

**Geologic Section of Pennsylvanian Rocks
Exposed in the Kansas City Area**

By

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INFORMATION CIRCULAR NO. 8

May, 1952

STATE OF MISSOURI

Department of Business and Administration

Division of

GEOLOGICAL SURVEY AND WATER RESOURCES

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ERRATA

Page 1, line 16, read page, instead of pages
Page 7, line 17, read Mound City, instead of Mound
Page 8, line 7, read Bronson, instead of Kansas City
Page 19, read Flint Hill, instead of Flint Hills

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ABSTRACT

This report includes a graphic section illustrating the stratigraphic sequence exposed in the vicinity of Kansas City, Missouri, extending from the base of Marmaton group to the Tonganoxie sandstone at the base of the Douglas group. The text is essentially an outline of the classification of the beds illustrated in the columnar section together with annotations on authorship and classification.

INTRODUCTION

This chart has been prepared for distribution to quarry operators, drillers, and other interested parties in the Kansas City area as an aid in the selection of rock materials, and as an outline of the succession of rock beds exposed in that part of the state.

Description of each bed, including thickness, type of rock, etc., has been supplied by Frank C. Greene of the Missouri Geological Survey staff. The entire section is illustrated graphically. Thicknesses of individual units are included in the short description of each unit, or, they may be found by use of the scale provided on each page. The classification of the rock beds included in the section is that of the Missouri Geological Survey. The following paragraphs describing the classification of the beds included in the columnar section are taken with slight modifications directly from Report of Investigations No. 11 of the Missouri Geological Survey.¹

¹Greene, F. C., and Searight, W. V., Revision of the classification of the post-Cherokee Pennsylvanian beds of Missouri: Missouri Geol. Survey and Water Resources, Rept. Inv. no. 11, 1949.

PENNSYLVANIAN SYSTEM
DESMOINESIAN SERIES

Marmaton Group

The term Marmaton as applied to the group includes all Desmoinesian beds younger than Cherokee. The name was first used to apply to beds now known as the Labette member of the Fort Scott formation² but this usage was not followed. Instead, the name as applied to beds from the base of the Fort Scott to the top of the Pleasanton³ was adopted in Kansas and later modified to include only those strata below the unconformity which separates the Desmoinesian and Missourian series.⁴ Thus defined, the Marmaton group was adopted by the Kansas, the Missouri, and the Nebraska Geological Surveys. The designation has wide use among geologists, particularly among petroleum geologists of the Mid-Continent area. The name Henrietta⁵ has been suppressed. This change was desirable because the post office at the site of Henrietta, Johnson County, Missouri, has long been abandoned, the succession of beds included in the group is incompletely represented, and beds not properly included in the Henrietta have been included by some authors.

The Marmaton of Missouri includes, from the base up, the Fort Scott, the Labette, the Pawnee, the Bandera, the Altamont, the Nowata, the Lenapah, and the Memorial formations.

The Fort Scott^{6, 7} formation is dominantly limestone in southwestern Missouri, but the limestones thin and the shales thicken to the northward, and more shale than limestone therefore is included in the formation of north Missouri. The Blackjack Creek⁸ limestone member lies at the base of the formation and is overlain by the Little Osage⁹ member which, in turn, is overlain by the Higginsville¹⁰ limestone member. A coal bed, the Summit¹¹, occurs in many places within

²Keyes, C. R., Stages of the Des Moines, or Coal-Bearing Series of Kansas and Southwestern Missouri, and Their Equivalent in Iowa: Iowa Acad. Sci. Proc., vol. 4, pp. 22-25, 1897.

³Haworth, E. Stratigraphy of the Kansas Coal Measures: Kansas Univ. Geol. Survey, vol. 3, p. 92, 1898.

⁴Moore, R. C., Kansas Geol. Soc. Guidebook, Sixth Ann. Field Conf., p. 89, 1932

⁵Keyes, C. R., op. cit., pp. 22-24, 1897.

⁶Swallow, G. C., Kansas Geol. Survey Preliminary Rept., p. 25, 1866.

⁷Hinds, H., and Greene, F. C., Stratigraphy of the Pennsylvanian Series in Missouri: Missouri Bur. Geology and Mines, 2d ser., vol. XIII, p. 20, 1915.

⁸Cline, L. M., Traverse of Upper Des Moines and Lower Missouri Series from Jackson County, Missouri, to Appanoose County, Iowa: Am. Assoc. Petroleum Geologists Bull., vol. 25, p. 36, 1941.

⁹Jewett, J. M., Classification of the Marmaton group, Pennsylvanian: Kansas Univ. Geol. Survey Bull. 38, p. 302, 1941.

¹⁰Cline, L. M., op. cit., p. 36, 1941.

¹¹McGee, W. J., Notes on Geology of Macon County, Missouri: Acad. Sci. St. Louis Trans., vol. 5, pp. 305-336, 1892.

the Little Osage member in Missouri. Northward from Johnson County a thin limestone, the Houx¹², lies above the horizon of the Summit coal, separated from it by black, fissile shale. The Houx limestone has not been identified in southwestern Missouri and may be absent or it may be indistinguishable from the lower part of the Higginsville. Shale at the top of the Little Osage, between the Houx limestone and the Higginsville, has been called the Blackwater Creek shale.¹³ Channel type sandstone and siltstone between the Houx and the Higginsville limestone and above the Blackwater Creek shale is present over an area extending from northern Boone County into southeastern Grundy County. The name Flint Hill, from Flint Hill near Flint Hill School, northern Boone County, Missouri, has been suggested as a name for this sandstone by A. G. Unklesbay¹⁴, who discovered the channel filling characteristics of these beds. The type section, in NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, T. 50 N., R. 13 W., Boone County, Missouri, will be described in a report being prepared by Unklesbay. The Higginsville¹⁵ is the uppermost member of the Fort Scott formation.

The Labette¹⁶ formation occupies the interval between the Higginsville member of the Fort Scott and the Anna shale member of the Pawnee. The Lexington¹⁷ coal horizon lies at or near the top of the formation. Below the position of the coal, a channel sandstone, the Englevalle¹⁸, occurs in Bates County and probably elsewhere.

The Pawnee¹⁹ formation includes beds from the base of the black, fissile Anna shale to the top of the Coal City limestone member. The Anna shale²⁰ has been included previously in the Labette of Missouri, but a thin limestone in Kansas²¹ below the shale indicates closer relationship with the Pawnee than with the Labette. The formation boundary in Missouri therefore has been drawn below the Anna shale rather than above it. The Myrick Station²² limestone member, the Mine Creek²³ shale member, and the Coal City²⁴ lime-

¹²Cline, L. M., op. cit., p. 36, 1941.

¹³Clair, J. R., Oil and Gas Resources of Cass and Jackson counties: Missouri Geol. Survey and Water Resources, 2d ser., vol. XXVII, pl. I, 1943.

¹⁴Unklesbay, A. G., personal communication, November 22, 1949.

¹⁵Cline, L. M., op. cit., p. 36, 1941.

¹⁶Haworth, E., op. cit., p. 36, 1898.

¹⁷Broadhead, G. C., Iron Ores and Coal Fields: Geol. Survey of Missouri, pt. II, p. 46, 1872.

¹⁸Pierce, W. G., and Courtier, W. H., Englevalle Channel Sandstone of Pennsylvanian Age, Southeastern Kansas: Am. Assoc. Petroleum Geologists Bull. 19, pp. 1061-1064, 1935.

¹⁹Swallow, G. C., op. cit., p. 24, 1866.

²⁰Jewett, J. M., op. cit., p. 312, 1941.

²¹Jewett, J. M., op. cit., p. 312, 1941.

²²Cline, L. M., op. cit., p. 37, 1941.

²³Jewett, J. M., op. cit., p. 318, 1941.

²⁴Cline, L. M., op. cit., p. 31, 1941.

stone member, in ascending order, complete the Pawnee formation. The name Laberdie²⁵ was recognized for the upper limestone member of the Pawnee until the identity of the Coal City limestone with the upper Pawnee was established.²⁶ Inasmuch as the term Coal City has priority over Laberdie the latter name was suppressed in favor of Coal City.

The Bandera²⁷ formation includes all beds between the Pawnee and the lowest limestone of the Altamont. In many places the formation is mostly shale, but in Bates County and probably elsewhere an important coal bed, the Mulberry²⁸, lies near the base. A channel sandstone, the Bandera Quarry²⁹ member, is near the top of the formation. The Polo sandstone³⁰, a gas sand of southern Caldwell County, Missouri, is also within the Bandera formation and may be equivalent to the Bandera Quarry sandstone.

The Altamont³¹ formation in Missouri includes two relatively thin limestones separated by shale. The name Amoret, as used by the Missouri Geological Survey and Water Resources, is applied to the lower limestone member of the Altamont formation.³² The Lake Neosho³³ shale member lies between the Amoret member and the Worland. The name Worland³⁴, first applied to beds now known to include the entire Altamont, has been restricted to the uppermost limestone^{35, 36}.

The Nowata³⁷ shale formation separates the Altamont from the Lenapah. The formation has been identified in the field and by sub-

²⁵Jewett, J. M., *op. cit.*, p. 320, 1941.

²⁶Cline, L. M., and Greene, Frank C., A stratigraphic study of the upper Maraton and lowermost Pleasanton groups, Pennsylvanian, of Missouri: Missouri Geol. Survey and Water Resources Rept. Inv. no 12, pp. 8, 9, 1950.

²⁷Adams, G. I., Stratigraphy and Paleontology of the Upper Carboniferous Rocks of Kansas: U. S. Geol. Survey Bull. 211, p. 32, 1903.

²⁸Broadhead, G. C., Bates County: Geol. Survey of Missouri, p. 168, 1873-1874.

²⁹Moore, R. C., Frye, J. C., Jewett, J. M., Tabular Description of Outcropping Rocks in Kansas: Kansas Univ. Geol. Survey Bull. 52, p. 196, 1944.

³⁰Greene, F. C., and McQueen, H. S., The Polo Gas Field Caldwell County, Missouri: Missouri Geol. Survey and Water Resources, 62nd Bienn. Rept., App. I, 1943.

³¹Adams, G. I., Kansas Univ. Geol. Survey, vol. I, p. 22, 1896.

³²Cline, L. M., and Greene, Frank C., *op. cit.*, p. 18, 1950.

³³Jewett, J. M., *op. cit.*, p. 331, 1941.

³⁴Greene, F. C., Oil and Gas Pools of Western Missouri: Missouri Bur. Geology and Mines, 57th Bienn. Rept., App. II, pp. 14-18, 1933.

³⁵Cline, L. M., *op. cit.*, p. 29, 1941.

³⁶Jewett, J. M., *op. cit.*, pp. 333-334, 1941.

³⁷Ohern, D. W., The Stratigraphy of the Older Pennsylvanian Rocks of Oklahoma: Oklahoma State Univ. Research Bull. 4, p. 23, 1910.

surface studies by Missouri geologists in Bates County³⁸ and in eastern Jackson County³⁹, and elsewhere in Missouri.

The name Warrensburg is retained in Missouri for sandstones occupying the Warrensburg⁴⁰, ⁴¹ and Moberly channels. The name has also been applied by Missouri geologists to sandstone⁴² now known to lie between the Altamont and Sni Mills limestone in Jackson County. Because of priority in usage, the name Warrensburg will continue to be used in Missouri to include post-Altamont, pre-Memorial sandstones of Marmaton age, and the well-known channel sands of the Warrensburg and Moberly channels. If future studies show that the subsurface channel sandstones differ in age from the Warrensburg and Moberly channels, the term will be confined to the channels to which the name was first applied.

Two thin limestones separated by shale compose the Lenapah⁴³ of western Missouri. The basal limestone is the Norfleet⁴⁴, the overlying shale is the Perry Farm⁴⁵ member, and the uppermost limestone is the Sni Mills⁴⁶ member. The Sni Mills⁴⁷ limestone outcropping in Jackson and Ray counties and identified in many logs in western Missouri is correlated with the Lenapah. Howe⁴⁸ correlated a thin limestone lying below the Sni Mills of eastern Jackson County with the lower Lenapah (Norfleet) and the Sni Mills of the type locality with the upper Lenapah (Idenbro)⁴⁹. Further tracing of the outcrops between the locality of the Sni Mills and the upper Lenapah of western Missouri by L. M. Cline and F. C. Greene supports the correlation of the Sni Mills with the Lenapah⁵⁰.

Shale lying on the Lenapah and apparently conformable with it is logged in Bates County, Missouri, and shale is present above the Sni Mills in logs of Cass and Jackson counties. The beds crop out in

³⁸Moore, R. C., Classification of Pennsylvanian Rocks in Iowa, Kansas, Missouri, Nebraska, and Northern Oklahoma: Am. Assoc. Petroleum Geologists Bull., vol. 32, p. 2025, 1948.

³⁹Howe, W. B., The Geology of the Oak Grove Quadrangle: Thesis, University of Missouri, pp. 29-35, 1948.

⁴⁰Winslow, A., A Preliminary Report on Coal: Missouri Geol. Survey, pp. 35-36, 1891.

⁴¹Winslow, A., A Report on the Higginsville Sheet, Lafayette County: Missouri Geol. Survey, vol. IX, pp. 45-54, 1892.

⁴²Bartle, G. G., The Geology of the Blue Springs Gas Field: Missouri Bur. Geol. and Mines, 57th Bienn. Rept., App. III, pp. 16-17, 1933.

⁴³Moore, R. C., op. cit., p. 2025, 1948.

⁴⁴Jewett, J. M., op. cit., p. 338, 1941.

⁴⁵Jewett, J. M., op. cit., p. 339, 1941.

⁴⁶Greene, F. C., Kansas Geol. Soc. Guidebook, Tenth Ann. Field Conf., pp. 19-20, 1936.

⁴⁷Clair, J. R., op. cit., pl. I, 1943.

⁴⁸Howe, W. B., op. cit., pp. 29-35, 1948.

⁴⁹Jewett, J. M., op. cit., p. 340, 1941.

⁵⁰Cline, L. M., and Greene, Frank C., op. cit., p. 25, 1950.

eastern Jackson County⁵¹ and elsewhere. Marmaton shale above the Lenapah has been named the Memorial shale⁵² and the name is applied to shale at this position in Missouri.

The stratigraphic relations of the Lenapah and other upper Marmaton formations in western Missouri is the subject of studies now in progress by W. B. Howe, Missouri Geological Survey.

MISSOURIAN SERIES

The Missourian⁵³, Series ⁵⁴, first used in a geographic sense to replace the "Upper Coal Measures" of Broadhead and others, has been modified through the years until it now includes all Pennsylvanian beds from the unconformity at the base of the Pleasanton to the unconformity at the base of the Douglas group⁵⁵.

Pleasanton Group

The Pleasanton^{56, 57} group includes all beds above the disconformity at the top of the Marmaton group and below the Kansas City group throughout the northern Mid-Continent. The Pleasanton is so variable in lithology from place to place that details in many places are not yet clearly indicated. In general, however, the Pleasanton group contains several units which have been recognized in Missouri.

In western Missouri, particularly in Bates County, sandstone known as the Hepler⁵⁸ sandstone in Kansas is the base of the Pleasanton. In Cass and Jackson counties and elsewhere in northern Missouri this sandstone appears to be one known to drillers as the "Wayside"⁵⁹ sand. A thin limestone or calcareous zone, the Exline⁶⁰ limestone, which is the "Treospira" zone of northern Missouri, lies above the "Wayside." The Knobtown⁶¹ lies above the position of the Exline. Recent field work in western Missouri indicates that the Ovid coal

⁵¹Howe, W. B., op. cit., pp. 35-36, 1948.

⁵²Dott, R. H., Unpublished manuscript, 1936, cited by Jewett, J. M., op. cit., p. 340, 1941.

⁵³Keyes, C. R., Iowa Geol. Survey, vol. I, pp. 85, 114-116, 1893.

⁵⁴Wheeler, H. A., Clay Deposits: Missouri Geol. Survey, vol. XI, pp. 46-47, 1896.

⁵⁵Moore, R. C., Stratigraphic Classification of the Pennsylvanian Rocks of Kansas: Kansas Univ. Geol. Survey Bull. 22, pp. 45, 68-141, 1935.

⁵⁶Haworth, E., The Stratigraphy of the Kansas Coal Measures: Kansas Univ. Quart. vol. 3, p. 274, 1895.

⁵⁷Marbut, C. F., Geological Description of the Clinton Sheet: Missouri Geol. Survey, vol. XII, p. 34, 1898.

⁵⁸Jewett, J. M., Oil and Gas in Linn County, Kansas: Kansas Univ. Geol. Survey Bull. 30, pp. 8-9, 1940.

⁵⁹McQueen, H. S., and Greene, F. C., Geology of Northwestern Missouri: Missouri Geol. Survey and Water Resources, 2d ser., vol. XXV, pp. 25-26, pl. V, 1938.

⁶⁰Cline, L. M., op. cit., p. 65, 1941.

⁶¹McQueen, H. S., and Greene, F. C., op. cit., p. 26, 1938.

occurs above the Critzer limestone and therefore should be included in the lowermost formation (Hertha) of the Kansas City group.

Kansas City Group

The Kansas City group, as now defined, is that adopted by the Missouri Geological Survey in 1915⁶², with some modification. The base remains at the bottom of the Hertha formation. The group has been expanded upward to include all beds below the Plattsburg formation. Thus defined, the Kansas City group is readily divisible lithologically over the northern Mid-Continent into three subgroups. From the base upward, these are the Bronson, the Linn, the Zarah.

Bronson Subgroup

The Bronson⁶³ subgroup includes those lower Kansas City beds of the northern Mid-Continent area which are dominantly limestones. From the base up, the subgroup includes the Hertha, Ladore, Swope, Galesburg, and Dennis formations.

The Hertha⁶⁴ formation now includes a lower thin related limestone member, the Critzer⁶⁵, the Mound⁶⁶ shale member and the upper or Sniabar limestone member. The most prominent and commonly identified member of the Hertha in Missouri is the Sniabar⁶⁷ limestone member.

The Ladore⁶⁸ shale formation separates the Hertha from the Swope formation. The Ladore is not further subdivided.

The Swope⁶⁹ formation includes the Bethany Falls⁷⁰ limestone member, together with the Hushpuckney shale member⁷¹ and the Middle Creek⁷² limestone member.

The Galesburg⁷³ shale formation separates the Swope formation from the Dennis.

The formation has been redefined to exclude the Canville limestone and Stark shale formerly included in it by the Missouri Geolog-

⁶²Hinds, H., and Greene, F. C., *op. cit.*, pp. 23-28, 1915.

⁶³Adams, G. I., U. S. Geol. Survey Bull. 238, pp. 17-19, 1904.

⁶⁴Adams, G. I., *op. cit.*, p. 35, 1903.

⁶⁵Jewett, J. M., Some Details of the Stratigraphy of the Bronson Group of the Kansas Pennsylvanian: Acad. Sci. Kansas Trans., vol. 36, pp. 132-136, 1933.

⁶⁶Jewett, J. M., *op. cit.*, pp. 132-136, 1933.

⁶⁷Jewett, J. M., *op. cit.*, pp. 131-135, 1933.

⁶⁸Adams, G. I., *op. cit.*, p. 18, 1904.

⁶⁹Moore, R. C., and Newell, N. D., in Moore, R. C., Kansas Geol. Soc. Guidebook, Sixth Ann. Field Conf., p. 90, 1932.

⁷⁰Broadhead, G. C., Acad. Sci. St. Louis Trans., vol. 2, p. 320, 1868 (First issued 1865).

⁷¹Newell, N. D., in Jewett, J. M., Kansas Geol. Soc. Guidebook, Sixth Ann. Field Conf., p. 101, 1932.

⁷²Newell, N. D., *Mss.*, cited in Jewett, J. M., *op. cit.*, p. 101, 1932.

⁷³Adams, G. I., *op. cit.*, p. 36, 1903.

ical Survey⁷⁴. The Dennis⁷⁵, ⁷⁶ formation includes the thin Canville⁷⁷ limestone member at the base, the well-known Winterset⁷⁸ limestone member at the top, and a shale member, the Stark⁷⁹, in the interval between the limestone members.

Linn Subgroup

The Linn⁸⁰ subgroup was named and defined at the Lawrence Conference. The succession, in contrast with the Kansas City subgroup, is dominated by shale, but limestone members are included. In Missouri, the subgroup is divided lithologically into four formations. From the base upward, these include the Cherryvale, Drum, Chanute, and Iola formations.

The Cherryvale⁸¹ formation at the base of the Linn subgroup retains the original definition and includes all beds in Missouri between the Winterset and the Drum limestone. The formation consists of five members, the Fontana⁸² shale member at the base, overlain in succession by the Block⁸³ limestone member, the Wea ^{84a} shale member, the Westerville^{84b} limestone member, and the Quivira^{84c} shale member at the top.

The Drum⁸⁵ limestone formation of the northern Mid-Continent consists of two limestone members, the lower being known as the Cement City⁸⁶ and the upper as the Corbin City⁸⁷ which is not known to be present in Missouri.

The Chanute⁸⁸ shale formation lies between the Cement City limestone member of the Drum formation and the Paola limestone member of the Iola formation.

The uppermost formation of the Linn subgroup is the Iola formation⁸⁹, which includes, in ascending order, the Paola limestone mem-

⁷⁴McQueen, H. S., and Greene, F. C., *op. cit.*, pl. V., 1938.

⁷⁵Adams, G. I., *op. cit.*, p. 36, 1903.

⁷⁶Moore, R. C., *op. cit.*, pp. 90-95, 1935.

⁷⁷Jewett, J. M., Kansas Geol. Soc. Guidebook, Sixth Ann. Field Conf., p. 102, 1932.

⁷⁸Tilton, J. L., and Bain, H. F., Iowa Geol. Survey, vol. 7, pp. 517-519, 1897.

⁷⁹Jewett, J. M., *op. cit.*, p. 102, 1932.

⁸⁰Moore, R. C., *op. cit.*, pp. 2029-2033, 1948.

⁸¹Haworth, E., *op. cit.*, p. 47, 1898.

⁸²Newell, N. D., Mss., cited by Moore, R. C., *op. cit.*, p. 91, 1932.

⁸³Newell, N. D., Mss., cited by Moore, R. C., *op. cit.*, p. 91, 1932.

^{84a}Newell, N. D., Mss., cited by Moore, R. C., *op. cit.*, p. 91, 1932.

^{84b}Bain, H. F., Iowa Geol. Survey, vol. 8, pp. 276-277, 1898.

^{84c}Newell, N. D., Mss., cited by Moore, R. C., *op. cit.*, p. 91, 1932.

⁸⁵Adams, G. L., *op. cit.*, p. 37, 1903.

⁸⁶Hinds, H., and Greene, F. C., *op. cit.*, pp. 27 and 118, 1915.

⁸⁷Moore, R. C., *op. cit.*, p. 92, 1932.

⁸⁸Haworth, E., and Kirk, M. Z., Kansas Univ. Quart., vol. 2, p. 109, 1894.

⁸⁹Haworth, E., and Kirk, M. Z., *op. cit.*, pp. 109, 116, 119, 1894.

ber⁹⁰, the Muncie Creek shale member⁹¹, and the Raytown limestone member⁹².

Zarah Subgroup

The Zarah⁹³ subgroup was proposed and adopted at the Lawrence Conference as the uppermost subgroup of the Kansas City group. All beds from the top of the Raytown limestone to the base of the Plattsburg formation are included in it. The succession consists of three formations: these are, from the base up, the Lane, Wyandotte, and Bonner Springs. The Lane⁹⁴ and Bonner Springs⁹⁵ are shale and are not subdivided within themselves. The Wyandotte⁹⁶ formation is composed of a thin limestone, the Frisbie⁹⁷, which is separated from the thick, prominent Argentine⁹⁸ limestone member by the Quindaro⁹⁹ shale member. The Argentine member is overlain by the Island Creek¹⁰⁰ shale which, in turn, is overlain by the Farley¹⁰¹ limestone, the top member of the formation.

Lansing Group

The Lansing¹⁰² group includes the Plattsburg¹⁰³ and Stanton¹⁰⁴ formations, together with the intervening Vilas¹⁰⁶ shale formation.

The Plattsburg includes the Merriam¹⁰⁷ limestone member at the base, the Spring Hill¹⁰⁸ limestone member at the top, and the Hickory Creek¹⁰⁹ shale member which lies between the limestone members. The Vilas shale above the Plattsburg is not subdivided.

The Stanton formation includes three limestone members and two shale members. From the base up, the members are the Captain

⁹⁰Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 92, 1932.

⁹¹Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 92, 1932.

⁹²Hinds, H., and Greene, F. C., op. cit., p. 27, 1915.

⁹³Moore, R. C., op. cit., p. 2033, 1948.

⁹⁴Haworth, E., and Kirk, M. Z., Kansas Univ. Quart., vol. 3, p. 277, 1895.

⁹⁵Newell, N. D., op. cit., p. 93, 1932.

⁹⁶Newell, N. D., op. cit., p. 92, 1932.

⁹⁷Newell, N. D., op. cit., p. 92, 1932.

⁹⁸Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 92, 1932.

⁹⁹Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 92, 1932.

¹⁰⁰Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 92, 1932.

¹⁰¹Hinds, H., and Greene, F. C., op. cit., p. 29, 1915.

¹⁰²Hinds, H., Coal Deposits: Missouri Bur. Geol. and Mines, 2d ser., vol. XI, p. 7, 1912.

¹⁰³Broadhead, G. C., op. cit., p. 317, 1865.

¹⁰⁴Swallow, G. C., Kansas Geol. Survey Preliminary Rept., p. 75, 1865.

¹⁰⁵Haworth, E., and Bennett, J., op. cit., p. 104, 1908.

¹⁰⁶Adams, G. I., Kansas Univ. Quart., vol. 7, p. 96, 1898.

¹⁰⁷Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 93, 1932.

¹⁰⁸Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 93, 1932.

¹⁰⁹Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 93, 1932.

Creek¹¹⁰ limestone, the Eudora¹¹¹ shale, and the Stoner¹¹² limestone, the Rock Lake¹¹³ shale, and the South Bend¹¹⁴ limestone members.

Pedee Group

The Pedee¹¹⁵ is the youngest group of the Missourian Series. The strata of which it is composed were included in the Douglas formation (now Douglas group) by Hinds and Greene¹¹⁶; but the discovery of an important unconformity at the base of the Tonganoxie sandstone, within the Douglas are previously defined, made redefinition of the Douglas group advisable, with the basal contact at the bottom of the Tonganoxie sandstone. The beds excluded from the Douglas group were included in a new group, the Pedee¹¹⁷. The Pedee group has been recognized in Missouri since 1938¹¹⁸, and consists of two formations, the Weston¹¹⁹ shale formation and the Iatan¹²⁰ limestone formation. The Iatan is the youngest known formation of the Missourian Series in Missouri.

VIRGILIAN SERIES

The Virgilian¹²¹ Series includes all Pennsylvanian beds of the northern Mid-Continent region above the base of the Douglas group. The Virgilian of the Missouri Geological Survey thus includes the upper three Pennsylvanian groups.

Douglas Group

The Douglas group includes two formations, the Stranger at the base, and the overlying Lawrence. The Tonganoxie¹²² sandstone, unconformable on older rocks, lies at the base of the Stranger¹²³ formation. In Missouri the Tonganoxie sandstone is overlain by the Vinland^{124, 125} shale member which is overlain, in turn, by the Haskell¹²⁶ limestone member. The Westphalia¹²⁷ limestone member of Kansas,

¹¹⁰Newell, N. D., Kansas Univ. Geol. Survey Bull. 21, p. 76, 1932.

¹¹¹Condra, G. E., Nebraska Geol. Survey Bull. 3, p. 12, 1930.

¹¹²Condra, G. E., op. cit., p. 11, 1930.

¹¹³Condra, G. E., Nebraska Geol. Survey Bull. 1, 2d ser., p. 59, 1927.

¹¹⁴Condra, G. E., and Bengston, N. A., Acad. Sci. Nebraska, vol. 9, p. 23, 1915.

¹¹⁵Moore, R. C., op. cit., p. 93, 1932.

¹¹⁶Hinds, H., and Greene, F. C., op. cit., p. 30, 1915.

¹¹⁷Moore, R. C., op. cit., p. 93, 1932.

¹¹⁸McQueen, H. S., and Greene, F. C., op. cit., pl. V, 1938.

¹¹⁹Keyes, C. R., Am. Geologists, vol. 23, p. 300, 1899.

¹²⁰Keyes, C. R., op. cit., p. 300, 1899.

¹²¹Moore, R. C., Proposed New Type Section of the Pennsylvanian System: Abstract, Geol. Soc. America Bull., vol. 43, p. 279, 1932.

¹²²Moore, R. C., Elias, M. K., and Newell, N. D., Pennsylvanian and "Permian" rocks of Kansas: graphic stratigraphic section, Kansas Univ. Geol. Survey, 1934. (Tonganoxie named by Moore.)

¹²³Newell, N. D., Mss., cited by Moore, R. C., op. cit., p. 93, 1932.

¹²⁴Patterson, J. M., and Addison, C. C., Unpublished thesis, Kansas University, 1934.

¹²⁵Moore, R. C., Stratigraphic Classification of the Pennsylvanian Rocks of Kansas: Kansas Univ. Geol. Survey Bull. 22, p. 151, 1935.

¹²⁶Moore, R. C., op. cit., p. 93, 1932.

¹²⁷Moore, R. C., op. cit., p. 150, 1935. (Named by Moore and Newell.)

which separates the Tonganoxie from the Vinland, is not known to occur in Missouri and the Robbins¹²⁸ shale member, at the top of the Stranger formation of Kansas, has not been differentiated in Missouri.

The Lawrence¹²⁹ formation in Missouri consists of two unnamed shale members separated by the Amazonia¹³⁰ limestone, which is the most prominent member of the succession in Platte, Holt, Buchanan, and other counties. The Ireland¹³¹ sandstone member at the base in Kansas has not been identified in Missouri. Because of the absence of this sandstone, the Robbins shale at the top of the Stranger formation cannot be differentiated, if present in Missouri, from the shale of the Lawrence formation below the Amazonia limestone member. The base of the Lawrence formation, for this reason, is drawn in Missouri at the top of the Haskell limestone.

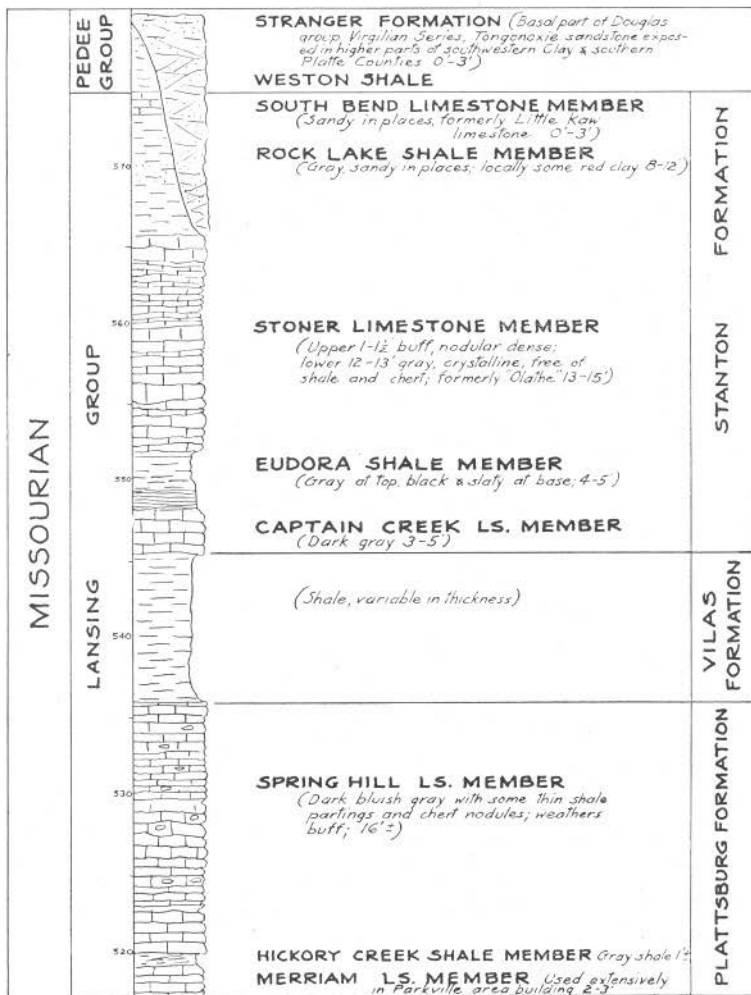
¹²⁸Moore, R. C., *op. cit.*, p. 153, 1935.

¹²⁹Haworth, E., *Kansas Univ. Quart.*, vol. 2, p. 122, 1894.

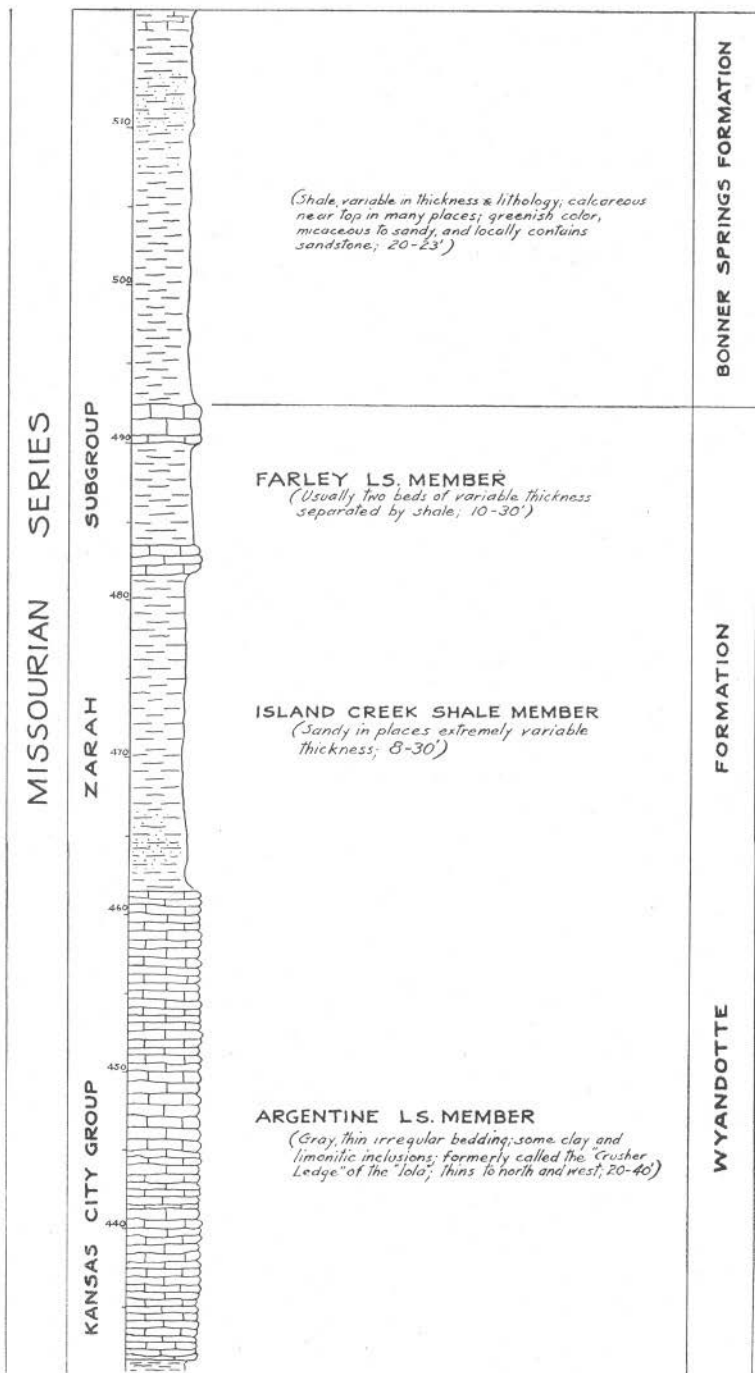
¹³⁰Hinds, H., and Greene, F. C., *op. cit.*, pp. 31, 170, 1915.

¹³¹Moore, R. C., *op. cit.*, p. 93, 1932.

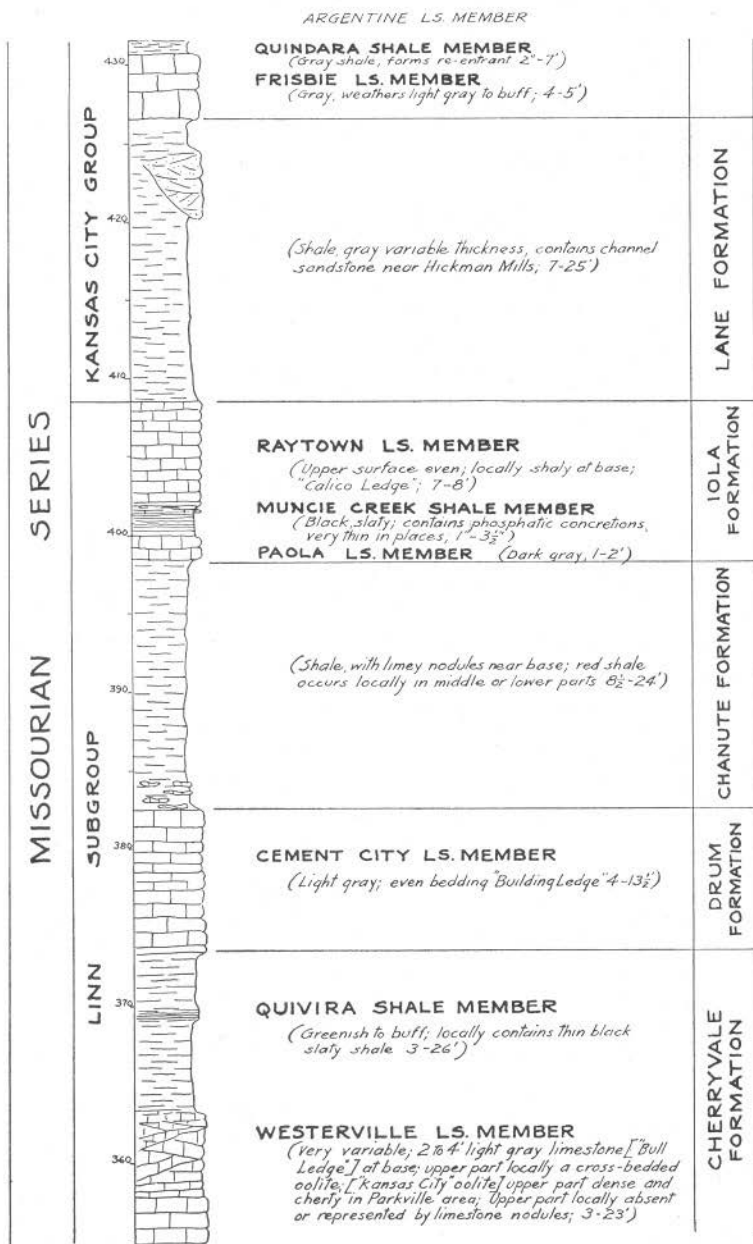
GEOLOGIC SECTION OF PENNSYLVANIAN ROCKS EXPOSED IN THE KANSAS CITY AREA



MERRIAM LS. MEMBER

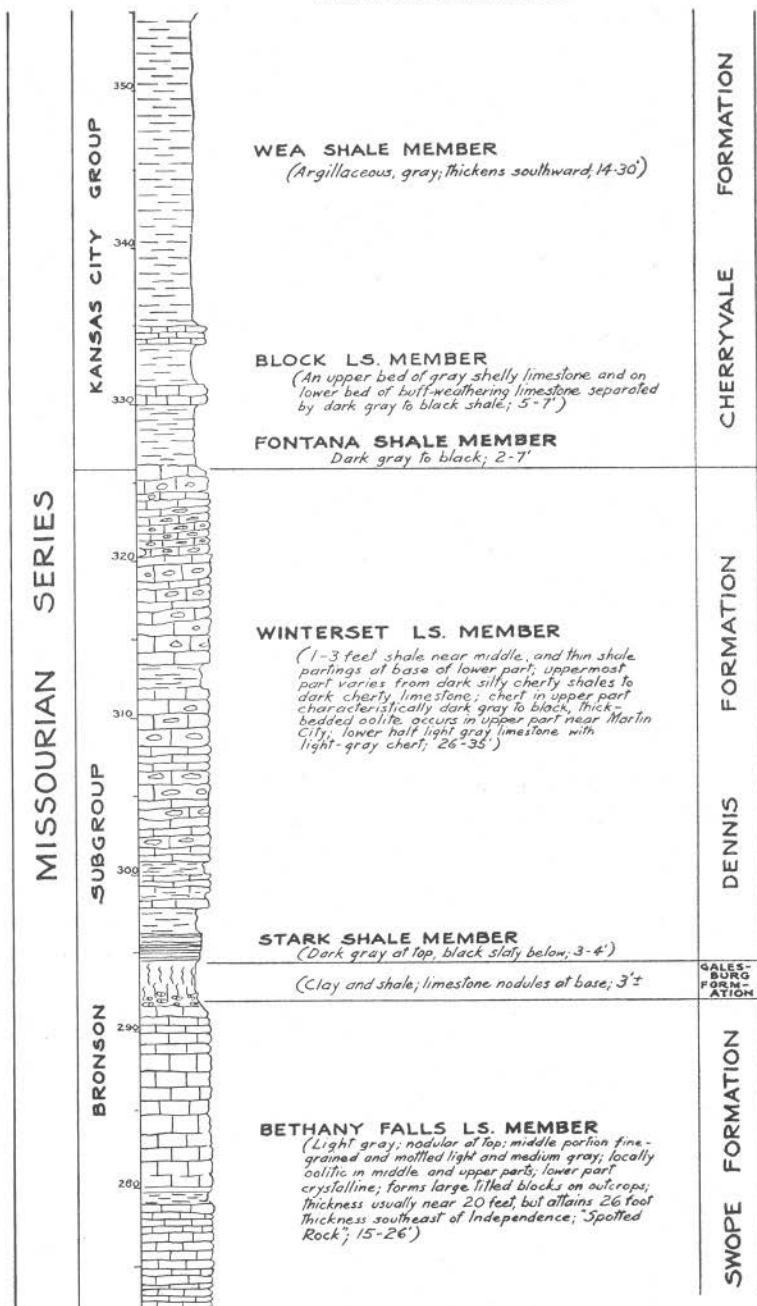


QUINDARA SHALE MEMBER



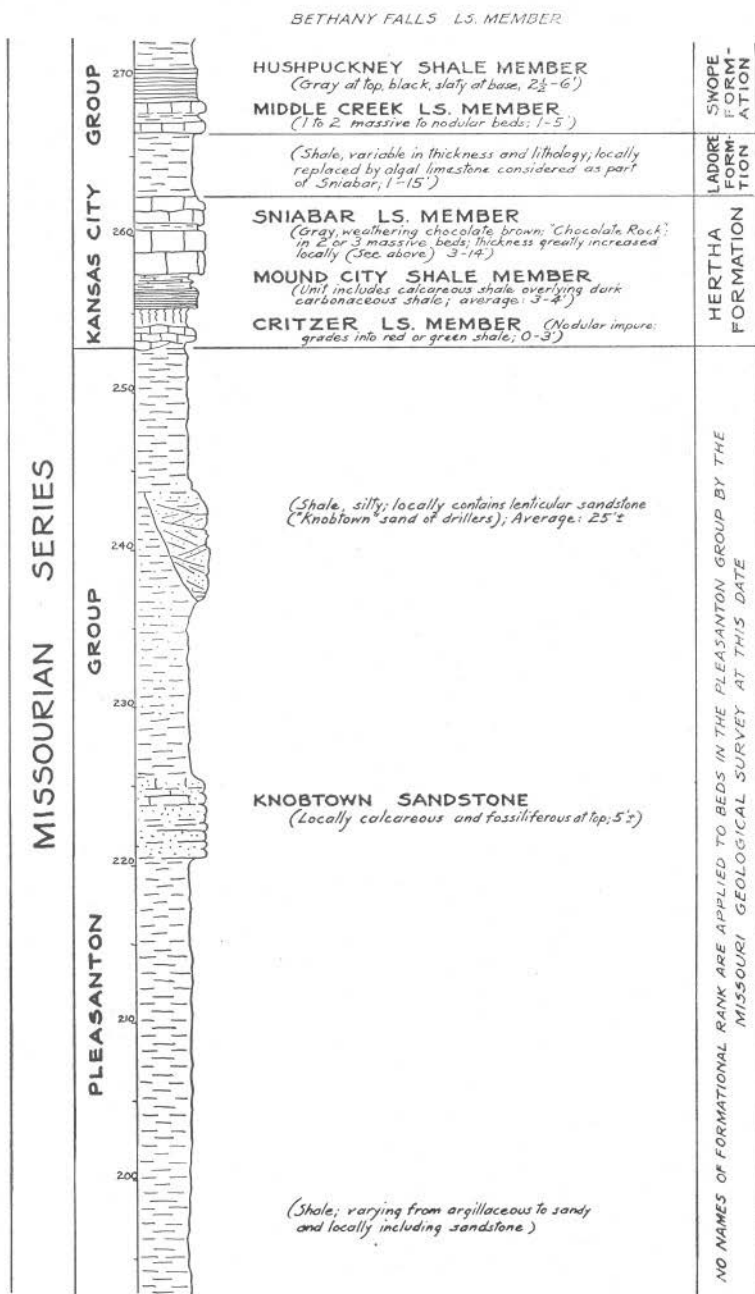
WEA SHALE MEMBER

WESTERVILLE LS. MEMBER

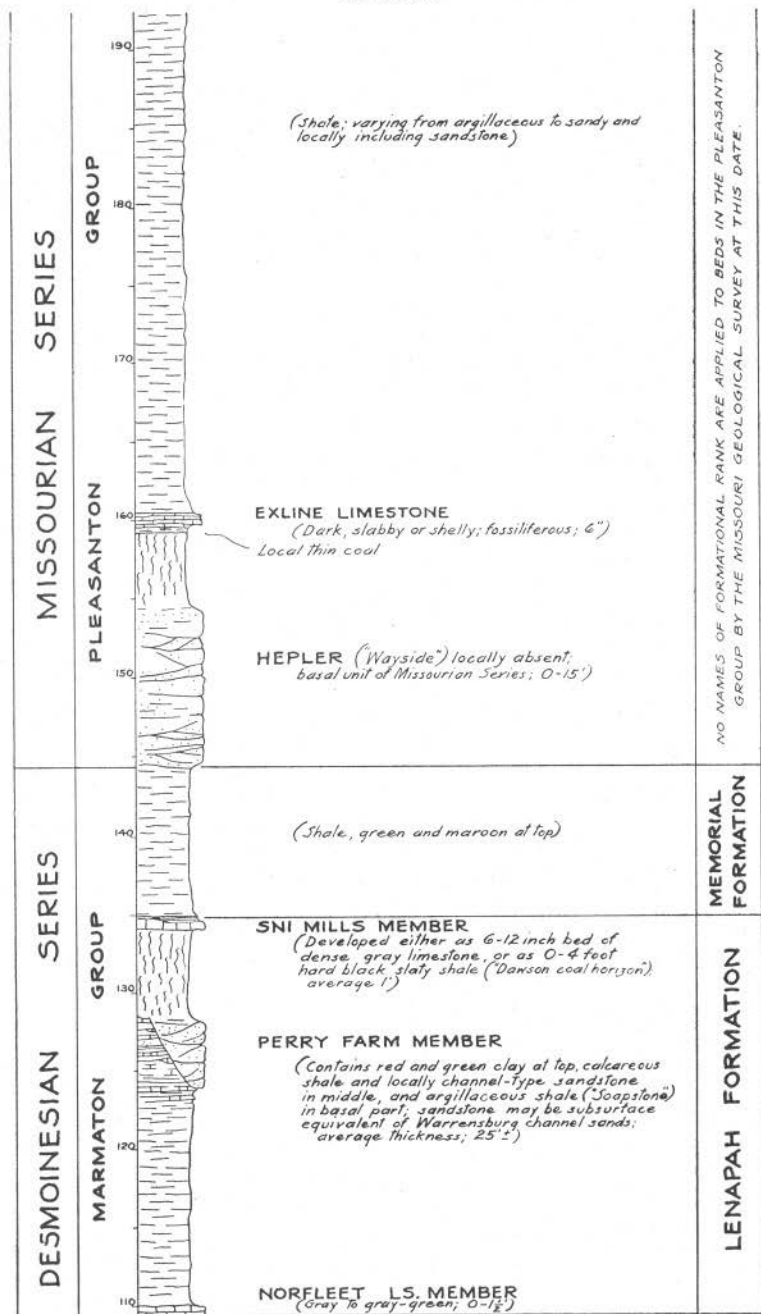


HUSHPUCKNEY SHALE MEMBER

Section of Rocks in Kansas City Area



CONTINUED



NOWATA FORMATION

Section of Rocks in Kansas City Area

HIGGINSVILLE LS. MEMBER



ROCK SYMBOLS USED IN GEOLOGIC SECTION

