Geology and Construction-Material Resources of Marion County, Kansas

GEOLOGICAL SURVEY BULLETIN 1060-B

Prepared in cooperation with State Highway Commission of Kansas, as part of a program of the Department of the Interior for development of the Missouri River basin

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By F. E. BYRNE, C. P. WALTERS, J. L. HILL, *and* L. RISEMAN

GEOLOGY AND CONSTRUCTION MATERIALS OF PART OF NORTHEAST KANSAS

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GEOLOGY AND CONSTRUCTION-MATERIAL RESOURCES OF MARION COUNTY, KANSAS

By F. E. Byrne, C. P. Walters, J. L. Hill, and L. Riseman

ABSTRACT

Sources of construction materials in Marion County, Kans., were studied as a joint project of the U. S. Geological Survey and the State Highway Commission of Kansas. The county is in south-central Kansas at the west edge of the Flint Hills.

Rocks of early and middle Permian age crop out extensively over the eastern two-thirds of the county. These rocks are composed of alternating beds of gray limestone, many of which are markedly cherty, and varicolored shale. Two formations of Early Cretaceous age at the surface in the western part of the county are the Kiowa shale, a marine deposit that rests disconformably on the Wellington formation of Permian age, and the Dakota sandstone, a series of interfingered lenses of shale and sandstone. In many parts of the county the Permian and Cretaceous rocks are covered by thin layers of sediments deposited by the wind and streams during the Quaternary period. These sediments, divided into three units, are shown on an accompanying geologic map as the Sanborn formation, terrace deposits, and alluvium.

Limestone, the local material most useful in construction, is suitable for use as aggregate, road metal, riprap, and structural stone. Sand from the Sanborn formation is used as road metal. Silt from the Sanborn formation and from terrace deposits might be used as mineral filler.

INTRODUCTION

Members of the U. S. Geological Survey studied the sources of construction materials in Marion County, Kans., during the summer of 1948 and during 1950 as part of a statewide project conducted in cooperation with the State Highway Commission of Kansas. This report, which is based on that study, is a contribution to the geologic mapping and mineral resources investigations being made as a part of the U. S. Department of the Interior program for the development of the Missouri River basin.

The primary purpose of the investigation was to accumulate field and laboratory data on the availability and suitability of geologic materials in Marion County that could be used in the construction of dams, irrigation canals, highways, airports, or other structures. Additional geologic data are included to facilitate the exploitation of known prospects and the search for other sites where materials might be obtained economically.

GEOGRAPHY

LOCATION OF THE AREA

Marion County is in the fourth tier of the counties south of the Kansas-Nebraska boundary and is the sixth county west of the Kansas-Missouri boundary (fig. 3). It has an area of about 954 square miles and comprises slightly more than 26 townships. The county lies between parallels 38°05′ and 38°37′ north latitude, and meridians 96°49′ and 97°23′ west longitude. It is bordered on the east by Morris and Chase Counties; on the west by McPherson and Harvey Counties; on the north by Dickinson and Morris Counties; and on the south by Butler and Harvey Counties.

The eastern townships of Marion County, at the west edge of the Flint Hills, are characterized by a well dissected topography with deeply incised valleys, thin soils, and many limestone outcrops. The major drainage is southeastward along the axis of Cottonwood River. The central part of the county is characterized by lower, more rounded hills because of the greater thickness of shale exposed at the surface. The northwestern part of the county shows a more rugged terrain developed in sandstone and shale of Cretaceous age.

DRAINAGE

The Cottonwood River, the largest stream in the county (pl. 3), flows southeastward across the center of the county. The major tributaries are Clear and Mud Creeks, which flow southward; French Creek and the South Cottonwood River, which flow eastward; and Doyle Creek which flows northeastward.

CLIMATE

Marion County is in an area of continental-type climate in which the summers are relatively long and hot, and the winters short and fairly cold. The mean annual temperature is 56°F. and the monthly mean ranges from a low of 20°F. in January to a high of 80°F. in July. There is an average of 95 cloudy days, 95 partly cloudy days, and 175 clear days each year. The ground is covered by snow on an average of 20 days of the year. Normal annual precipitation is 30.13 inches. The average date of the first killing frost is October 18 and that of the last killing frost is April 18 (Flora, 1948). A chart of temperature ranges at Herington, Kans., and precipitation ranges at

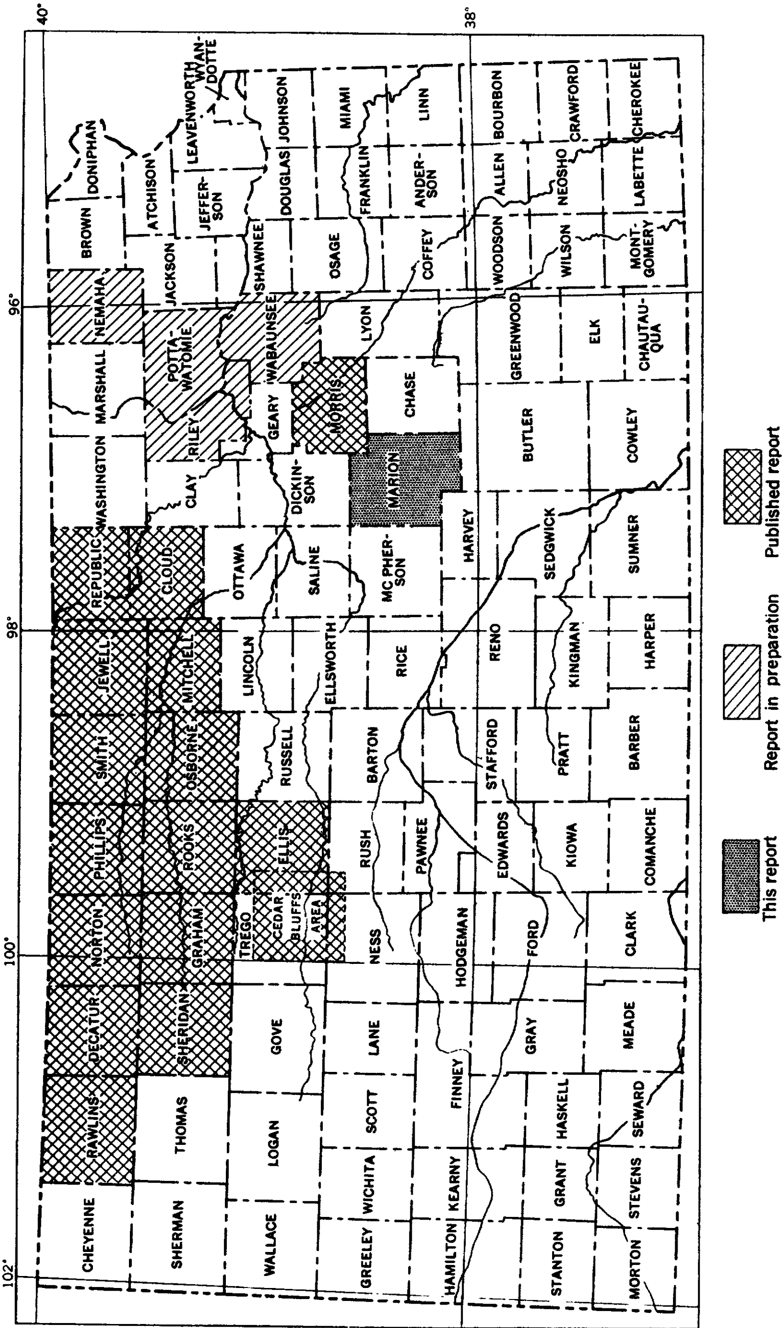

FIGURE 3.—Index map of Kansas showing area of this and other reports on construction materials.

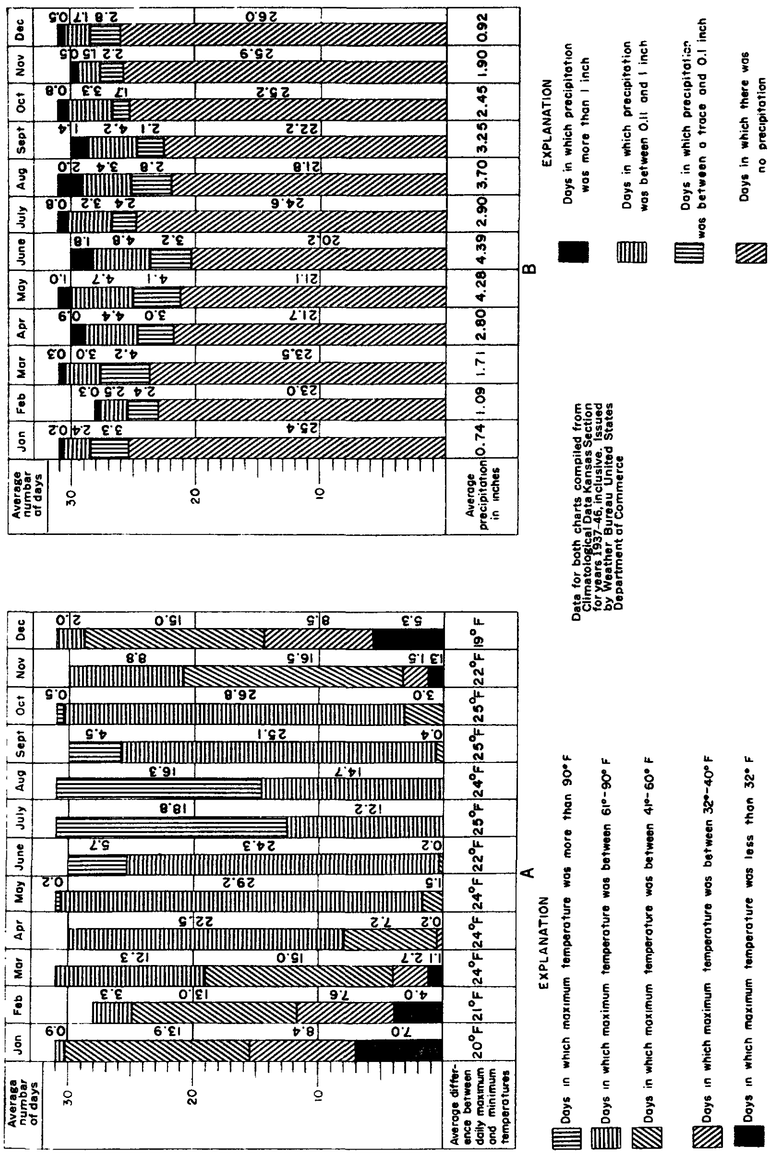

FIGURE 4.—Chart of temperature ranges at Herington, Kans., and precipitation ranges at Marion, Kans.

Marion, Kans. (fig. 4), was compiled from "Climatological data" (U. S. Dept. Commerce, 1937–46) to provide basic data necessary for good engineering construction. The chart indicates, for the 10-year period, the average number of days each month in which the maximum daily temperature fell within one or another of the temperature ranges vitally important in various kinds of engineering construction. Only from November to March, inclusive, are there days in which the maximum temperature does not exceed 32°F., and the maximum average incidence is 7 such days in January. July, the warmest month of the year, has an average of 18.8 days with maximum temperatures above 90°F. The chart shows the average difference between the daily maximum and minimum temperatures for each month. The greatest of these average differences in daily temperatures, 25.4°F., is in October; the least of them, 19.4°F., is in December.

The chart also shows arbitrarily selected precipitation ranges at Marion, Kans. Records for the 10-year period 1937–46 show that in June, for example, there is an average of 20.2 days that do not have measurable precipitation; 3.2 days that have from a trace to 0.1 inch; 4.8 days that have 0.11 to 1 inch; and 1.8 days that have more than an inch.

TRANSPORTATION ROUTES

Two railroads serve the county (pl. 3). One branch line of the Atchison, Topeka and Santa Fe Railroad crosses the southeastern part through Florence and Peabody; a second extends westward from Florence through Marion, Hillsboro, and Lehigh; the third branch passes through Lost Springs near the northeastern corner of the county. The county is also served by two branch lines of the Chicago, Rock Island, and Pacific Railroad. One crosses diagonally from Dickinson County to McPherson County, passing through Ramona, Tampa, and Durham. The other branch extends southward through Lost Springs, Lincolnville, Antelope, Marion, Aulne, and Peabody.

There is a well-developed system of Federal, State, and county roads (pl. 3). The Federal highways are of concrete (U. S. 50) or black-top construction (U. S. 56 and U. S. 77). Kansas Highway 15 has both black-top and metaled sections; Kansas Highway 150 is black-topped. County and township roads are usually metaled and give access to graded earthen roads laid out along most of the section lines in the county.

INVESTIGATION PROCEDURE

This report is based on field work of the reconnaissance type. The eastern two-thirds of the county were mapped by Riseman and Hill in the summer of 1948, and the western third by Walters in the summer of 1950. The base map (Highway Planning Map, scale: 1 inch equals 1 mile) was provided by the State Highway Commission of Kansas. Drainage lines were added to the base map for greater ground control in mapping. These were taken from aerial photographs (scale: 4 inches equal 1 mile) made available by the Soil Conservation Service, U. S. Department of Agriculture. The drainage lines were checked against maps compiled by the Soil Conservation Service (scale: 1 inch equals 2 miles) and further checked in the field.

The areal distribution of stratigraphic units exposed in Marion County was mapped in the field. Because the project was primarily concerned with construction materials, no attempt was made to include geologic problems not related to the occurrence of these materials.

ACKNOWLEDGMENTS

For assistance in the compilation of the geologic map and the data on construction materials, acknowledgment is made to S. E. Horner, then chief geologist, R. D. Finney, engineer of materials, and W. E. Gibson, engineer of tests, of the State Highway Commission of Kansas at Topeka and Manhattan, Kans.; Victor Muse, Marion County conservationist of the Soil Conservation Service, U. S. Department of Agriculture; and many residents of the county who contributed information of value.

CHARACTERISTICS OF STRATIGRAPHIC UNITS

This discussion of the geologic formations that crop out in Marion County emphasizes the areal distribution, general characteristics, and thickness of each stratigraphic unit. A representative measured section is given for each formation or member. The measured sections are not complete, especially in poorly exposed sections of shale, but each presents the characteristic features of a formation or member. The construction materials of each unit are listed in plate 4.

Plate 3 shows the location of construction materials and the geology of Marion County, Kans. Each stratigraphic unit is indicated by an identifying symbol and its outcrop areas are shown by a distinctive pattern. Railroads, roads, and drainage lines are shown also to provide a basis for evaluating the availability of sources of construction materials.

Symbols indicate whether a pit or quarry is operating, has been operated, or is a prospect; the type of construction materials available at each site; and the quantity of material (in units of 10,000 cubic yards) that can be removed from beneath unconsolidated sediments less than 6 feet thick.

The oldest system of rocks exposed at the surface in Marion County is the Permian which crops out in all but the northwestern part of the county, where it lies close to the surface (pls. 3 and 4). Rocks of Cretaceous age overlie Permian strata in the northwestern part of the county and have a maximum thickness of about 140 feet. Deposits of gravel, sand, silt, and clay of Pleistocene age that once overlay nearly all the older rocks are now scattered erosional remnants, some as thick as 20 feet. Recent deposits are in stream valleys and are thickest in the valleys of the larger streams.

PERMIAN SYSTEM

The oldest formation of Permian age outcropping in Marion County is the Wreford limestone which is exposed in a single small outcrop in the Cottonwood River channel (pls. 3 and 4). The next oldest formation, the Matfield shale, crops out in the valley of the Cottonwood River and along the eastern border of the county in the deeper valleys tributary to the river. Prominent in the eastern tier of townships is the Barneston limestone which forms bluffs and terraces. Above the Barneston limestone and parallel to it in outcrop is the Doyle shale which erodes easily, except for a step formed by the Towanda limestone member. A still higher terrace is formed by the Winfield limestone which is separated from the next terrace-forming unit, the Nolans limestone, by the Odell shale.

The youngest Permian formation in the county is the Wellington, which is 700 feet thick. The 450 feet that crop out forms a broad, northward-trending band in the western part of the county.

CHASE GROUP

WREFORD LIMESTONE

Of the Wreford limestone, only the Schroyer limestone member, the upper subdivision of the formation, is visible at the surface in the county; it is the oldest stratigraphic unit exposed in the county and may be observed beneath a bridge over the Cottonwood River in the NW¼SW¼ sec. 10, T. 21 S., R. 5 E. The limestone is light to dark gray and contains two blocky beds of gray chert and several partings of gray shale. Because the formation is deeply buried elsewhere in the county, it is not a likely source of construction material.

MATFIELD SHALE

The Matfield shale crops out in the southeastern part of Marion County—mostly in the valley of the Cottonwood River east of Florence. Its outcrops are generally inconspicuous because of greater resistance to erosion of the overlying Barneston limestone and the consequent slumping of blocks of limestone which conceal the shale outcrop.

The formation is composed largely of shale but includes a limestone member, the Kinney, which crops out near Florence in the channel of the Cottonwood River. As exposed in the valleys of the Cottonwood River and its tributaries, the Matfield is a varicolored shale in which red and green-gray zones predominate; there are a few thin interbedded layers of gray limestone and calcareous shale and some marine fossils in the calcareous zones.

About 50 feet of the shale is exposed; its total thickness is about 80 feet.

Because of its few outcrops and the predominance of shale, the formation is of little value as a source of construction materials.

BARNESTON LIMESTONE

The Barneston limestone crops out prominently at Florence and throughout the southeastern part of the county. The Cottonwood River has cut completely through the formation at Florence, as have some of the river's tributaries to the east. Other streams have cut down to or into the formation and its massive beds form the steep limestone walls distinctive of valleys in the eastern part of the county.

This formation is composed of two limestone members separated by a thin shale member. The lowest is the Florence limestone member in which chert is so abundant that in highway and other cut sections the rock appears to be predominantly chert with only a minor amount of nodular limestone inclusions. It is gray to tan, highly fossiliferous, and broken by vertical jointing into blocks about 1 foot across. Brown limonite stain marks the fracture surfaces.

The chert is generally gray but has bands of tan color in places. Small crystals of quartz line the solution cavities and coat some of the fracture surfaces.

The Oketo shale member, which overlies the Florence limestone member, is silty and calcareous, massive or poorly bedded, and contains marine fossils. It is dark gray and weathers to buff or light gray. The shale is only 1 or 2 feet thick in Marion County.

The Fort Riley, the uppermost member of the formation, is a fairly hard, very fossiliferous limestone. Thin beds of gray shale form partings between thick sequences of limestone beds. With the exception of a zone of rather massive limestone near the base and another in the middle of the member, the limestone beds are platy, and the shale partings are mostly among the platy beds of limestone. The massive beds tend to form broad terraces. The lower zone of massive limestone is known as rimrock.

When unweathered the Fort Riley is gray to buff, but it appears white in the outcrops, where blocks several feet across are conspicuous evidence of vertical jointing in the member.

Outcrops of the Barneston limestone may be observed near Florence and in T. 18 S., R. 5 E.; T. 19 S., R. 5 E.; T. 20 S., R. 5 E.; and T. 21 S., R. 5 E. There is an unusually good exposure of the Fort Riley limestone member along U. S. Highway 77 in the NE¼NE¼ sec. 13, T. 21 S., R. 4 E.; the Oketo shale and Florence limestone members are well exposed in an Atchison, Topeka and Santa Fe railroad quarry half a mile northeast of Florence in the SW¼SE¼ sec. 6, T. 21 S., R. 5 E. The full thickness of the Barneston limestone, about 80 feet, is exposed on the hillsides east of Florence.

Representative section of the Florence limestone and Oketo shale members of the Barneston limestone in an Atchison, Topeka and Santa Fe Railroad quarry in the SW¼SE¼ sec. 6, T. 21 S., R. 5 E.

	Feet
Barneston limestone:	
Oketo shale member:	
Shale, silty, calcareous, dark-gray, hard; little evidence of bedding; weathers buff; upper and lower contacts indistinct; abundant fossils	1.0
Florence limestone member:	
Limestone, massive, light-tan, hard; a few scattered chert nodules in basal part; weathers to darker tan; contains fossils	3.3
Limestone, light-gray to buff, massive; with layers and nodules of dark-gray flint; weathers tan; fossils abundant in lower half	2.3
Limestone, light-buff, massive, moderately hard; with thin wavy horizontal streaks; weathers gray tan; a few scattered chert nodules; fossils abundant	.7
Limestone, light-buff, massive, moderately hard; contains abundant layers and scattered nodules of dark-gray chert; stylolites; weathers darker buff; scattered fossils	19.8
Total exposed thickness of the Florence limestone and Oketo shale members	27.1
Base covered	

Representative section of the Fort Riley limestone member of the Barneston limestone in a road cut in the NE¼ NE¼ sec. 13, T. 21 S., R. 4 E.

Doyle shale.	
Barneston limestone:	
Fort Riley limestone member:	*Feet*
Limestone, gray, clayey, porous, massive, soft, thin-bedded; calcite geodes in upper 18 in.; streaked along bedding planes with limonite; weathers dark tannish gray	3.0
Limestone, slightly clayey, hard, light gray-buff; weathers light gray; limonite stains	3.0
Limestone, clayey; soft in upper part; large areas blue gray, other areas tan gray; weathers to lighter gray and tan; upper half weathers to very thin beds; lower half weathers to blocky, irregular beds; fossiliferous	5.7
Limestone, massive, hard, tan-gray to blue-gray; weathers light tan gray; fossiliferous	1.5
Limestone, soft, clayey; breaks up into angular fragments of unequal size; light buff mottled with blue gray; weathers lighter buff and blue gray; weathers platy; fossiliferous	10.0
Limestone, clayey, dark blue-gray mottled with buff; splits easily; weathers lighter color	1.3
Limestone, thin-bedded, light gray-buff: weathers buff; fossiliferous	8.5
Total exposed thickness of the Fort Riley limestone member	33.0
Base covered	

DOYLE SHALE

The Doyle shale tops the broad bench underlain by the Barneston limestone. The Towanda limestone member, the middle member of the formation, forms a small but conspicuous terrace about 30 feet above the Fort Riley. Stream valleys are deeply incised into the Barneston limestone, but those in the Doyle shale generally are broad and gently sloping except near their heads where they become markedly steeper especially near the overlying Winfield limestone.

This formation is exposed in the valley of Doyle Creek southwest of Florence and in the valley of the Cottonwood River northwest of Florence. Most of its other exposures are in the easternmost tier of townships where the outcrops parallel those of the Barneston limestone.

The Doyle shale is composed of two members of varicolored shale separated by a slabby or platy limestone member. The lowest, the Holmesville shale member, is calcareous, thin bedded to blocky, contains few fossils, and has gray, buff, green, and red zones. Where locally present a few thin beds of limestone in the Holmesville make it difficult to determine the contact with the underlying Fort Riley limestone member. The Towanda limestone member is thin bedded, hard, slabby, bluish gray to buff, contains few fossils, and splits into thin pieces suitable for use as flagstones; in some zones the bedding planes total 10 or 15 to an inch. It crops out as a persistent hillside terrace. Uppermost in the formation is the Gage shale member. It is calcareous and fossiliferous in the upper part and in most places is gray to buff or olive. The lower and middle zones are varicolored, clayey, and contain fewer fossils. These beds are green, gray, buff, red, maroon, and chocolate. The walls of the broad valleys cut into the member in many places are covered by a soil too thin to hide the varicolored bands.

The total thickness of the Doyle shale is about 80 feet, of which about 45 feet is the Gage shale member, 10 feet is the Towanda limestone member, and 25 feet the Holmesville shale member.

Representative section of the Towanda limestone and Holmesville shale members of the Doyle shale in a road cut in the NE¼NE¼ sec. 13, T. 21 S., R. 4 E.

	Feet
Soil: silty clay loam, crumbly, dark-brown (1.5 feet).	
Doyle shale:	
Towanda limestone member:	
Limestone, fine-grained, gray to tan, very thin bedded; breaks along bedding planes into plates 0.5–1 in. thick; shaly appearance in outcrop; weathers light buff	3.5
Limestone, well-bedded, gray to tan-gray, fairly coarse textured; splits along bedding planes and forms blocks and plates 1–6 in. thick; weathers light buff; thin, irregular partings of shale	4.0
Limestone, massive to platy, blue-gray to buff; fine- to coarse-grained and angular, weathers buff-gray and to massive blocks about 8 in. thick	3.0
Holmesville shale member:	
Shale, silty, calcareous; buff to tan; limestone stringer in middle, with geodes; weathers light tan	.9
Shale, silty, calcareous, buff, blocky; partially consolidated lens in lower part; weathers tan	1.1
Shale, silty, slightly calcareous, thin-bedded, buff and gray; weathers light tan	.8
Shale, silty, calcareous, massive, gray-brown; weathers light tan with fretwork; transparent calcite crystals present	1.2
Shale, clayey, slightly calcareous, hard, mottled gray-green; weathers light gray green	1.5
Shale, clayey, noncalcareous, dark gray-green; upper part more blocky than lower part; weathers gray green	1.2
Shale, clayey, calcareous, massive, light tan-gray, mottled with gray-green: weathers lighter tan gray	.7
Shale, clayey, calcareous, massive, gray-green; weathers light gray green	1.3
Limestone, hard, massive, gray; weathers light gray with limonite stains	.8
Shale, clayey, calcareous, soft, light-gray; grades to buff in lower part; weathers light tan gray	.6
Shale, clayey, noncalcareous, massive to blocky, hard; dark gray streaked with black and green; weathers dark gray green	.5

Representative section of the Towanda limestone and Holmesville shale members of the Doyle shale in a road cut in the NE¼NE¼ sec. 13, T. 21 S., R. 4 E.—Continued

	Feet
Doyle shale—Continued	
Holmesville shale member—Continued	
Shale, clayey, brittle, hard, light-gray; noncalcareous except for upper part which contains abundant calcite geodes; lower part has thin bedding laminae; weathers gray	1.2
Total exposed thickness of the Holmesville shale and Towanda limestone members (top eroded)	22.3
Base covered	

Representative section of the Gage shale member of the Doyle shale along U. S. Highway 77 in the SW¼NW¼ sec. 26, T. 20 S., R. 4 E.

	Feet
Doyle shale:	
Gage shale member:	
Shale, silty and clayey, fairly well bedded, gray-green to buff; jointed at 4-in. intervals; highly fossiliferous zone at base	4
Shale, calcareous, clayey, light-gray to white; nodular calcareous concretions; fossiliferous	4
Shale, calcareous and clayey, greenish-gray to tan; calcite vein fillings; fossiliferous	10
Shale, clayey, massive to blocky, varicolored, red to gray-green, predominantly maroon	15
Total thickness exposed	33
Base covered	

WINFIELD LIMESTONE

The Winfield limestone forms a conspicuous hillside bench south and east of Marion and throughout the eastern tier of townships. Elsewhere the formation is beneath the surface or crops out only in the bottoms of stream valleys.

The formation consists of two limestone members separated by a shale member. The Stovall limestone member, which overlies the Doyle shale, is recognized easily because it contains large nodules of gray chert. This member is gray or buff and about 2 feet thick. The chert nodules are about 6 inches across, and many small fossils are embedded in them. The chert is more resistant to weathering than is the limestone matrix, but when highly weathered it forms a porous material called "tripoli."

Overlying the Stovall limestone member is the Grant shale member which is about 8 feet thick, gray to buff or olive, fossiliferous, and calcareous.

The Cresswell limestone member, the upper unit of the formation, is about 20 feet thick, and contains fossils and a few thin partings of shale. The thin-bedded upper half is sometimes called the "Luta limestone." Concretions and geodes are displayed in weathered outcrops.

The total thickness of the formation is about 40 feet of which about 30 feet is limestone.

Representative section of the Stovall limestone and Grant shale members of the Winfield limestone along U. S. Highway 77 in the SW¼NW¼ sec. 26, T. 20 S., R. 4 E.

	Feet
Winfield limestone:	
Cresswell limestone member (8 feet).	
Grant shale member:	
Shale, silty, calcareous, massive, gray-green; numerous geodes; fossiliferous	4.0
Shale, silty and clayey; massive to poorly bedded; fossiliferous	5.0
Stovall limestone member:	
Limestone, hard, dense, light-gray to buff; chert nodules; fossiliferous; in two distinct beds, each about 1 ft thick	2.0
Total thickness of Stovall limestone and Grant shale members	11.0
Doyle shale.	

Representative section of the Grant shale and the Cresswell limestone members of the Winfield limestone in a quarry in the SE¼NW¼ sec. 15, T. 19 S., R. 4 E.

	Feet
Winfield limestone:	
Cresswell limestone member:	
Limestone, clayey, thin-bedded to platy, light-gray; weathers lighter gray	1.9
Limestone, massive, soft, light-gray; contains abundant geodes; weathers slightly darker gray; fragments of shale in upper part	4.6
Shale, clayey, slightly calcareous, light-green; platy to thin bedded; weathers to lighter green	.5
Limestone, clayey, soft, tan-gray; generally massive, but thin bedded in places; weathers light buff	2.1
Shale, clayey, slightly calcareous, gray-green; abundant siliceous concretions; weathers light green	.5
Limestone, clayey, soft, massive, tan-gray; contains abundant siliceous and calcareous geodes in lower half; weathers nearly white	12.0
Limestone, slightly clayey, thin-bedded, light-gray; varied in thickness; weathers tan	.3
Limestone, medium-hard, massive, gray; contains large siliceous geodes in basal part; weathers tan gray; fossiliferous	4.3
Limestone, hard, massive, gray; weathers light gray and has limonite stains; contains siliceous concretions 1–8 in. thick; bottom of concretion zone is about 8 in. from bottom of bed; concretions are gray to very dark gray, and weather red brown and to lighter weight; fossils abundant in concretions	2.3
Grant shale member:	
Shale, limy or clayey, light-gray; breaks out in angular blocks; upper foot grades into Cresswell; weathers tan gray	7.0
Total exposed thickness of the Grant shale and Cresswell limestone members (top eroded)	35.5
Base covered	

ODELL SHALE

The Odell shale overlies the Winfield limestone, both cropping out in the same parts of the county. Because the Odell shale is easily eroded, it forms concave stream valleys whose floors are in the Winfield limestone.

The subdued colors generally are visible through the soil mantling the Odell shale. Its color zones grade from green through buff, chocolate brown, and maroon to red; red is dominant near the top; greenish gray and buff near the bottom. The 20- 30-foot formation contains few fossils.

Representative measured section of the Odell shale in a quarry in the SE¼NW¼ sec. 15, T. 19 S., R. 4 E.

	Feet
Odell shale:	
Shale, clayey, calcareous, blocky to massive, gray-green; weathers tan gray	4.5
Shale, clayey, slightly calcareous, blocky to massive, dark-green; weathers gray green	1.8
Shale, clayey, slightly calcareous, blocky; chocolate-brown with thin (1 in. or less) beds of gray-green and mottled shales; weathers to rose	9.8
Shale, silty, noncalcareous, blocky with angular fragments, gray-green; weathers light green	2.7
Total thickness present	18.8
Winfield limestone.	

NOLANS LIMESTONE

The Nolans limestone consists of two limestone members separated by a shale member (pl. 4). The basal Krider limestone member overlies the Odell shale and is overlain by the Paddock shale member; the Herington limestone member is at the top. The main area of the outcrop, marked by broad flat hills capped by the Herington limestone member, is along U. S. Highway 77 north of Marion and extends irregularly east and west of this line for a distance of 4 or 5 miles (pl. 3). South of Marion and west of the Cottonwood River, the outcrop is intersected by Doyle Creek near Peabody before it swings eastward toward Burns where it is found as narrow erosional remnants on the highest hills.

The Krider limestone member consists of two thin beds of limestone, each about a foot thick, separated by a bed of shale which usually is also about a foot thick. The limestone is clayey, massive, soft, tan to gray, and fossiliferous.

The Paddock shale member is 2 to 12 feet thick, calcareous, clayey, and gray to tan. Fossils are abundant in some outcrops.

The Herington limestone member is somewhat dolomitic, buff to tan, and rather dense and massive. It separates into large blocks during weathering because the joints cutting it are widely spaced. Calcareous geodes and siliceous concretions are present, and some zones are fossiliferous.

The full thickness of the Nolans limestone in Marion County is at least 25 or 30 feet, but its high topographic position has facilitated weathering and erosion so its outcrops are only 10 to 15 feet thick in most places.

Representative section of the Nolans limestone in a road cut in the NW¼NE¼ sec. 26, T. 18 S., R. 4 E.

	Feet
Soil (0.1±foot).	
Nolans limestone:	
Herington limestone member:	
Limestone, clayey, soft, massive, light-gray; weathers rapidly and tan; calcareous geodes fairly abundant; fossiliferous	7.9
Shale, clayey, calcareous, thin-bedded, tan-gray; weathers tan	.1
Limestone, clayey, soft, tan-gray, large blocky pieces; weathers tan	.7
Paddock shale member:	
Shale, clayey, calcareous, blocky, gray; weathers tan gray; fossiliferous	2.0
(Note: This is the minimum observed thickness of this member; in the same area a maximum thickness of 9 ft was observed.)	
Krider limestone member:	
Limestone, clayey, soft, massive, tan-gray; weathers slightly darker gray; fossiliferous	1.3
Total thickness of the Nolans limestone present	11.8
Odell shale.	

SUMNER GROUP—WELLINGTON FORMATION

The Wellington formation is several hundred feet thick and crops out in about half the county (pls. 3 and 4). North of Marion, most of the outcrops are west of U. S. Highway 77; south of Marion, the formation caps hills near Aulne and Peabody; along the west boundary of the county the Wellington is covered by formations of Cretaceous and Pleistocene age.

Most of the outcrop area is a rolling land given variety by a few subdued terraces developed from beds of limestone. Outcrops are composed largely of shale, but some contain beds of limestone or gypsum. The Hutchinson salt member, which is near the middle of the formation, does not crop out because the salt dissolves rapidly when exposed to rainwash; however, it is present in the subsurface only a short distance west of Marion County and is mined there at Kanopolis, Hutchinson, and Lyons.

The Wellington is 700 feet thick; the lower 450 feet of it crops out in Marion County.

The following members and beds of the Wellington formation were identified in the field. This terminology follows closely that of Ver Wiebe (1937, p. 4, 5), and the rocks are in ascending stratigraphic order.

1. Pearl shale member: Predominantly a faint-hued varicolored clayey and calcareous shale; includes at least one thin bed of tan-gray crystalline dolomitic limestone; about 40 feet thick.

2. Hollenberg limestone member: Also known as the Hollenberg limestone bed; coarsely crystalline cellular tan-gray limestone of which some zones are dolomitic; 8 feet thick.

3. Geuda Springs shale member: A greenish-gray clayey shale which includes, in its middle part, a bed of hard gray anhydrite and a layer of thin-bedded soft light-buff limestone; about 200 feet thick. The Prairie Creek limestone bed, near the top of the Geuda Springs shale member, has been only tentatively identified; it is composed of two thin beds of chalky white limestone separated by a layer of greenish-gray shale; about 9 feet thick.

4. Annelly gypsum member: A series of dark-gray thin-bedded shale beds alternating with beds of white, pink, or gray gypsum; about 20 feet thick.

5. Chisholm Creek shale member: Thin-bedded soft varicolored clayey shale; about 40 feet thick.

6. Carlton limestone member: Interbedded thin layers of soft platy clayey gray to buff limestone and soft calcareous gray to tan-gray shale; zones containing fossil plants and insects (Elmo insect bed) are included in this member; about 70 feet thick.

7. Highland shale member: Thin-bedded clayey varicolored shale; about 40 feet thick.

8. Slate Creek shale member: Thin-bedded dark-gray clayey shale; about 10 feet thick.

9. Afton shale member: Thin-bedded to blocky red, green, and gray calcareous clayey shale; interbedded thin layers of gray-tan limestone; includes numerous calcareous concretions; about 30 feet thick.

Representative section of the Pearl shale member of the Wellington formation in a road cut in the SW¼SW¼ sec. 14, T. 20 S., R. 3 E.

	Feet
Wellington formation:	
Pearl shale member:	
Shale, calcareous, irregularly bedded, gray to buff	2.0
Limestone, dolomitic, cellular, tan-buff; badly weathered	1.4
Shale, calcareous (beds of thin lime), very thin bedded, gray-buff	8.0
Shale, clayey, green-gray	2.0
Shale, calcareous, thin-bedded; clayey and green-gray in basal 2 ft	10.0
Limestone, clayey, cellular, soft, platy; lower 1 ft shaly; buff tan	1.5
Shale, calcareous, blocky to thin-bedded, greenish-tan	2.0
Shale, clayey, green-gray, thin-bedded to blocky; lower 0.5 ft calcareous, with concretions	2.5
Shale, clayey, silty and calcareous, blocky; maroon and green zones	2.0
Shale, calcareous, platy, buff to tan	3.0
Limestone, crystalline, cellular, dark-tan	1.2
Shale, clayey and calcareous, thin-bedded to blocky; banded gray, buff, and green	3.0
Total thickness of Nolans limestone	38.6
Base covered	

Representative section of the Pearl shale and Hollenberg limestone members of the Wellington formation in the SE¼SE¼ sec. 34, T. 19 S., R. 3 E.

	Feet
Soil: dark-brown sandy loam (2.0 feet).	
Wellington formation:	
Hollenberg limestone member:	
Limestone, dolomitic, crystalline, unevenly bedded, gray; weathers tan	2.0
Pearl shale member:	
Shale, calcareous, thin-bedded, green-gray to buff, faintly varicolored; chalky zone 4 ft below top; many thin calcareous plates along bedding planes; irregular mudstone concretions	20.0±
Total exposed thickness of the Pearl shale and Hollenberg limestone members	22.0±

Representative section of the Geuda Springs shale member of the Wellington formation (probably including the Prairie Creek limestone bed) in a road cut in SE¼SE¼ sec. 36, T. 14 S., R. 2 E.

	Feet
Wellington formation:	
Geuda Springs shale member:	
Shale, calcareous, thin-bedded, platy, buff to gray	6.0
Prairie Creek(?) limestone bed:	
Limestone, platy, thin-bedded, buff to white, nonfossiliferous	2.0
Shale, calcareous, thin-bedded, buff-gray	5.0
Limestone, platy to blocky, buff to white; limonite stains on surface	2.0
Shale, calcareous, platy, gray-buff	1.0
Total thickness exposed	16.0

Representative section of the Annelly gypsum member of the Wellington formation in creek bank in the NW¼NW¼ sec. 19, T. 20 S., R. 2 E.

	Feet
Soil, sandy and gravelly, gray (2 feet).	
Pleistocene or Pliocene:	
Conglomerate, coarse, poorly sorted, crudely stratified; pebbles mostly limestone, a few siliceous, and a maximum of 2 in. in diameter; siliceous sand; mass cemented with calcite (3 feet).	
Wellington formation:	
Annelly gypsum member:	
Shale; upper part massive, silty, light gray; lower part thin bedded, clayey, dark gray	10
Gypsum beds, massive to jumbled, coarse, crystalline, dark gray; scattered lenses of finer grained pink gypsum; shaly partings, dark gray, about an inch thick	12
Total exposed thickness of the Annelly gypsum member	22

Representative section of the Chisholm Creek member of the Wellington formation in a gully in the SW¼SW¼ sec. 4, T. 17 S., R. 2 E.

	Feet
Wellington formation:	
Carlton limestone member	20
Chisholm Creek shale member:	
Shale, clayey, blocky, light-green and maroon	3
Shale, clayey, red	2
Shale, clayey, light-green	6
Total exposed thickness of the Chisholm Creek shale member	11
Base covered	

Representative section of the Carlton limestone member of the Wellington formation in a road cut in the SW¼SW¼ sec. 24, T. 20 S., R. 1 E.

	Feet
Wellington formation:	
Carlton limestone member:	
Shale, very calcareous, gray, thin-bedded to platy; weathers buff; thin limestone partings	10. 0
Limestone, thin-bedded, fine-textured, light-gray	3. 0
Shale, calcareous, thin-bedded, buff to gray; thin limestone in middle part	6. 0
Limestone, thin-bedded, buff to white; thin partings of shale	2. 5
Shale, calcareous, thin-bedded, gray-buff; thin limestone beds in middle part	6. 0
Limestone, flaggy, buff to light-gray; uneven nodular surface and thin, curved laminations	. 5
Shale, thin-bedded, dark-gray; some very calcareous beds	10. 0
Limestone, flaggy to thin-bedded; with concentric laminations	. 4
Shale, thin-bedded, dark-gray	1. 5
Limestone, thin-bedded, buff to gray	1. 0
Total exposed thickness of the Carlton limestone member	40. 9
Base covered	

Representative section of the Carlton limestone and Highland shale members of the Wellington formation in a streambank in the SE¼SE¼ sec. 8, T. 17 S., R. 2 E.

	Feet
Wellington formation:	
Highland shale member:	
Shale; silty in zones; thin bedded, crumbly; varicolored bands of gray-green, gray, maroon	10.0
Carlton limestone member:	
Limestone, platy, gray to tan	1.5
Shale, clayey, very thin bedded, gray-green	1.5
Limestone, platy, tan	.5
Shale, clayey, thin-bedded, dark-gray to black	2.0
Limestone, shaly, platy, gray	1.5
Shale, clayey, thin-bedded; banded dark gray and black	12.0
Shale, clayey and calcareous; banded dark gray and light gray	3.0
Limestone, clayey, platy, gray-buff; brecciated and recemented at outcrop	1.0
Shale, clayey, platy, dark-gray	3.0
Shale, very calcareous, gray	.5
Shale, clayey, platy, dark-gray	2.0
Limestone, lenticular, gray	.2
Shale, calcareous, light-gray	2.0
Limestone, gray	.5
Shale, calcareous, light-gray	3.0
Total exposed thickness of the Carlton limestone and Highland shale members	44.2
Base covered	

Representative section of the Slate Creek and Afton shale members of the Wellington formation in the NW¼NE¼ sec. 33, T. 19 S., R. 1 E.

	Feet
Wellington formation:	
Afton shale member:	
Shale, thin-bedded to blocky; includes calcareous zones containing biscuit-shaped concretions; red toward top; the rest is gray buff	20.0
Shale, calcareous, gypsiferous, thin-bedded, buff, concretionary	.5
Shale, thin-bedded to blocky; calcareous zones; gray with a few thin red beds	12.0
Shale, thin-bedded to blocky, gray and maroon; with calcareous zones	7.0
Slate Creek shale member:	
Shale, clayey, gray; with calcareous seam in middle part; upper half blocky, lower half very thin bedded	4.0
Shale, clayey, with blocky calcareous zones 2 in. thick; mostly very thin bedded; gray	1.8
Shale, clayey, thin-bedded, dark-gray, fairly hard	10.0
Shale, silty, massive, red	2.0
Total exposed thickness of the Slate Creek and Afton shale members	57.3
Base covered	

CRETACEOUS SYSTEM

Rocks of Early Cretaceous age crop out in all the western part of the county (pl. 4), but exposures are most extensive in the area west and northwest of Hillsboro (pl. 3). In the Cretaceous of Marion County, the Kiowa shale is the older formation and the Dakota sandstone is the younger.

KIOWA SHALE

The Kiowa shale is exposed principally in townships 17, 18, and 19 S., R. 1 E. (pls. 3 and 4), but there are isolated outcrops south and east of these three townships which are in the northwestern part of the county. Erosion of the Kiowa shale has exposed the underlying Wellington formation in some places, such as in the walls of the Cottonwood River valley west of Durham.

The Kiowa shale, largely a marine deposit, underlies the Dakota sandstone and overlies the Wellington formation. As mapped on plate 3, the Kiowa shale includes only predominantly fine-grained and well-stratified material. Weathering of the thick clay shales forms landslide or slump topography.

The basal part of the Kiowa shale is a moderately soft fine-grained well-bedded light-buff nonfossiliferous sandstone that grades upward into a fine, white or gray, poorly cemented silt, 15 feet thick. Together the sandstone and silt are 20–25 feet thick, but they are not present throughout the area. Carbonized plant remains are in the light-colored silts. Clay shale beds, totaling 20–80 feet thick and generally black or dark colored and thin bedded, make up most of the Kiowa shale which has a maximum thickness in Marion County of 130 feet.

Thin beds of bentonite and of iron-cemented sandstone are in the formation; some of the weathered outcrops of shale are covered in places with crystals of gypsum (the variety known as selenite) as much as 6 inches in length.

Typical exposures of the dark, clayey, shale beds occur throughout the outcrop area, but the thickest are in secs. 1–6 in T. 17 S., R 1 E. An outcrop along the road between secs. 2 and 3, T. 17 S., R 1 E., is easily accessible. An outcrop at the west side of sec. 7, T. 17 S., R. 1 E., also easily accessible, shows the effects of landslide and slump.

Representative section of the Kiowa shale in the SE¼SE¼ sec. 2, T. 17 S., R. 1 E.

	Feet
Dakota sandstone	30.0
Kiowa shale:	
Shale, silty, gray; with yellow streaks	3.0
Shale, sandy, massive, buff	2.0
Sandstone, fine-grained quartz, brown	1.3
Shale, silty, massive, gray	2.0
Shale, sandy, buff; interbedded with gray silt and brown sandstone, with repetition of sequence about every 1.5 ft	20.0
Shale, clayey, blocky, greenish-gray	6.7
Sandstone, massive to concretionary, crossbedded in part; cemented by iron oxide; lenticular; strongly resistant to weathering	2.5
Shale, sandy, silty, laminated, light-brown and gray; interbedded with thin layers of fine, well-sorted, micaceous, brown sandstone containing plant fossils	5.0
Shale, clayey, thin-bedded; dark gray near top, grading to light greenish gray. Many thin zones of iron oxide concretions with a 2-foot bed of brown iron oxide in middle of zone; gypsum	20.0
Shale, clayey, thin-bedded, dark blue-gray; subject to slumping; yellow and brown iron oxide; thickness variable; contains clay	.4
Shale, clayey, thin-bedded, dark blue-gray to black. A few thin, sandy zones; some gypsum crystals at surface. Subject to slumping	30.0
Total exposed thickness of the Kiowa shale	92.9
Base covered.	

DAKOTA SANDSTONE

The high hills near the northwestern corner of Marion County were formed from the Dakota sandstone which crops out most prominently in T. 17 S., R. 1 E., and in the western part of T. 17 S., R. 2 E. There are less conspicuous exposures in T. 18 S., R. 1 E., and in T. 19 S., R. 1 E.

The Dakota sandstone as mapped on plate 3 may be a part of the Kiowa shale, but on the basis of topographic position and because of different uses which would be made of the rock in engineering construction, the upper beds of standstone are here designated as the Dakota sandstone.

Beds of fine- to medium-grained massive brown to red sandstone make up the conspicuous part of its outcrop. Nearly as much soft clayey shale is present in the formation, but in most places it is partly covered by blocks slumped from an overlying ledge of sandstone.

The massive to well-bedded sandstone shows crossbedding in some zones. Where it is firmly cemented with silica and iron oxide it is very resistant to weathering and erosion, but most beds are cemented with varying amounts of calcium carbonate; their outcrops are not prominent. Exposures of this formation may be distinguished from those of the underlying, soft Kiowa shale by the lack of slumping and landsliding; the different kind of vegetation above the Dakota sandstone reflects a subsurface drainage superior to that of the Kiowa shale. The total thickness of rocks mapped as Dakota sandstone is about 45 feet.

Representative section of the Dakota sandstone in the SE¼SE¼ sec. 2, T. 17 S., R. 1 E.

	Feet
Dakota sandstone:	
Shale, sandy and clayey; includes thin beds of brown sandstone; gray, mottled with buff and red	5.0
Clay, bentonitic, gray-white	.6
Clay, bentonitic, tan to gray	1.0
Shale, clayey, dark-gray to black	8.0
Shale, silty to clayey, greenish-gray; thin seams of brown micaceous sand	1.4
Sandstone, massive, medium-grained and well-sorted; upper 3 ft maroon to reddish, lower 5 ft gray green to buff; contains thin partings of blue clay	8.0
Sandstone, well-bedded, medium-grained and well-sorted, buff to reddish; partings of blue-gray shale	6.0
Total thickness present	30.0
Kiowa shale.	

QUATERNARY SYSTEM

Rocks of Quaternary age crop out in every township in Marion County (pls. 3 and 4). Those in the western part of the county, near the McPherson County line, are the oldest deposits of this age. They are water-deposited gravel, sand, silt, and clay and were, until recently, called the McPherson formation. Because that name has been abandoned by the Kansas Geological Survey (Moore and others, 1951), the rocks are included in the Sanborn formation in this report. Also mapped on plate 3 as Sanborn formation are the wind, slope wash, and gravity deposits. Terrace deposits formed when the streams were at higher levels than at present are mapped along the major drainage lines. Present deposits of streams are designated alluvium but most are too small to be mapped.

SANBORN FORMATION

The thickest deposits of the most widely distributed formation in Marion County, the Sanborn formation of Pleistocene and Recent(?) age, are in the southwestern part of the county and there mask nearly all of the older, underlying formations (pls. 3 and 4). In other parts of the county the formation is exposed principally in the areas between streams.

Frye and Fent (1947) divided the Sanborn formation into members which the writers did not map separately because the purpose of this survey did not warrant the field work, including test drilling, that would have been required. Reference to the Sanborn formation as an undivided unit seems adequate for the purpose of this inventory of construction materials.

The oldest material mapped as Sanborn formation is a high-level deposit of sand, gravel, silt, and clay about 20 feet thick that is now restricted to the western edge of the county but which at one time extended over at least half the county. The coarser material was deposited by streams; some of the finer sand and silt was deposited by the wind. No extensive deposits of gravel were noted, but scattered pebbles remain in extensive areas where erosion has removed the finer material.

Reworked and wind-deposited silt is also mapped as Sanborn formation on plate 3. This material is principally in the interstream areas and along the valleys of the larger streams. These widely distributed deposits average 4 or 5 feet in thickness, but may be as much as 15 feet thick. This wind-deposited silt merges near the base of the hills with deposits of slope wash and gravity-moved material. Three representative sections are described.

The maximum thickness of the formation is about 20 feet.

Representative section of the Sanborn formation measured by augering in the NW¼NW¼ sec. 11, T. 22 S., R. 4 E.

	Feet
Soil, silty clay loam, dark-brown (1 foot).	
Sanborn formation:	
Clay, dark chocolate-brown	2.0
Clay, silty, dark chocolate-brown	2.0
Silt, clayey, light chocolate-brown	.8
Total thickness present	4.8
Limestone of Permian age.	

Representative section of the Sanborn formation obtained by augering in the SW¼NE¼ sec. 30, T. 21 S., R. 4 E.

	Feet
Sanborn formation:	
Silt, red-brown	9.0
Sand, fine, light red-brown	1.5
Total thickness present	10.5
Limestone of Permian age.	

Representative section of the Sanborn formation visible in a creek bank in the NW¼NW¼ sec. 19, T. 20 S., R. 2 E.

	Feet
Soil, sandy and gravelly, gray (2 feet).	
Sanborn formation:	
Conglomerate, coarse, poorly sorted, poorly stratified; pebbles predominantly light-colored, mostly limestone, but a few quartz; sand coarse and mostly siliceous; cement calcareous, porous, fairly hard, tan to buff	3.0
Wellington formation.	

TERRACE DEPOSITS

There are terrace deposits in the valleys of all the major streams in the county. Smaller tributary streams commonly flow in terraced valleys, but in most of them the distribution of terrace deposits is very irregular. The width of the terrace deposits is most uniform in the valley of the Cottonwood River where it ranges from 0.25 mile (west of Durham) to 1 mile (east of Florence).

The terrace deposits are composed mostly of silt, but also include some intermixed clay and lenses of sand and gravel. The silt is dark gray to brown, but an appreciably darker "A" soil horizon 1 foot thick has developed at the top. Lenses of sand at different depths in the terrace deposits of the Cottonwood River valley, south of Marion, lie beneath the water table and have not been tested as a source of fine aggregate.

The highest terrace along the Cottonwood River is about 30 feet above the normal river level. Recent floods have deposited silt on some of the lower levels mapped as terrace deposits on plate 3.

Terrace deposits were not measured, but cut banks reveal uniformly stratified beds of dark silt containing lenses of sand. Drillers' logs of water wells indicate a maximum thickness of 50 or 60 feet.

ALLUVIUM

The deposits formed by streams in their present erosion cycles are designated alluvium and constitute the youngest stratigraphic unit in the county. In this report alluvium is defined as the material which underlies the present flood plain of a stream, and the flood plain is defined as the area adjacent to the stream channel that is covered by water at normal flood stage. Only a small amount of alluvium has been mapped on plate 3 because most of the deposits are too small to be shown.

Alluvial deposits of the Cottonwood River are predominantly silt and fine sand, but include some lenses of coarse sand and gravel. The sand is composed principally of grains of quartz and feldspar, but the gravel includes particles of chert and limestone derived from locally outcropping rocks. The alluvium is generally dark gray or dark brown, but in the valleys of the smaller streams, especially in the western half of the county, the sand is light tan to light orange. These deposits are too limited in area to be shown on plate 3, but some local use has been made of them.

The alluvium, which has a maximum thickness of about 20 feet, could not be measured in representative section because of its low topographic position.

INVENTORY OF CONSTRUCTION MATERIALS

The objectives of this inventory of construction materials in Marion County are to define the construction materials as they are classified in this report and to relate the materials to the map units in which they occur.

Whenever available, laboratory test data have been introduced into the report to aid the reader in the evaluation of materials. The information given in table 1 is based on standard testing procedures of the State Highway Commission of Kansas (1945, Gradation factor, p. 16; Sieve analysis, p. 333–334; Soundness, p. 335–336). This information is based also on the procedures of the American Association of State Highway Officials (1947, Absorption, p. 251–252; Compressive strength, p. 257–258; Deval abrasion, p. 235–236; Liquid limit, p. 198–201; Los Angeles abrasion, p. 237–239; Plasticity index, p. 202–204; Specific gravity, p. 249–250; Toughness, p. 240–241; Weight per cubic foot, p. 253–254).

It is expected that prospects listed in this report will be proven by augering, drilling, or test pitting, and that the materials will be subjected to laboratory testing for specific uses before production.

No attempt was made to complete an exhaustive survey of all possible sources of materials, but every effort was made to correlate the available construction materials with the geologic formations mapped on plate 3.

AGGREGATE FOR CONCRETE

ENGINEERING AND GEOLOGIC CHARACTERISTICS

Aggregate for concrete is classified in this report as fine aggregate and mixed aggregate. At this writing, no satisfactory fine aggregate has been produced in the county although a siliceous sand in the Sanborn formation outcrop area southwest of Hillsboro might prove suitable. The material is listed in table 1 as fine aggregate even though the sample tested contained a considerable amount of clay and soft shale. Mixed aggregate consists of sand and hard, durable pebbles or stone pieces free from adherent coatings. The natural gravel in the county has not been utilized for this purpose, but a number of limestone beds in the eastern half of the county have yielded rock that, after crushing, is suitable for use as the coarse fraction in aggregate for concrete. Most of the sand used locally in mixed aggregate is shipped from Wichita, Kans.

Because only the material used as the coarse fraction is being produced locally, materials of the other fractions are not considered in this report. The materials in all classifications are exposed at the surface or have a soft or unconsolidated overburden sufficiently thin to permit economic development. Most of the deposits overlain by thick or consolidated beds, or that are relatively inaccessible, are not listed in this inventory because the cost of removal or transportation is considered prohibitive.

Plate 3 shows that the sampled localities for individual limestone units are relatively few. Although the samples can be taken as an indication of the general character of the same bed at other localities, further tests should be made before opening new quarries and pits.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

Actual or potential sources of the coarse fraction of aggregate for concrete are:

1. Nolans limestone. Much of the Herington limestone member is too soft for use in aggregate for concrete. (See ls 1, ls 2, ls 3, ls 4, ls 6, and ls 7 in table 1.) If the limestone is to be used for this purpose, testing of each ledge may be necessary before the rock is quarried.
2. Winfield limestone. The Cresswell limestone member is the most exploited source of crushed rock in Marion County. The Riddle quarries in secs. 6 and 7, T. 20 S., R. 4 E. produce from this member which has a few ledges that supply durable stone for concrete aggregate. (See ls 11 in table 1.) Other tested localities are ls 5, ls 8, ls 10, ls 12, and ls 22. The test data given in table 1 for these samples show that the rock is variable in quality.
3. Doyle shale. The Towanda limestone member in some outcrops appears to be hard and durable. It is a possible source of coarse aggregate for concrete, and test data for it are shown in table 1 under ls 13, ls 20, and ls 21.
4. Barneston limestone. The Fort Riley and Florence limestone members are potential sources of coarse aggregate for concrete. Because of their great thickness these limestone units can supply large quantities of crushed-stone aggregate. Data for localities tested (ls 14, ls 15, ls 16, ls 17, ls 18, and ls 19), appear in table 1.

ROAD METAL

ENGINEERING AND GEOLOGIC CHARACTERISTICS

Road metal, known also as surfacing material, base-course material, crushed stone, and aggregate, is material that may be applied to a road to improve the performance characteristics of that road and to insure an all-weather surface. Many geologic materials fulfill this requirement, and the list of such materials differs from one area to another. Materials available in Marion County for use as road metal are:

1. Fine aggregate (fa 1, table 1).
2. Indurated rocks: limestone—a compact massive layer of calcareous material, fairly hard; and flinty limestone—limestone that

contains a considerable amount of gray, nodular, siliceous material.

Limestone and flinty limestone are not distinguished in the classification in table 1 because they may be used also as structural stone and riprap.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

Sandy material is found in the Sanborn formation in several areas in the western half of Marion County, generally in the uplands. Material tested thus far has not been suitable for use in concrete because of its fairly large content of fine or soft material. However, the material is suitable for certain uses in road construction: sand similar to sample fa 1 can be used in aggregate for bituminous surface course, bituminous concrete, binder base course, and asphalt base course. Field observation indicates that even though the sand deposits may underlie rather extensive areas in the western tier of townships, their thickness generally does not exceed 6 feet under a soil less than 3 feet thick.

Sources of indurated rock are:

1. Florence limestone member of the Barneston limestone. The Florence is a very siliceous limestone and contains some beds that are more than 50 percent flint. It has been quarried extensively near Florence: east of Florence a large quantity is available under approximately 2 feet of overburden. (See pl. 3.) Outcrops tested are ls 15 and ls 17. The material is suitable for use in bituminous surface course, for cover material, aggregates for surfacing or resurfacing, and for keyed-type crushed stone base course.

2. The Fort Riley limestone member of the Barneston limestone. This limestone is exposed at the surface or has less than 6 feet of overburden throughout an area of several square miles in eastern Marion County. The rock changes considerably in character throughout its 40 feet of thickness. Tested samples, ls 14, ls 16, ls 18, and ls 19 (data in table 1), indicate that the limestone is satisfactory for use in road construction.

3. Doyle shale. The Towanda limestone member is a local source of road metal (ls 13, ls 20, and ls 21 in table 1). The material has been found satisfactory for use as aggregate for bituminous surface course and for keyed-type crushed stone base course.

4. Winfield limestone. Limestone from the Cresswell limestone member has been widely used for crushed rock in Marion County. It has been found suitable as aggregate for bituminous surface course, bituminous concrete and sheet asphalt surface course, cover material,

bituminous retread-surface and bituminous drag treatment, surfacing and resurfacing, and stone for keyed-type crushed-stone base course. (See ls 5, ls 8, ls 10, ls 11, ls 12, and ls 22 on pl. 3 and in table 1.)

5. Nolans limestone. The Herington limestone member crops out in a large part of northeastern Marion County. The properties of the stone differ from one outcrop to the next (ls 1, ls 2, ls 3, ls 4, ls 6, and ls 7 in table 1) but all are acceptable for use as road metal.

6. Wellington formation. The Carlton limestone member (of Ver Wiebe, 1937) is the only abundant limestone in the western half of the county. It has been used locally as crushed rock, but the only sample reported here, ls 9, was found unsuitable for that use.

7. Dakota sandstone. Dakota sandstone is widely used as road metal in central and north-central Kansas. It was not tested in the laboratory.

MINERAL FILLER

ENGINEERING AND GEOLOGIC CHARACTERISTICS

Material composed predominantly of silt-size particles (50 percent or more of the material passing the No. 200 sieve) is classified as mineral filler. It has no more than a trace of sticks or other organic impurities, but may contain minor amounts of fine sand or clay. W. E. Gibson of the Road Materials Laboratory of the State Highway Commission of Kansas states (oral communication) that material will qualify for mineral filler only if laboratory tests indicate a low coefficient of cementation.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

Samples of mineral filler were not obtained in Marion County, but suitable silty material appears to be in sufficient quantity in the Sanborn formation in the southwestern quarter of the county, and the terrace deposits may also be a source of material acceptable as mineral filler.

RIPRAP

ENGINEERING AND GEOLOGIC CHARACTERISTICS

Riprap, as defined in this report, is any material suitable for protecting earthen fills from erosion. To be acceptable for this use the material must have a specific gravity of 2.0 or higher and be sound and free from cracks and other structural defects or impurities that would cause it to disintegrate through erosion, slaking, or freezing and thawing. The material should be in blocks having approximately rectangular faces 7 inches or more in width.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

Both the Florence and Fort Riley limestone members of the Barneston limestone are suitable for use as riprap if the rock is produced from sound ledges. Tested samples are ls 14, ls 15, ls 16, ls 17, ls 18, and ls 19. Very porous cherty beds in the Florence limestone member should be avoided because of their rapid disintegration in freezing and thawing weather.

Some of the limestone from the Towanda limestone member of the Doyle shale is suitable for use as riprap although much of the stone breaks into thin plates during weathering. Samples tested are ls 13, ls 20, and ls 21.

The Cresswell limestone member of the Winfield limestone is a source of rock suitable for use as riprap and, apparently, so is the Stovall limestone member of the Winfield. These beds may be observed in the spillway and dam at Marion County lake. Tested samples of the Cresswell are ls 5, ls 8, ls 10, ls 11, ls 12, and ls 22.

The Herington limestone member of the Nolans limestone is extensive in outcrop where it is obtainable in pieces of suitable size and shape for use as riprap. Tested localities are ls 1, ls 2, ls 3, ls 4, ls 6, and ls 7.

STRUCTURAL STONE

ENGINEERING AND GEOLOGIC CHARACTERISTICS

Structural stone, as defined in this report, is any hard dense rock material that can be quarried and cut to the desired size and shape. Materials fulfilling the requirements are in the Permian limestones in the eastern half of Marion County.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

Individual ledges within both the Florence and Fort Riley limestone members of the Barneston limestone are suitable for use as building stone (ls 14, ls 15, ls 16, ls 17, ls 18, and ls 19). The rimrock beds of the Fort Riley are quarried extensively for dimension stone.

Rock from the Towanda limestone member of the Doyle shale is suitable for use as structural stone, but, except for the basal massive zone, most of the rock has a tendency to split into thin plates. (See ls 13, ls 20, and ls 21 on pl. 3 and in table 1.)

The Cresswell limestone member of the Winfield limestone is quarried locally for use as structural stone (ls 5, ls 8, ls 10, ls 11, ls 12, and ls 22). Buildings in Marion that were constructed of the material 50 years ago show little deterioration.

The Herington limestone member of the Nolans limestone has been quarried locally for use in the construction of houses and farm buildings. The stone is easily shaped into building blocks because of the spacing of joints and the well-defined bedding plane separations at about 1 foot intervals. Tested samples are ls 1, ls 2, ls 3, ls 4, ls 6, and ls 7.

SUBGRADE AND EMBANKMENT MATERIAL

ENGINEERING AND GEOLOGIC CHARACTERISTICS

The definition of subgrade and embankment materials, designated "fill material" in plate 4, is adapted from the specifications compiled for the American Association of State Highway Officials (1947). Geologic materials suitable for this kind of construction are: fine-granular unconsolidated sediments, including soil, of which 50 percent or more pass through a No. 22 sieve; coarse-granular unconsolidated sediments and broken or crushed consolidated rocks, of which at least 65 percent by weight is retained on a No. 200 sieve; broken or crushed rock.

STRATIGRAPHIC SOURCES AND PERFORMANCE CHARACTERISTICS

All materials listed in the definition are available in Marion County for the construction of subgrades and embankments; they may be the product of excavation along the alinement of the structure or they can be obtained from adjacent areas.

Fine-granular sediments of the Sanborn formation and the terrace deposits contain large quantities of silt or clayey silt. The extensive outcrops of these formations mapped on plate 3 indicate that the material is available in most of the county.

A small quantity of sand is available for use in the construction of subgrades and embankments. The two sources of this coarse-granular sediment readily accessible are the Sanborn formation, in the southwestern part of the county, and the alluvium of the Cottonwood River.

Formations of both Permian and Cretaceous ages are actual or potential sources of broken or crushed rock for subgrade and embankment material. Each one of the limestones of Permian age listed in plate 4 and mapped on plate 3 is a source of broken or crushed rock for this use. In most places the Permian shales are silty and have an adequate bearing strength for use in the construction of subgrades or embankments. The high content of clay in the shales of the Wellington formation might be a limiting factor in the use of the shales.

Dakota sandstone of Cretaceous age appears to be entirely acceptable as a source of crushed rock for subgrade or embankment construction.

The bentonite and clay in the Kiowa shale make its use undesirable in the construction of subgrades or embankments.

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