWAY 43 AND VERNON COUNTY HIGHWAY N. Leave 43 and follow N straight ‘ahead.

13.0 Railroad crossing, 3 tracks.

13.6 Strip mines on both sides of road in Croweburg coal. Note similarity of spoil to that from above the Weir-Pittsburg. Between this point and the next crossroad west, the Croweburg and Mineral coal beds have both been stripped. Spoil banks with black shale are Mineral.

13.95 Turn right on road to strip mine.

14.15 STOP 6.

STOP 6. Ellis Mine. This mine is a stripping in the Mineral coal bed. The exposures which are typical of this area extend from the top of the Mineral formation to the basal portion of the Verdigris. The Robinson Branch formation which normally lies between the Mineral and Fleming formations is either absent here or has not been identified.

Turn back to Vernon County Highway H.

14.35 Highway N turn right (west).

14.65 Turn right (north) on country road.

14.8 CAUTION! SLOW! Narrow curving road. Lead car blow horn.

15.5 Croweburg stripping, left.

15.65 SLOW! Turn right (east) on rock road.

15.85 Verdigris limestone in road. Ahead, right, strip mines in Croweburg coal. Strip mines in Mineral coal, right, behind barn. SLOW! Turn cars around facing west. STOP 7.

STOP 7. This mine is a stripping in the Croweburg coal bed. Although the coal bed is not exposed, it is known that
Early Cabaniss beds exposed in the highwall of the Ellis Mine in the SW-1/4 SW-1/4 sec. 18, T. 34 N., R. 32 W., Vernon County, Missouri. Coal bed at the lower right is the Mineral. The thin coal below the head of the pick is the Fleming and the coal near the top is the Croweburg.

the mudstones seen here are the same as those which overlie the Croweburg coal at STOP 6. The Verdigris limestone referred to as the "diamond rock" at this locality immediately underlies the Bevier coal bed at STOP 8. The succession here is typical of the Verdigris formation.

16.1 Turn right (north) on country road.

16.05 Middle distance to left, abandoned strip mines mostly in Mineral and Croweburg coal beds.

16.3 STOP 8.

STOP 8. This mine is a stripping in the Bevier coal. The section is only partially exposed, but the spoil banks and outcrops give an indication of the characteristics of the strata associated with this coal bed. These exposures are typical of this portion of the section which extends from Vernon County, Missouri, to southeastern Kansas.

16.45 Lower Fort Scott (Blackjack Creek) limestone in road.

16.5 Shallow strip mines in Mulky coal bed, right.

16.85 Turn right (east).

17.0 Old strip mines in Mulky coal bed, left.

17.05 Blackjack Creek limestone in road; strip mines in Mulky coal, both sides of road.
FIG. 16. STOP 7. SECTION OF BEDS OF THE VERDIGRIS FORMATION IN THE SW\(\frac{1}{4}\) SW\(\frac{1}{4}\) SEC. 7, T. 34 N., R. 32 W., VERNON COUNTY, MISSOURI.

Verdigris formation exposed in the highwall of the abandoned strip mine in the SW-1/4 SW-1/4 sec.7, T. 34 N., R. 32 W., Vernon County, Missouri. The ledge of limestone near the top of the exposure is the "diamond rock".
Large concretions in black fissile shale below the "diamond rock", in the Verdigris formation in the SW-1/4 SW-1/4 sec. 7, T. 34 N., R. 32 W., Vernon County, Missouri.

17.25 SLOW! Turn into Jones Mine and quarry, right. STOP 9.

STOP 9. This mine serves a dual purpose; the Mulky coal bed is mined and the Blackjack Creek limestone (lower Fort Scott) is quarried for use as road material. The outcrop shows the contact between the Cabiniss and Marmaton groups.

17.3 Turn back on to entrance road to Jones Mine, turn right (east). Road built on Blackjack Creek limestone.

17.5 Blackjack Creek in road.

17.6 Road built on Lagonda, concealed.

17.75 Lagonda shale in ditch.

17.8 Verdigris limestone in road.

18.1 Turn right (south).

19.1 Cross roads.

19.65 Abandoned strip mine in Croweburg coal, right.

20.1 Turn left to Missouri Highway 43 to U.S. 54; turn left on 54 to Nevada.
FIG. 19. STOP 8. SECTION OF PARTS OF THE BEVIER AND LAGONDA FORMATIONS FORMERLY EXPOSED IN THE SE₁⁄₄ SE₂₁⁄₂ SEC. 12, T. 34 N., R. 33 W., VERNON COUNTY, MISSOURI.
LEXICON OF PRE-MARMATON TERMS WITH NOTES

A

Ardmore.--The name applied by Gordon (1896, p. 20) to the "sump rock" limestone of the "Bevier" coal, now the Wheeler bed. The name was expanded to include the several associated limestones in the succession below the Wheeler coal and above the Croweburg (Cline, 1941). The name, "Lower Ardmore", has also been applied to the coal bed (commonly Croweburg) below the limestone.

Ardmore cyclothem.--The cyclothem which includes the "Ardmore"; now the Verdigris limestone (Abernathy, 1938). See cyclothem and cyclic formation.

Atoka.--A succession of late pre-Desmoinesian beds in Oklahoma, below the Hartshorne sandstone. Beds of this age have been recognized in the Joplin district (Thompson, 1953).

Bartlesville sand.--An Oklahoma subsurface designation for sandstone situated stratigraphically at the position of the Bluejacket. The name has been loosely applied to various sandstone beds in the lower "Cherokee".

Bastard coal bed.--The Fleming coal; so called in southeastern Kansas.

Bedford coal.--A name applied to the upper bench of the "Bevier" in Carroll and Livingston Counties, Missouri. Although coal bed names are informal, the application of the name to a Mississippian limestone in Indiana prevents formational use of the name, and the application to the coal bed in Missouri is discouraged.

Bellamy coal.--Named from mining areas near Bellamy, Vernon County, Missouri (Greene and Pond, 1926, p. 80). The coal that was mined at Bellamy apparently consisted of the coal beds now known as the Rowe and Drywood and the two coals were probably mined together wherever the intervening beds were sufficiently thin to permit such an operation. The name Rowe has been consistently applied to the lower of these two beds in southeastern Kansas, and the name has been adopted for a bed occupying a similar stratigraphic position in Missouri.

Bernadotte sandstone.--A sandstone in the Tradewater formation of western Illinois which is stratigraphically situated at or near the position of the Bluejacket sandstone of the northern midcontinent.

Bevier coal.--Commercially mined coal from the two beds or benches (Wheeler and Bevier) of the "Bevier" in Randolph and Macon Counties, Missouri. Most of the coal is taken from the thicker, upper bed. This bed is now defined as the Bevier.

Bevier coal bed.--The upper bench of the "Bevier". Where the two benches of the "Bevier" are separated by sandstone, shale, and underclay as in Carroll and Livingston Counties, Missouri, and in Iowa, the bed was referred to as the Bedford. The Bevier was named by McGee in 1888 from the coal mining town of Bevier, Macon County, Missouri.

Bevier cyclothem.--The cyclothem which includes the Bevier coal bed (Abernathy, 1938). See cyclothem and cyclic formation.

Bevier formation.--The formation which is topped by the Bevier coal bed (Searight and others, 1953). It rests on the Wheeler coal bed and lies immediately below the Lagonda formation.

Blackjack Creek cyclothem.--The cyclothem which contains the Blackjack Creek limestone. This cyclothem also contains the Mulky coal bed. It thus straddles the Cynghan-Marmaton boundary. See cyclothem and cyclic formation.

Bluejacket coal bed.--The coal bed which constitutes the top bed of the Bluejacket formation. The coal is thin or absent in many places in Henry County, Missouri, but it is of minable thickness locally. It has also been mined in some sink structures in Miller, Morgan, and Lincoln Counties, Missouri. It is stratigraphically situated at or near the position of the Rock Island (No. 1) coal of western Illinois, and is possibly representative of that bed.

Bluejacket formation.--The formation which lies below the Seville limestone and is assigned to the upper portion of the Krebs group of Venteran age in Missouri (Searight and others, 1953). The Bluejacket coal bed lies immediately below the Seville limestone and constitutes the top bed of the formation. In most localities the most prominent unit in the formation is the Bluejacket sandstone.

Bluejacket sandstone.--The type locality of the Bluejacket sandstone is west of the town of Bluejacket, Craig County, Oklahoma, (Gould, 1925). It is the unit of the Bluejacket formation most commonly seen. In many places it is probably considered as the Bartlesville of the Oklahoma subsurface. In Vernon and Barton Counties, Missouri, it is commonly petroliferous ("asphaltic").
FIG. 20. STOP 9. SECTION OF UPPER KREBS AND LOWER MARMATON GROUPS IN THE JONES MINE AND QUARRY IN THE SE\(\frac{1}{4}\) NW\(\frac{1}{4}\) SEC. 7, T. 34 N., R. 32 W., VERNON COUNTY, MISSOURI.
Fig. 21. STOP 9.

Upper Krebs and lower Marmaton in the Jones Mine and quarry in the SE-1/4 NW-1/4 sec. 7, T.34 N., R. 32 W., Vernon County, Missouri. The head of the pick rests on Mulky coal; the handle rests on Excello. The handle of the fork is on the "cement rock" in the basal Fort Scott (Blackjack Creek).
Breezy Hill cyclothem.--The cyclothem which includes the Breezy Hill limestone (Abernathy, 1938). In Missouri, the only known bed representing this cyclothem is the Breezy Hill limestone which lies at the bottom of the Mulky formation. See cyclothem and cyclic formation.

Breezy Hill limestone.--The highest limestone known in the Cabaniss group. The name is from Breezy Hill, southeast of Mulberry, Crawford County, Kansas, (Pierce and Courtier, 1937, p. 33). The bed occurs sporadically and extends from the Kansas-Missouri boundary eastward into Macon County, Missouri. In Missouri the rock is the hackly underlimestone ("freshwater limestone") type at the base of the underclay of the Mulky coal. In some localities of southeastern Kansas and northeastern Oklahoma the rocks contain marine fossils including large specimens of Dictyoclostus and fusulinids.

Broken Arrow coal.--A coal bed of northeastern Oklahoma which is correlated with the Croweburg coal bed.

Brown limestone.--A term used by Greene and Pond (1925, pp. 106-107) to designate the Seville limestone.

Bunker Hill coal.--An old name for Mulky coal in northeastern Crawford County, Kansas.

Cabaniss group.--The succession of strata between the Krebs and Marmaton groups (Oakes, 1953). The assignment of Missouri rocks to this group is provisional. The type Cabaniss is a basin facies; considerably different structurally, lithologically, and perhaps faunally from the platform facies of Missouri and Kansas.

Cement rock.--An old name applied to the massive, somewhat earthy facies in the lower portion of the lower Fort Scott (Blackjack Creek). In many places a somewhat lenticular bedded, relatively pure limestone facies lies above it. Locally the two facies are separated by shale. Some outcrops contain only one of the lithologic units and locally both are absent.

Chelsea sandstone.--A well known sandstone in the Krebs of Oklahoma. It is correlated with the sandstone in the Scammon formation. The base of this sandstone cuts down through the Tiawah limestone to within a few feet of the bottom of the Tebo formation in Barton County, Missouri.

Cheltenham clay.--Pennsylvanian clays of eastern Missouri. In part, these represent underclays, inasmuch as Stigmia, rootlets, and three or more coal beds are known to be present within the deposits. The Cheltenham lies under greenish "poison clays" which are in part underclays of a local coal bed lying beneath the Loutre limestone. This coal bed is correlated with the Tebo, and the Loutre limestone is correlated with the Tiawah. The age of the chert residuum and sandstone, "Graydon", beneath the Cheltenham is uncertain. It may be either Bluejacket or Warner, or an older sandstone. It also may vary in age from place to place. Near Belle in Maries and Osage Counties, Missouri, and north of Owensville in Gasconade County, Missouri, late Venteran and early Marmaton deposits lie on Cheltenham. North of Owensville, thin Exce11o under the Blackjack Creek limestone rests unconformably on Cheltenham. In that area most of the Cabaniss group is absent between the Cheltenham and the Excello.

Cherokee formation.--A name applied to Pennsylvanian beds below the Fort Scott by Haworth and Kirk (1894) and given formal rank in Iowa by Keyes (1896). Since then, it has been used for these lower Desmoinesian rocks of the northern midcontinent. The type area is in Cherokee County, Kansas. Inasmuch as the Pottsiville-Allegheny boundary lies within the succession it is most desirable that the beds be separated into two units; a lower unit of late Pottsiville age (Kanawha) and an upper unit of early Allegheny age which is believed to be closely related to the Marmaton historically and faunally. In an interstate conference (Seattle and others, 1953) it was decided that the best solution to the problems involved was to relegate the term "Cherokee" to informal usage and to recognize the time-rock units Venteran and Cygnian. New terms, the Krebs and Cabaniss groups, were likewise adopted for Oklahoma. These group terms are now used provisionally by the Missouri Geological Survey since it is apparent that the Krebs group as defined in Oklahoma straddles the Pottsiville-Allegheny boundary.

Cherokee shale.--Shale and sandstone bracketed by the Mississippian and Fort Scott ("Oswego") (Haworth and Kirk, 1894, p. 105).

Clear Creek member.--A term used in Vernon County, Missouri, by Broadhead (1874, p. 100) for the sandstone now called Bluejacket, and by Greene and Pond (1926) for the beds from the base of the Warner sandstone to the top of the Bluejacket sandstone. The name was preempted from an Illinois limestone (Worthen, 1866). It appears to include, by Greene and Pond's definition, the same succession as the
Graydon (Winslow, 1894, pp. 422-425; Shepard, 1898, p. 124 and 1907, p. 22) of Missouri and the Columbus of southeastern Kansas (Haworth and Kirk, 1894, p. 106).

Coal balls.—Masses of peat petrified in limestone and pyrite, and found in coal beds in some localities. Their value lies in the preservation of the uncollapsed plant structures. These coal balls are an important source of information on coal formation.

Coal cycle.—A succession of beds extending from the top of a coal bed to the top of the next stratigraphically higher coal bed. The span is identical with the cyclic formation. It is used in Oklahoma where basin rather than platform terminology is used. Formations in Oklahoma in many cases include more than one cyclic succession and are divided at positions other than the tops of coal beds.

Colchester (No. 2) coal.—An Illinois coal bed correlated with the Croweburg.

Columbus coal.—A coal bed in the “Columbus” sandstone. It is probably the Rowe bed of present terminology.

Columbus sandstone.—An old name used in southeastern Kansas for a sandstone and shale succession which apparently includes beds ranging from the Warner through the Bluejacket (Haworth and Kirk, 1894, p. 106).

Conostichus broadheadi zone.—A zone of shale and sandstone in the lower part of the Drywood formation. It contains the nested cone-shaped structures described as Conostichus broadheadi Lequereaux (White, 1899).

Cordaites.—Strap or ribbon-like leaves commonly found in “rashy” coal at the top of a coal bed.

Croweburg coal bed.—A very widespread and persistent coal bed above the middle of the Cavaniss group (Pierce and Courtier, 1937, p. 74). It constitutes the top of the Croweburg formation. The type Croweburg is in strip pits about a mile east of Croweburg, Crawford County, Kansas. This place is less than two miles west of the Missouri line. The bed has been known in western Missouri by many local names, such as: “mud vein”, “clay vein”, “one foot”, and “10 inch”. In many places in northern Missouri it has been called “Lower Ardmore”. It has been erroneously identified as the “Bevier” in northeastern Henry County, Missouri, and southeastern Johnson County, Missouri. It is correlated with the Broken Arrow coal bed of Oklahoma, the Whitebreast coal of Iowa, and the Colchester (No. 2) of Illinois.

Croweburg formation.—A formation lying between the Fleming and Verdigris (Seairport and others, 1953). The name is from the Croweburg coal bed which lies at the top of the formation.

Cyclothem.—A repetitive succession of beds which occur in definite stratigraphic order as displayed in coal bearing Pennsylvanian and Permian strata. The original concept postulated sandstone deposition upon an uplifted and eroded base. The cyclothem is terminated at the top by elevation and erosion and recurrence of sandstone deposition in the succeeding cycle.

Cyclic formation.—A repetitious stratigraphic series displayed in deposits of platform facies beginning at the top of a coal bed and including the next stratigraphically higher coal bed at the top. Cyclic formations are the basic units used in classification and nomenclature in the pre-Marmaton of Kansas and Missouri (Seairport and others, 1953). See coal cycle.

Cyclical formation.—As defined by Wanless (1931) a cyclical formation included the following stratigraphic units from the base upward: (1) sandstone, (2) sandy shale, (3) “freshwater” limestone, (4) coal, (5) carbonaceous shale, (6) limestone and calcareous shale, and (7) clay shale with ironstone concretions. Thus, as used by Wanless, the succession is the same as a cyclothem.

Cynogian Substage (pronounced Seenian).—A time-rock term including the interval between the Venteran and the Pleasanton (Seairport and others, 1953). The rocks include the “provisional” Cavaniss (Oakes, 1953) and the Marmaton groups.

Dederick shale member.—The abandoned name for the lower Cherokee succession in Vernon County, Missouri, (Greene and Pond, 1926, pp. 40-44). Normally beds situated between the Mississippian and Warner were included in the formation, but at the type locality at Dederick, beds between the Warner and Bluejacket sandstones are included.

Des Moines group.—A stratigraphic sequence given group rank by Keyes (1893, 1896) for the “Lower Coal Measures.” It extended upward to the “Bethany”; base of the Kansas City group.

Desmoinesian Stage.—Middle Pennsylvanian strata which in Missouri include all post-Atokan beds below the base of the Pleasanton. The base of the Pleasanton is now considered to be at the bottom of the Hepler sandstone (Seairport and others, 1953; Greene and Seairport, 1949). This series of strata has been
variously designated the Des Moines formation (Keyes, 1893), the Des Moines Series (Keyes, 1896, Moore, 1932), Des Moines Series (Greene and Searight, 1949), and the Des Moines Group (Hinds and Greene, 1915). Keyes' designations have been redefined. The type locality is along the Des Moines River in Iowa. The Hartshorne sandstone is not identified in Missouri, but in Oklahoma the Hartshorne lies below beds equivalent to the Riverton of Kansas and Missouri and is included in the Desmoinesian.

Drywood coal.--This coal constitutes the top bed of the Drywood formation. It is mined 4.2 miles south of Lamar, west of Highway 71; STOP 2. The type section of the coal is in the NE-1/4 SE-1/4 NE-1/4 sec. 4, T. 32 N., R. 33 W., and is situated in the strip pit below the spillway of an artificial lake on a tributary of Dry Wood Creek. At this place, the relations with the Rowe coal bed below and the Bluejacket sandstone above are clearly indicated.

Drywood formation.--A formation of Venteran age which lies between the Rowe and Bluejacket (Searight and others, 1953). The type locality is below the spillway of the artificial lake on a tributary of Dry Wood Creek in the NE-1/4 SE-1/4 NE-1/4 sec. 4, T. 32 N., R. 33 W., 1-1/4 miles west of Liberal, Barton County, Missouri.

Type section of the Drywood formation; location, NE-1/4 SE-1/4 NE-1/4 sec. 4, T. 32 N., R. 33 W., Barton County, Missouri.

Pennsylvanian System
Middle Pennsylvanian Series
Desmoinesian Stage
Venteran Substage
Krebs group
Bluejacket formation
8. Sandstone, fine-grained, micaceous
7. Shale, gray, nearly black, rusty; siderite concretions in one inch bed six inches above coal
Drywood formation
6. Coal streak
5. Shale or clay, sandy, with concretionary, lenticular, fine sandstone masses, about 8 inches thick and 2 feet across; these masses are calcareous and sporadically contain abundant minute crinoid stems or arm segments
4. Underclay, buff, brown; gray below
3. Shale, black, flaky, gray when dry
Rowe formation
2. Coal (the Rowe bed, stripped)
1. Underclay, gray

The formation appears to be the source of most of the plant fossils described by White (1899). He states that they came from "an horizon at the base of the Allegheny formation, if not, as seems slightly more probable, in the uppermost portion of the Pottsville" (White, 1915, p. 261).

Drywood seam.--Local miner's term for Bevier in Kansas.

Excello formation.--A thin formation at the top of the Cabaniss group which separates the Mulky coal from the lowest Marmaton bed, the Blackjack Creek limestone (Searight and others, 1953). The type section is near the NW-1/4 NW-1/4 sec. 30, T. 56 N., R. 14 W., west of Excello, Macon County, Missouri, and about two and one-half miles west of U.S. Highway 63 south of a country road. It is the youngest Venteran deposit. This formation is largely composed of black fissile shale which contains abundant, flattened, phosphatic concretions. In many places it contains large biscuit shaped concretions which measure a few feet in diameter. In some respects it resembles the black fissile shale in the Verdigris formation.

Type section of the Excello formation; location, NW-1/4 sec. 30, T. 56 N., R. 14 W., 2.6 miles west of U.S. Highway 63, west of Excello, Macon County, Missouri, in the highwall of a coal strip pit. Same succession exposed along the highwall north and south of east-west road.

Desmoinesian Stage
Cygnian Substage
Marmaton group
Fort Scott formation
6. Blackjack Creek limestone member. Limestone, gray, in one compact bed; horizontally streaked with discontinuous, wavy, darker gray limestone; fossiliferous; contains Chaetetes; fusulinids abundant in upper 8-10 inches

Cabaniss group
Excello formation
5. Shale, dark gray at base to light gray above; weathers into small buff and drab chips
4. Shale, black, less brittle than bed 3; phosphatic concretions very abundant in thin more or less continuous beds; weathers drab or medium gray
3. Shale, sooty black, fissile, brittle; abundant, flattened, drab, phosphatic concretions as much as 1/2 inch thick

Mukly formation
2. Coal, bright, blocky
1. Underclay, not well exposed; gray, root impressions in upper part

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35
F

Fireclay coal bed.--Local Kansas miner's name for Croweburg.

Fleming coal bed.--A persistent coal bed of western Missouri and Kansas. The bed is mined only locally because of its lenticular character. The type locality is near Fleming, in southern Crawford County, Kansas, (Pierce and Courtier, 1937, p. 73).

Fleming cyclothem.--The cyclothem which includes the Fleming coal bed (Abernathy, 1938). See cyclothem and cyclic formation.

Fleming formation.--A cyclic formation lying between the Robinson Branch and the Croweburg (Searight and others, 1953). The Fleming coal bed lies at the top of the formation.

Foot coal.--Miner's term for Croweburg; the "one-foot".

Fort Scott coal.--An old name for the Mulky coal bed.

Fort Scott formation.--The lowest Marmaton formation of the northern midcontinent. The Blackjack Creek limestone is the bottom member which rests with knife-edge sharpness on the Excello formation of the Cabaniss group.

Fort Scott marble.--The Fort Scott formation of current terminology.

Francis Creek shale.--A shale of western Illinois which is the equivalent of the shale in the Verdigris formation immediately above the Croweburg coal bed.

G

Graydon sandstone and conglomerate.--A conglomerate and sandstone named from the type locality near Graydon Springs, Polk County, Missouri, (Winslow, 1894, pp. 422-425; Shepard, 1898, p. 124 and 1907, p. 22). The succession appears to be the same as the "Clear Creek" and includes beds from the base of the Warner sandstone to the top of the Bluejacket. The relation between this succession and the "Graydon" of north Missouri is not known (McQueen, 1943, Unklesbay, 1952).

Ganister.--A term used in the Pennsylvanian stratigraphy of Britain to denote quartziferous root and stigmatic sandstone immediately below a coal bed. This appears to be the original usage of the term. Ganister thus defined is a quartziferous, sandy, seat rock. The "bench rock" between the Wheeler and Bevier coal beds in Randolph County, Missouri, is considered to be quite similar to a true ganister.

Hanover limestone.--The limestone situated above the No. 4 coal of Illinois and considered to be equivalent to the Blackjack Creek limestone or lower Fort Scott; thus equivalent to the base of the Marmaton group of the northern midcontinent.

Hartshorne sandstone.--A sandstone considered to be at the base of the Desmoinesian of Oklahoma by the Oklahoma Geological Survey. It rests on Atoka. The Hartshorne sandstone has not been identified in Missouri although an unnamed sandstone below the Warner is reported in several drilling records in Vernon County, Missouri.

Henrietta formation.--An abandoned name for the Marmaton. The name has priority over Marmaton, but the type locality is indefinite, the span of beds included is uncertain, and through wide usage the term Marmaton, in a precise sense, has become established.

Honey Creek coal.--Croweburg coal bed in Henry County, Missouri, (Marbut, 1898, pp.168, 173). At this locality black fissile shales in the lower part of the Verdigris formation rest on the Croweburg coal bed. The coal bed has been confused with the younger Mulky as the succession in such localities appears to be identical with the higher one.

I

Inola limestone.--A limestone, the lowest one in a succession of three cyclothsms of late Pottsville age in northeastern Oklahoma, which is correlated with the Seville of Missouri and Illinois.

Iron Post coal bed.--A coal bed lying at the top of the Lagonda succession in northeastern Oklahoma (Howe, 1952). The Breezy Hill limestone above it is separated from the coal bed by black fissile shale.

J

Jordon coal.--A coal named from the Jordan shaft near Deepwater, Henry County, Missouri. The name has been applied to both the Rowe and the Weir-Pittsburg beds of Henry County. The Drywood coal has also been included locally with the Rowe.

Jordon district.--The name formerly applied to the coal mining area in Henry County, Missouri. The important bed mined is the Tebo and the area is now more appropriately designated the Tebo district (Searight, 1954).
Jordan flora.--Flora collected by Dr. John Britts of Clinton, Henry County, Missouri, and described by David White (1899). Most of the collection appears to be from shale beds overlying the Rowe coal bed.

K

Knifeton coal.--The abandoned name of a coal bed low in the "Cherokee" of southeastern Kansas. It appears to be one of the indistinguishable coal beds of the Riverton formation (Howe, W. B., personal communication).

Krebs group.--The succession of beds from the bottom of the Desmoinesian to the base of the Cabaniss group (Oakes, 1953). The boundary between the two groups in Missouri is placed as nearly as possible stratigraphically to the one defined in Oklahoma. The rocks at the type locality in Oklahoma represent a basin facies whereas the strata in Missouri and in Kansas are representative of platform deposits.

L

Lagonda formation.--The formation which lies between the Bevier and Mulky formations (Searight and others, 1953). The base of the formation is at the top of the Bevier coal bed and in Missouri the top is beneath the base of the Breezy Hill limestone. As presently regarded, the formal definition is identical with Gordon's definition of the "Lagonda sandstones and shales" (Gordon, 1896, p. 19). The "squirrel" sandstone is a widely recognized zone of sandstone within this formation. McQueen's redefinition of Lagonda (McQueen, 1943) is not followed. In Oklahoma the Iron Post coal bed lies at the top of this succession, below the Breezy Hill (Howe, 1952).

Lexington coal bed.--A coal bed which lies between the Fort Scott and Pawnee formations in the Marmaton group. It is the Mystic coal of Iowa and the Herrin (No. 6) coal of Illinois. In some areas in Missouri it has been erroneously correlated with the "Fort Scott red" (Mulky) coal. Where this miscorrelation has been used in Missouri, the "Cherokee"-Marmaton boundary is in error.

Lightning Creek coal.--A name applied to the Mineral coal bed in Kansas although the coal on Lightning Creek is Bevier.

Limestone seam.--A local Kansas name for Bevier.

Little Cabin coal.--The Riverton; so called by Pierce and Courtier in Kansas on a map published in 1935.

Little Cabin sandstone.--A name applied to the sandstone at the position of the Warner in northeastern Oklahoma. The name has been abandoned because the name Warner has priority.

Loutre limestone.--A nodular limestone situated above the Cheltenham clays in eastern Missouri. The bed is correlated with the Tiawah and with the Seahorne limestone of Illinois. The coal bed below is cyclically related to it, and is referred to the Tebo of the northern midcontinent and the Seahorne coal of western Illinois.

Lower Clear Creek.--The Warner sandstone. It was not included in the "Clear Creek" by Broadhead but the definition was extended to include it by Greene and Pond (1926, p. 44). The name was pre-empted by Worthen.

Lower Coal Measures.--A succession of beds from the base of the "Cherokee" to the underclay of the Mulky coal. Swallow's (1866) designation was revised and defined by Broadhead, Winslow, and Gordon.

Lower Dederick coal.--The lowest coal bed of Vernon County, Missouri, (Greene and Pond, 1926, p. 43). The term has been abandoned because the type Dederick shale occurs at a higher position in the Krebs.

Lower Mercer limestone.--A limestone of late Pottsville age in Ohio which is correlated with the Seville of Illinois and of the northern midcontinent.

M

Macon City coal.--The Mulky of Macon County. It "lies three to five feet above the top of the Lower Coal Measures, from which it is separated by a thickness of clay" (Gordon, 1896, p. 29).

Marmaton group.--Beds of late Cygnian age which lie between the Cabaniss and Pleasanton groups. This group includes the youngest beds of Desmoinesian age. The boundary between the Cabaniss and Marmaton (Moore, 1948) is placed at the bottom of Blackjack Creek (lower Fort Scott) limestone (Greene and Searight, 1949).

Mazon Creek flora.--A widely known Pennsylvanian flora which is found above the No. 2 coal bed in Illinois. Fossil leaves are contained in flattened clay ironstone concretions. Similar fossils, similarly preserved are present at very near this stratigraphic position west of Windsor, northeastern Henry County, Missouri.
Megacyclothem.--A cycle of cyclothemes used by Moore in grouping cyclothemes of the Shawnee (Moore, 1935, p. 29).

Middle Dederick coal.--A coal bed commonly present between the "Lower" and "Upper" Dederick coal beds in Vernon County, Missouri. It is the middle coalbed of the three coal beds commonly logged in the Riverton formation of this area. The name has been abandoned to avoid confusion.

Mineral cyclothem.--The cyclothem which includes the Mineral coal bed (Abernathy, 1938). See cyclothem and cyclic formation.

Mineral Rider coal.--The Fleming coal bed; name used in Kansas.

Minshall limestone.--A limestone of late Pottsville age in Indiana which is correlated with the Seville of Illinois and of the northern midcontinent.

Mulky coal bed.--The highest coal bed in the Cabaniss group. It lies below the Excello which separates it from the Blackjack Creek limestone, the basal member of the Fort Scott of lower Marmaton age (Cline, 1941, p. 36). The coal was named from Mulky Creek, Johnson County, Missouri, by Broaddus (1872, pp. 45, 46). The bed has also been called the Macon City in Macon and Randolph Counties, Missouri, and is the old "Fort Scott red" coal of southeastern Kansas. This coal has locally been confused with the Croweburg and has also been miscorrelated with the higher Lexington bed.

Mulky formation.--The formation which is situated near the top of the Cabaniss group and is separated from the base of the Marmaton by the Excello formation (Searight and others, 1953). In Missouri it includes the Breezy Hill limestone at the base, the underclay of the Mulky, and the Mulky coal bed.

Munterville limestone.--An early Allegheny limestone of southern Iowa which appears to correlate with the marine fossiliferous beds near the base of the Tebo formation in Henry County, Missouri.

Neutral coal bed.--A coal bed which occurs below the Rowe bed in southeastern Kansas. The bed has not been certainly identified in Missouri. The Warner coal occupies a similar position in Missouri, but its identity with the Neutral has not been established.

Oak Grove.--A succession of alternating limestones and shales of western Illinois which is equivalent to the limestone and shale succession in the Verdigris formation of Missouri; the "Ardmore."

Oswego limestone.--The Fort Scott formation of current terminology.

One-foot coal.--A miner's term for the Croweburg coal bed; also called "10 inch", "mud vein", and "clay vein".

Pilot coal.--The Tebo of southeastern Kansas and adjacent areas of Missouri. The bed is very thin in this area, but the fairly constant interval of 25 to 30 feet between this bed and the persistently minable Weir-Pittsburg below permits the use of the "Pilot" as a guide to the position of the lower bed. The existence of the Tiawah above the "Pilot" in this area, and its correlation with the "caprock" of the Tebo of Henry County, Missouri, was ignored until recently.

Pilot cyclothem.--The cyclothem which includes a series of beds from the base of a sporadic sandstone below the "Pilot" coal (Tebo) to the base of the stratigraphically next higher sandstone (Chelsea) (Abernathy, 1938). See cyclothem.

Pioneer seam.--Local miner's term for Bevier in southeastern Kansas.

Pleasantview sandstone.--A sandstone which lies between the Oak Grove (Verdigris) and No. 4 coal bed (Mulky) in western Illinois and is the equivalent of the Lagonda sandstone or "squirrel" of the northern midcontinent.

Regressive hemicycle.--The portion of a cycle which is represented by the upper half of a cyclothem. The reverse of a transgressive hemicycle.

Rich Hill coal.--Now the Mineral. The name was used in Vernon and Bates Counties, Missouri, for the "Weir-Pittsburg upper" (Greene and Pond, 1926, p. 79). The name was also applied to beds now called the Verdigris limestone. For this reason and for lack of usage the name has been abandoned and the name Mineral adopted.

Rich Hill limestone.--A limestone of the Verdigris in Bates and Vernon Counties, Missouri, (Greene and Pond, 1926, pp. 51-52); the
"Ardmore" or "diamond rock". The name has been abandoned.

Riverton coal bed.--The highest of at least three coal beds which lie below the Warner sandstone. The bed received its name from the vicinity of Riverton, southeastern Cherokee County, Kansas, (Pierce and Courtier, 1937). It had previously been called the "Little Cabin" coal (Pierce and others, 1935).

Riverton formation.--The formation which includes the oldest beds of recognized Venteran age (Krebs group) in Missouri (Searight and others, 1953). It contains three or more coal beds in a succession of black, brittle shale. The upper boundary is drawn at the stratigraphically highest coal (the Riverton bed) in the succession. Where the succession of coals is incomplete or where the coal beds are absent or unknown, the boundary with the Warner must be drawn arbitrarily at the base of Warner sandstone. The name is derived from the Riverton coal near Riverton, Cherokee County, Kansas.

Robinson Branch coal bed.--A coal bed which lies at the top of the Robinson Branch formation. The type locality is in the coal strip pit in the SW-1/4 sec. 2, T. 36 N., R. 30 W., near Robinson Branch northeast of Walker, Vernon County, Missouri. The bed was mined by stripping at this place, but after the mine was abandoned the coal bed was covered by water. The bed has been identified near Bronaugh, Vernon County, Missouri. It has also been identified locally in southeastern Kansas (Howe, W. B., personal communication).

Robinson Branch formation.--The formation which lies between the Mineral and Fleming formations (Searight and others, 1953). The top is the fugitive Robinson Branch coal bed. In the lower part, in many places in Vernon and Bates Counties, Missouri, in southeastern Kansas, and in northeastern Oklahoma there is a bed of black calcareous shale containing great numbers of Marginifera muracatina, Lino- productus cora, gastropods, and pelecypods. Sporadic limestone in the lower part, in western Missouri, southeastern Kansas, and northeastern Oklahoma, is called the Donely limestone in Oklahoma. The upper one was named Ardmore (Gordon, 1896, p. 20), and the entire limestone and shale succession was included in the Ardmore by Cline (1941). The prominent ledge of limestone in Vernon County, Missouri, is the well known "diamond rock", so known from the jointing of the bed into large rhomboidal blocks. The name Rich Hill has also been applied to it (Greene and Pond, 1925). It is the Oak Grove succession of Illinois.

Rock Island (No. 1) coal.--The first coal bed which occurs below the Seville in western Illinois. It lies at the position of the Bluejacket coal of the northern midcontinent, and is correlated with it.

Rowe coal bed.--The coal bed situated at the top of the Rowe formation. It was named from coal strip pits near Rowe School in the NE-1/4 sec. 34, T. 30 S., R. 25 E., Crawford County, Kansas, about two miles west of the Missouri boundary (Pierce and Courtier, 1937, p. 65). It is the thickest and most persistent coal between the Warner and Bluejacket sandstone and has been mined across the outcrop area from the Kansas-Missouri boundary in Barton and Jasper Counties, Missouri, into Henry County, Missouri. It has been variously known as the Bellamy (in part), Jordan (in part), Dederick (in part), and Columbus coal.

Rowe formation.--A formation of Venteran age which lies between the Warner and Drywood (Searight and others, 1953). A coal bed from which the name was derived lies at the top.

Rusty coal.--The Mulky bed which occurs in the Fort Scott area of Kansas and in adjacent portions of Missouri.

Scammon coal bed.--A coal bed which received its name from the Village of Scammon, northern Cherokee County, Kansas, (Abernathy, 1938). The bed has not been positively identified in Missouri, but the prominent sandstone below it is fairly persistent in western Missouri and the stratigraphic position of the coal can be determined with considerable accuracy under favorable outcrop conditions.

Scammon cyclothem.--The cyclothem which includes the Scammon coal bed (Abernathy, 1938). See cyclothem.

Scammon formation.--The formation which lies between the Tebo formation below and the Mineral formation above (Searight and others, 1953). The top bed of the formation is the Scammon coal bed. The Scammon formation includes, near the base, the persistent and widespread Tiawah limestone. The sandstone near the middle of the formation appears to occupy the position of the Chelsea sandstone of Oklahoma.

Seahorne coal.--A coal bed in western Illinois which lies below the Seahorne limestone. The stratigraphic position of this coal bed is apparently at or near the horizon of the Tebo coal bed in the northern midcontinent.
Seahorne limestone.—A limestone in western Illinois which is of early Allegheny age. It contains an unusual gastropod fauna like that of the Tiawah limestone of Missouri. It is lithologically similar to the Loutre limestone of eastern Missouri. The Tiawah, Seahorne, and Loutre are correlated.

Seat rock.—A term used commonly in Britain to designate the rock immediately below a coal bed. Seat rock is a useful term which includes underclay or seatearth, ganister, and stigmatic sandstone.

Seville formation.—The Seville formation is essentially the Seville limestone (Searight and others, 1953). Locally, shale lies between the Bluejacket coal and the limestone and in some places calcareous beds containing Seville fossils lie above the limestone. These are included with the limestone as part of the Seville in order to simplify classification.

Seville limestone.—The limestone which is identified as the Seville in western Missouri appears to be identical lithologically and faunally with the Seville limestone of Illinois. The type locality is along the Spoon River near Seville, Fulton County, Illinois, (Wareless, 1931, 1939). The bed is correlated with the Inola of Oklahoma, the Minshull of Indiana, and the lower Mercer of Ohio and Pennsylvania. It contains the highest representatives of the Pottsville fauna in Missouri. It is Kanawha or Upper Pottsville in age. The Seville lies 135-165 feet above the Mississippian in Barton and Vernon Counties, Missouri.

Sink coals.—Coal normally found in collapsed sinks and other solution structures. In many cases the coal is very thick; as much as 80 feet or more. Much of the coal is non-beded canneloid coal of rather high ash content. Some banded bituminous coal is also present in most deposits. In some of these structures in Miller, Morgan, and Lincoln Counties, Missouri, marine beds above the coals are identifiable as Venteran in age.

Soapstone coal.—An old miner's term for the Croweburg coal bed; mostly in Vernon County, Missouri.

Squirrel sandstone.—A sandstone in the Lagonda. It is commonly called "squirrel" by drillers because it "jumps around" between the Verdigris and the Fort Scott.

Stice coal bed.—A name applied to a coal in southeastern Kansas. It appears to be Bevier. The term is no longer in use.

Stigmatic clays.—Clays containing Stigmaria, (See stigmatic sandstone). Some of the fire clays of the Cheltenham are stigmatic.

Stigmatic sandstone.—A sandstone which lies stratigraphically near and below a coal bed or its position. The sandstone contains Stigmaria and impressions of rootlets. Stigmaria are casts of the root stocks of Lepidodendron, the Pennsylvanian tree fern.

Tebo coal bed.—A well-known coal bed in Henry County, Missouri. The type locality is assumed to be along the Tebo Creek (probably West Tebo in Henry County, Missouri). The limestone which overlies it is the Tiawah. The coal has long been known as the "Pilot", in Kansas, because it has been a guide or "pilot" in exploring for the widely mined Weir-Pittsburg which lies about 25-30 feet below it. The Tebo coal is economically the most important bed mined in the Tebo district which extends from Appleton City in northwestern St. Clair County, Missouri, across Henry County, Missouri, to its northeast corner in the western part of the state.

Tebo formation.—A formation of early Cygnian age which lies between the Weir and Mineral formations (Searight and others, 1953). It is topped by the Tebo coal bed.

Ten inch coal.—An old miner's term for the Croweburg coal bed. The term is used mostly in Vernon County, Missouri.

Tiawah limestone.—The persistent "cap-rock limestone" of the Tebo coal. It lies in the lower part of the Scammon formation. It is distinguished in western Missouri, Kansas, and Oklahoma by very abundant platy algal remains. It is the source of the gastropod fauna described by Girty from Garland, Henry County, Missouri, (Girty, 1915). The fauna is common in this limestone and in the Seahorne of Illinois with which it is correlated. The Loutre limestone of east central Missouri is believed to be the same bed.

Transgressive hemicycle.—That portion of a cycle which is represented by the lower half of a cyclothem and which culminates in marine conditions.

U

Upper Clear Creek.—The Bluejacket sandstone; the Clear Creek of Broadhead (1874, pp. 69, 100, 122) which was named from exposures along Clear Creek near Dederick,
Vernon County, Missouri. The name was pre-empted by Worthen and is now abandoned.

Upper Dederick coal.--A coal bed which by definition is the highest coal bed below the Warner ("Lower Clear Creek"); the Riverton coal bed. At the type locality of the Dederick, the coal bed appears to be the Drywood.

Underclay.--Clay, commonly of silty texture, without bedding which occurs immediately below a coal bed. It commonly contains carbonized root impressions; at least in the upper portion. Slickensides are common in some underclays. The important clay mineral is commonly illite.

Underlimestone.--Limestone which is commonly present at the base of an underclay. The rock is mostly hackley and earthy, but in some cases it is fairly pure dense limestone. Fossils are commonly absent. Limestone at this position has also been referred to as fresh water limestone. The term underlimestone is preferred.

Upper Lamar coal.--The Drywood coal bed. The upper coal bed mined near Lamar is undoubtedly the Drywood coal. It was called Upper Lamar by Broadhead (1874, p. 102). The term has been discarded along with "Bellamy".

V

Verdigris formation.--The Verdigris formation (Searight and others, 1953) lies between the Croweuburg and Bevier formations. Near the top is the well known Verdigris limestone ("Ardmore") which is the "sump rock" of the Wheeler coal. This coal bed constitutes the top bed of the formation.

Verdigris limestone.--A limestone which lies near the top of the Verdigris formation. The name is derived from Verdigris River in southern Rogers County, Oklahoma. The name Verdigris is widely known and used in the mid-continent and for this reason has been applied in Missouri. Locally, in Missouri, it is separated from the Croweuburg coal bed below by a few feet of black fissile shale, but elsewhere a considerable thickness of mudstone separates the black shale from the coal bed. In Boone County, Missouri, as many as five limestone units separated by shale lie at this same stratigraphic position.

W

Walker coal.--This bed was described from an exposure near Walker, Vernon County, Missouri, (Greene and Pond, 1925, p. 80). The bed appears to be equivalent to the Tebo in the general section, but was described as Fleming. It was also correlated with the "Weir-Pittsburg intermediate" which was mistaken for the Fleming. The name has not been used extensively and has been abandoned to avoid confusion.

Warner coal.--Coal bed situated stratigraphically next above the Warner sandstone, at the top of the Warner formation. A coal bed, the Neutral, lies near the top of the Warner sandstone in Kansas. It cannot at present be identified with the coal bed next above the Warner sandstone in Missouri.

Warner formation.--A formation of Ventian age which lies between the Riverton and the Rowe (Searight and others, 1953). It includes the Warner ("Little Cabin") sandstone.

Warner sandstone.--The sandstone in the formation of the same name. The type locality is near Warner, Muskogee County, Oklahoma, (Wilson, 1936). The name has priority over "Little Cabin" which is considered to be the same deposit. This sandstone has been called "Lower Clear Creek" in older reports of the Missouri Geological Survey. It is probably also the lower part of the "Graydon" of western Missouri and the lower part of the "Columbus sandstone" of southeastern Kansas.

Weir formation.--The lowest formation of Cynian age recognized to date in Missouri (Searight and others, 1953). Two coal beds below the Weir-Pittsburg and apparently above the Seville have been reported in old shaft mines at Moundville, Vernon County, Missouri. These are not known to crop out, and too little is known about them for formal recognition. The name is derived from the Weir-Pittsburg coal bed which is the top bed of the formation.

Weir-Pittsburg coal bed.--The coal situated at the top of the Weir formation. It is named after the towns of Weir, northern Cherokee County, Kansas, and Pittsburg, southern Crawford County, Kansas, (Pierce and Courtier, 1937, p. 66). The bed has been mined for nearly a century. The bed has been referred to as the Jordan (in part) in Henry County, Missouri. The Mammoth coal of the Lewis trough also appears to be Weir-Pittsburg. The bed has been known as the "Weir-Pittsburg lower" in Vernon and Bates Counties, Missouri, and has also been known as the "Cherokee" and "true Cherokee" coal. It has been erroneously correlated with the "lower Rich Hill" (Mineral) bed of northern Vernon and Bates Counties, Missouri. It is the lower, persistent coal bed of the Cabaniss group (provisional) in Missouri and Kansas (Searight and others, 1953). In Oklahoma the bed is included in the Krebs group. It has been mined extensively in Barton County, Missouri.

Weir-Pittsburg Lower coal.--The Weir-Pittsburg coal of recent terminology.

Weir-Pittsburg Upper coal.--An old designation of the Fleming coal bed in Barton and Vernon Counties, Missouri. It seems to have been confused in some cases with the Mineral.

Wheeler coal bed.--A name applied to the first coal bed above the Verdigris limestone ("Ardmore") or "two layer limestone" of Iowa. It is the "lower bench of the Bevier" of Macon and Randolph Counties, Missouri.

As in Iowa, the two beds are separated by sandstone, shale, and underclay in Carroll and Livingston Counties, Missouri, and probably elsewhere in Missouri (Howe and Searight, 1953). The bed is the top bed of the Verdigris formation of Missouri. Possibly the "Williams" coal bed of Vernon County, Missouri, and the Bevier of southeastern Kansas is Wheeler rather than Bevier as now correlated.

Whitebreast coal.--A southern Iowa coal bed correlated with the Croweburg of the northern midcontinent.

Williams coal bed.--The coal bed situated next above the Verdigris ("Ardmore") limestone (Greene and Pond, 1926, pp. 52-53). The bed lies at the position of the Wheeler bed. It has been considered to be Bevier, but possibly is the lower or Wheeler coal.


