

ART. XX.—*A Geologic Section from 40 Miles West of St. Louis County to Jackson County, Missouri;* by E. B. BRANSON.

Sections of the geology of St. Louis County¹ and Jackson County,² Missouri have been published recently and it will help those not familiar with the geology of the state to have a section connecting these eastern and western counties. The sections shown in the accompanying figures were prepared from data obtained as described in the following paragraphs.

The writer has mapped in detail the geology through which the section passes from eastern Warren County to eastern Moniteau County, a distance of about 90 miles, and has examined large numbers of outcrops and made less detailed maps on the west end of the section through Moniteau, Cooper, and Pettis counties. Complete mapping in these counties will doubtless bring to light details not shown in the section. Between Charette Creek in Warren County and the west line of St. Louis County, a distance of about 20 miles, no mapping or sectioning has been done.

The extreme western end of the section, which involves Pennsylvanian strata, is taken mainly from the reports of Marbut³ and Hinds⁴ and is included merely to connect the western end, involving Mississippian and older strata, with the Jackson County section. The writer has made no investigations along the line of the section west of Sedalia, in Pettis County.

Maps showing details of Devonian distribution will appear in a bulletin of the Missouri State Bureau of Geology and Mines, and the stratigraphy of the Sylamore and related formations will be treated at length in a report soon to be published.

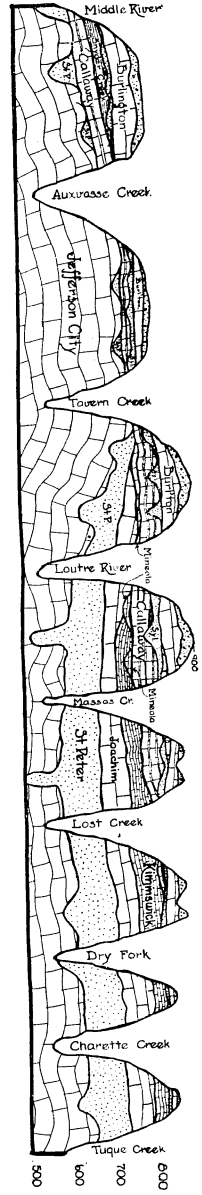
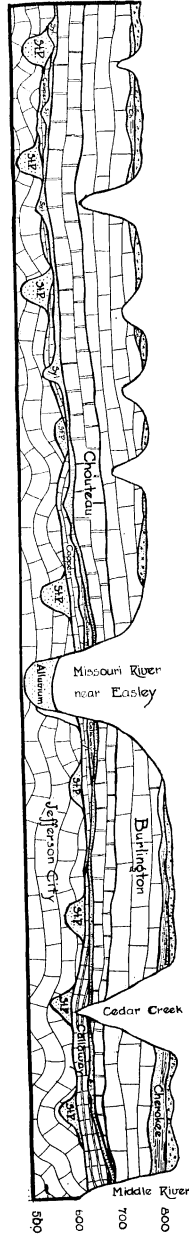
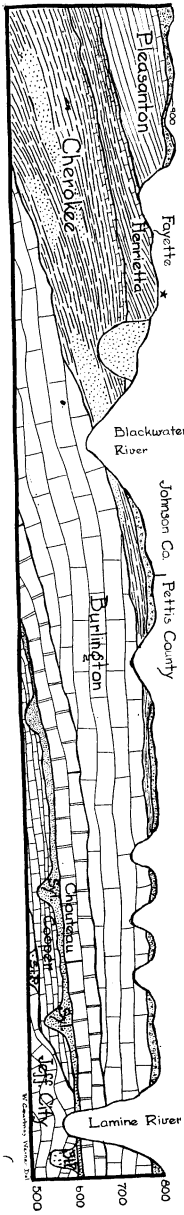
The strata shown are nearly horizontal along the line of the section if minor folds are neglected. The top of the Jefferson City dolomite lies at an elevation of about 650 feet in eastern Warren County and has about the

¹ Fenneman, N. M.: Geology and mineral resources of the St. Louis quadrangle, Missouri-Illinois, U. S. Geol. Survey, Bulletin 438.

² McCourt, Albertson and Bennett: The Geology of Jackson County, Missouri Bureau Geol. Mines, 2d Series, vol. 14.

³ Missouri Geol. Survey, vol. 12.

⁴ Missouri Bureau Geol. Mines, 2d Series, vol. 13.



same elevation on the Missouri River, 100 miles west. Westward from western Cooper County, 160 miles from St. Louis the dip is steeper, and eastward from the eastern edge of Warren County, 40 miles from St. Louis, the dip is great enough to bring Pennsylvanian strata to the 650-foot level within a few miles.

There are many minor folds along the line of the section, the most pronounced of which is at Mineola, in Montgomery County, about 85 miles west of St. Louis. Here the top of the Jefferson City arises 200 feet in about four miles from southeast to northwest and dips again to the westward several feet per mile. The structure is a sort of dome which the section does not cut at the summit. Numerous minor folds that rise 20 feet or more are not uncommon but in working along the section one is struck by the general horizontality of the strata.

Rocks from Lower Ordovician to Pennsylvanian are exposed in the section but no Silurian is present. The following are the formations present in a belt 10 miles wide, with about average and maximum thicknesses in that belt. The minimum thickness of all excepting the Jefferson City dolomite is zero.

<i>Pennsylvanian:</i>	Pleasanton formation	175 feet	
	Henrietta formation	100 feet	
	Cherokee shale	250 feet	
<i>Mississippian:</i>	Salem limestone	Usually absent	50 feet
	Burlington limestone	80 to 100 feet	190 feet
	Chouteau limestone	30 to 50 feet	70 feet
	Sylamore sandstone	8 inches to 2 feet	70 feet
<i>Devonian:</i>	Snider Creek shale	20 feet	50 feet
	Callaway limestone	20 to 30 feet	60 feet
	Mineola limestone	10 to 20 feet	40 feet
	Cooper limestone	10 to 20 feet	30 feet
	The Cooper and Mineola never occur in the same section.		
<i>Ordovician:</i>	Kimmswick limestone	40 feet	80 feet
	Joachim dolomite	40 feet	70 feet
	St. Peter sandstone	70 feet	200 feet
	Jefferson City dolomite	More than 200 feet exposed and the bottom not reached.	

The Jefferson City Dolomite (Lower Ordovician).—The Jefferson City is continuous from one end of the section to the other though it is not exposed west of central Pettis County, about 165 miles west of St. Louis. It is very sparsely fossiliferous and the writer has never collected an identifiable fossil from it in this region. It was uplifted, folded into a great many small folds and deeply eroded before the seas advanced over it to deposit another formation.

The St. Peter Sandstone (Lower Ordovician).—The lands were deeply covered with wind-blown sand, derived from unknown sources, when the seas readvanced over the Jefferson City, and this sand was used to form a marine formation that filled the valleys and spread widely over the uplands. The maximum thickness that still remains is about 200 feet and this is in old valleys. Over the uplands the maximum is little more than 100 feet. The irregularities in thickness in the eastern part of the section are due almost entirely to the irregularity of the surface on which the sand was deposited. Westward the formation thins, either on account of original deposition or subsequent erosion of the top, and west of eastern Callaway County, about 75 miles from St. Louis, becomes discontinuous. The sand between the old valleys has been removed by erosion and the St. Peter is left as isolated, linear masses, usually only a few hundred feet wide, and ranging up to more than 100 feet in thickness. This condition continues to eastern Pettis County, about 150 miles from St. Louis where the formation dips under. In a linear section one of these sandstone masses would be crossed every three or four miles on the eastern end and every five or six miles on the western.

In many places the Jefferson City and St. Peter were folded into sharp, narrow synclines and after erosion the St. Peter remained in the bottoms of the synclines. The contact between the St. Peter and Jefferson City is one of nonconformity, the latter presenting a surface of truncated, minor folds to the former.

The Joachim Dolomite (Lower Ordovician).—In eastern Callaway County, about 75 miles from St. Louis, appears a thin edge of dolomite, representing Broadhead's First Magnesian limestone, the Joachim of later writers. The formation gradually thickens to 40 feet

and ranges from 40 to 70 feet thick to the eastern edge of the section. It rests nonconformably on both St. Peter and Jefferson City, but mainly on the former. In the west it appears at about the same place that the St. Peter becomes discontinuous. Imperfect fossils occur in the dolomite in a few places but the writer has not found any well enough preserved to be identified.

The Kimmswick Limestone (Middle Ordovician).—In eastern Callaway County at the place where the St. Peter becomes patchy and the Joachim begins, the Kimmswick limestone enters as a thin wedge. It is patchy and though it occurs farther north does not occur again in the section until 15 miles farther east. From here it maintains a thickness of 40 to 70 feet to the eastern end of the section.

The Kimmswick is a limestone of middle Ordovician age and is abundantly fossiliferous. It has been divided into two distinct formations by Broadhead, and Ulrich considers that the bottom in the eastern end of the section is Plattin. The faunas have not been collected and studied thoroughly enough to warrant drawing positive conclusions, and the writer's study of the rock in the field leads him to class all of it as Kimmswick.

Along the line of this section the writer has never seen the Kimmswick resting on any formation but the Joachim and there is no positive evidence of unconformity between them. An unconformity is to be expected and as the writer has not studied this contact as he has most of the others, the evidence may have been overlooked.

The Silurian.—The writer has seen no evidence of the presence of Silurian rocks in the section.

The Devonian.—Devonian rocks in Missouri are thin and patchy, but in this section the Middle Devonian is represented by the Cooper limestone and the Mineola limestone and the Upper Devonian is represented by the Callaway limestone and Snider Creek shale. Their maximum thickness in any section is less than 100 feet.

The Mineola Limestone (Middle Devonian).—Near the eastern edge of Callaway County occur the westernmost outcrops of the Mineola limestone. For 40 to 50 miles along the section this formation occurs in patches and rarely has a thickness of more than 10 feet though southwest of Montgomery City it is 40 feet thick over an

area of a few acres. It is extremely irregular in composition, ranging from limestone of high purity to sandstone, though the commonest phase is a porous, sandy limestone. In many places it is highly fossiliferous, and the faunas are closely related to those of the Onondaga of Indiana and Ohio, though not to the Grand Tower of southeastern Missouri. It was deposited on an erosion surface of low relief and rests on various formations. Most commonly it lies disconformably on Kimmswick or Joachim, but in some places it lies on St. Peter and Jefferson City. It seems to have formed in a narrow bay extending westward from Indiana.

The Cooper Limestone (Middle Devonian).—The Cooper limestone, which was forming at the same time as the Mineola, extends westward from western Boone County and a barrier less than 20 miles in width separated the Cooper and Mineola seas. The formation is a very compact, fine-grained limestone, which ranges up to 30 feet in thickness though its average thickness is less than 15 feet. Like the Mineola it is not continuous but occurs in patches. It outcrops as far west as central Pettis County where it dips under westward. It rests nonconformably on Jefferson City dolomite in most places, but in a few places on St. Peter sandstone. The Kimmswick and Joachim do not extend into its territory and the St. Peter occurs there only in patches. It is usually nonfossiliferous, but in some places bears a fauna of a few species most of which are related to those of the lowest Devonian in Iowa. The lithologic characteristics of the Cooper have led to its identification as Louisiana limestone, though its position in the geologic column and its fauna place it far below that formation.

The Callaway Limestone (Upper Devonian).—From the Missouri River on the west to central Warren County in the east, a distance of about 90 miles, the Callaway limestone, of the upper Devonian, succeeds the Mineola and Cooper. Though it becomes patchy on the east and west, it is almost continuous for the entire distance. Where best developed, in Callaway County, it is commonly 50 feet thick, but near the eastern edge it is rarely more than 20 feet thick and the same is true for the western 30 miles of its extent. The Callaway is extremely limited in its north-south extent, not having been observed beyond one tier of counties, save for a few patches

in Cole County south of the Missouri River. It is unconformable on Mineola, Cooper, Kimmswick, Joachim, St. Peter, and Jefferson City. As the formation becomes mainly sandstone at the west its western margin of outcrop, along the west bluff of the Missouri River in Moniteau County, is probably near the western margin of the sea in which it was deposited.

The Snider Creek Shale (Upper Devonian).—In Montgomery and Warren counties the Callaway limestone is succeeded by the Snider Creek shale, which is mainly shale and subordinately limestone. It appears to be conformable on the Callaway limestone and at no place rests on other formations. Its thickness ranges up to 50 feet but is ordinarily less than 20 feet. Its present extent is formed of erosion remnants and as a consequence is patchy. It can not be traced for more than a few miles at any place and its total extent is confined to a small part of two counties. It is the highest Devonian formation in Missouri and the sea in which it formed evidently came from the north. Greger⁵ has pointed out the similarity of its fauna with the faunas of the upper Devonian of Iowa.

Interval between Devonian and Mississippian.—A period of erosion of considerable length followed the deposition of the Snider Creek. In many places Devonian strata were tilted a few degrees and the folds eroded to an even surface before Mississippian rocks were deposited and at no place has the writer found Mississippian conformable on Devonian. The evidences of unconformity are: old valleys in the Devonian; joints in the Devonian rocks filled with Mississippian sediments; caves in Devonian rocks partially filled with Mississippian sediments; overlap of earliest Mississippian sediments over various Devonian formations; a complete break in the faunas.

Mississippian.

The Sylamore Sandstone (Basal Mississippian).—The Mississippian seas advanced over a surface of gentle relief, with occasional valleys 30 to 60 feet deep, and deposited the Sylamore sandstone, which varies in thickness up to 70 feet. This averages little more than a foot in thickness and the greater thicknesses occur mainly in

⁵ This Journal, vol. 27, pp. 375-378.

old valleys. The Sylamore is almost continuous from the eastern part of the section to the western. In most places it underlies the Chouteau limestone but it lies on Snider Creek, Callaway, Mineola, Cooper, Kimmswick, Joachim, St. Peter, and Jefferson City. Its relationships to the underlying rocks include all of those discussed in the last paragraph. The Sylamore bears a basal Mississippian fauna which is illustrated and discussed in a paper soon to appear.

The Sylamore varies in color from light gray through grayish green to dark brown. In Warren County it has been mistaken for the Ferruginous sandstone of the Pennsylvanian. The greenish phase is peculiar and recurs in places from southwestern to northeastern Missouri. In a few places shales are associated with the sandstone and may occur above or below it.

The Sylamore has been considered as part of the Chouteau or part of the Devonian by most investigators of this region.

The Chouteau Limestone (Kinderhookian).—Through much of the section the Chouteau limestone rests on the Sylamore. The transition from the Sylamore to the Chouteau is usually brought about by the presence of shale, two or three inches thick, which bears a typical Chouteau fauna. The Chouteau consists of dark-colored argillaceous limestone below, and light-colored, sandy dolomite above, but the dolomite occurs only where the formation is thick. In Cooper and Pettis counties the upper half contains a great deal of sandstone. In the eastern 60 miles of the section the formation has been observed in only one place, and is absent through most of the distance. Near Fulton it is one foot to two feet thick and thickens to 60 feet in the bluffs of the Missouri, 25 miles west of Fulton. West of the Missouri River it averages 50 to 60 feet thick to Pettis County where it dips under.

The Chouteau seas were patchy along the middle part of the section and had withdrawn slightly from their Sylamore boundaries. The Sylamore keeps its thickness in areas where no Chouteau is present though that thickness is only one or two feet. On the other hand, the Chouteau remains limestone to the edge of the various patches showing that little or no erosion took place on the exposed Sylamore flats.

The Chouteau was rather extensively eroded before the Burlington seas advanced. This is shown by the thickening and thinning of the formation, and by the top part always being absent where the formation is thin. Also it is not uncommon to find Burlington resting on Devonian or older formations with no Chouteau or Sylamore present. Only rarely is there evidence of unconformity where contacts of Chouteau and Burlington are exposed.

The Burlington Limestone (Osagian).—The Burlington limestone is continuous from St. Louis County to Jackson County, the counties of St. Louis and Kansas City. Its nearest outcrop to Jackson County is about 40 miles east. It ranges from 20 feet thick to 190 feet thick and is much the same lithologically everywhere, save that the lower 10 to 30 feet are brown in the eastern end of the section. For more than half of its extent it rests on the Chouteau, for perhaps one-fourth of its extent on the Sylamore, and over small areas on Snider Creek, Callaway, Kimmswick, and Joachim. The irregularity in thickness is due to erosion of the top, and well sections seem to show that it thickens westward from the place where it dips under in Pettis County.

The Salem Limestone (Meramecian).—The Salem limestone outcrops only rarely but occurs over wide areas in small patches. At Boonville, in Cooper County, its outcrops are well known and in Boone County Broadhead⁶ found it outcropping 15 to 20 feet thick in one place. *Archimedes*, in cherts, occur in hundreds of places, scattered along the section, but the writer has not seen outcrops of rock bearing *Archimedes*, excepting at Boonville and Broadheads' locality. Only a short distance east of the section several other Mississippian formations occur but they were either eroded away or were not deposited west of St. Louis County.

The Pennsylvanian.—At the eastern end of the section patches of Pennsylvanian fire-clay and sandstone occur rarely at the tops of the hills, a little shale comes in a few places at the tops of the hills where the section crosses Boone County, and from western Pettis County westward nothing below Pennsylvanian outcrops. The Pennsylvanian is represented by the Cherokee, Henrietta, and Pleasonton formations and by the Warrensburg sandstone which was deposited in a valley in the Cherokee and on Henrietta shales.

⁶ Geol. Survey of Missouri, vol. 12, p. 333.

Younger Deposits.—East of the Missouri River along the section glacial drift occurs, undisturbed here and there in protected places, but much more commonly glacial materials are mingled with residual and wind-blown materials to make up the mantle rock. Loess caps most of the hills near the Missouri River and laps down over the sidehills in many places to meet the alluvium of the valleys. The loess reaches a thickness of 50 feet or more but is ordinarily less than 20 feet in thickness. On the hilltops a few miles from the river finer, wind-blown materials make up most of the mantle rock and under it are residual and glacial materials. Most of the residual deposits are composed of chert derived from the cherty limestones and dolomites.

*Keyes Sections.*⁷—Dr. Charles Keyes recently published sections that differ so widely from the writer's observations that it seems worthwhile pointing out the differences.

Keyes' sections show the Chouteau resting on the Hannibal shales, which, he says, "decline in thickness westward until by the time Cooper County is reached they disappear by attenuation." The writer does not know of a place where the Chouteau rests on the Hannibal excepting within about 20 miles of Hannibal. At the western end of his section Keyes shows the Chouteau resting on the Louisiana limestone but the Louisiana does not outcrop within 100 miles of this western end and probably does not occur within 90 miles of it. Keyes' section shows the Saverton shales extending nearly to the western end, but these shales are not known within 100 miles of that place. His section shows the Snider shales extending from Hannibal to Cooper County. The writer has mapped these shales in what appears to be their total extent, and that is entirely in Callaway and Montgomery counties. The Callaway limestone appears in Keyes' section from its western end to near Hannibal; some 30 miles too far west and at least that distance too far northeast.

Keyes' section shows Silurian all the way from Sedalia to Hannibal. The writer has not found Silurian outcropping at any place along the Missouri River or its tributaries. It probably does not come within 100 miles of Sedalia. His section shows no Cooper or Sylamore,

⁷Proceedings of the Iowa Academy of Sciences, vol. 23, p. 113.

and shows the Ordovician limestone (in the main Kimmswick but including some Joachim) extending from Hannibal to Sedalia. The western edge of both the Ordovician formations is in eastern Callaway County about 90 miles from Sedalia. His section also shows the St. Peter sandstone as a continuous formation from Hannibal to Sedalia, whereas it is discontinuous for about 90 miles from Sedalia.

It is true that the main object of Keyes' article is to show the relationships of the Chouteau, but even these are erroneous west of the outcrops of the Mississippi River and its tributaries.

These late sections of Keyes practically repeat those of an earlier article in a Bulletin of the Geological Society of America.⁸ Both articles mislead in verifying, by seemingly later investigations, errors of the reports of Swallow,⁹ Meek,¹⁰ and Broadhead.¹¹ None of these reports were detailed and many identifications of strata were left provisional awaiting further investigations. Some studies on the areas considered in this discussion were made by Keyes and his helpers on the Missouri Survey but they were in the nature of reconnaissance work. It is hard to understand how even a few days work on the geology of Pettis and Cooper counties could leave any warrant for the sections given by Keyes.

While mapping the Cooper limestone in Pettis and Cooper counties, the writer visited all the localities for Vermicular sandstone, Louisiana limestone, and Cooper marble mentioned by Swallow in Reports I and II of the Geological Survey of Missouri, and no Vermicular nor Louisiana was found. A sandy phase near the middle of the Chouteau seems to have been identified as Vermicular though it shows only rarely any Vermicular markings and contains a typical Chouteau fauna. The Chouteau limestone below the sandstone was identified as Louisiana by Swallow, though from bottom to top it contains the most typical of Chouteau species in abundance. The Sylamore is so thin and inconspicuous that it was not recognized as a formation by Swallow. Swal-

⁸ Bull. Geol. Soc. Am., vol. 13, pl. 44.

⁹ Geol. Survey of Missouri, First and Second Annual Reports, Part I, pp. 186-203.

¹⁰ *Ibid.*, Part II, pp. 95-119.

¹¹ Geol. Survey of Missouri, 1855-1871, pp. 37-64.

low mentions the great irregularities in thickness of the St. Peter but does not tell of the patchiness of its remnants.

Acknowledgments.—My first work in Callaway County was made easy by Mr. D. K. Greger who knew practically every outcrop of Devonian of importance in that county. Mr. Greger and several of my advanced students have worked with me on various parts of the section here discussed and many of the details and larger features were first brought to my attention by them.

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