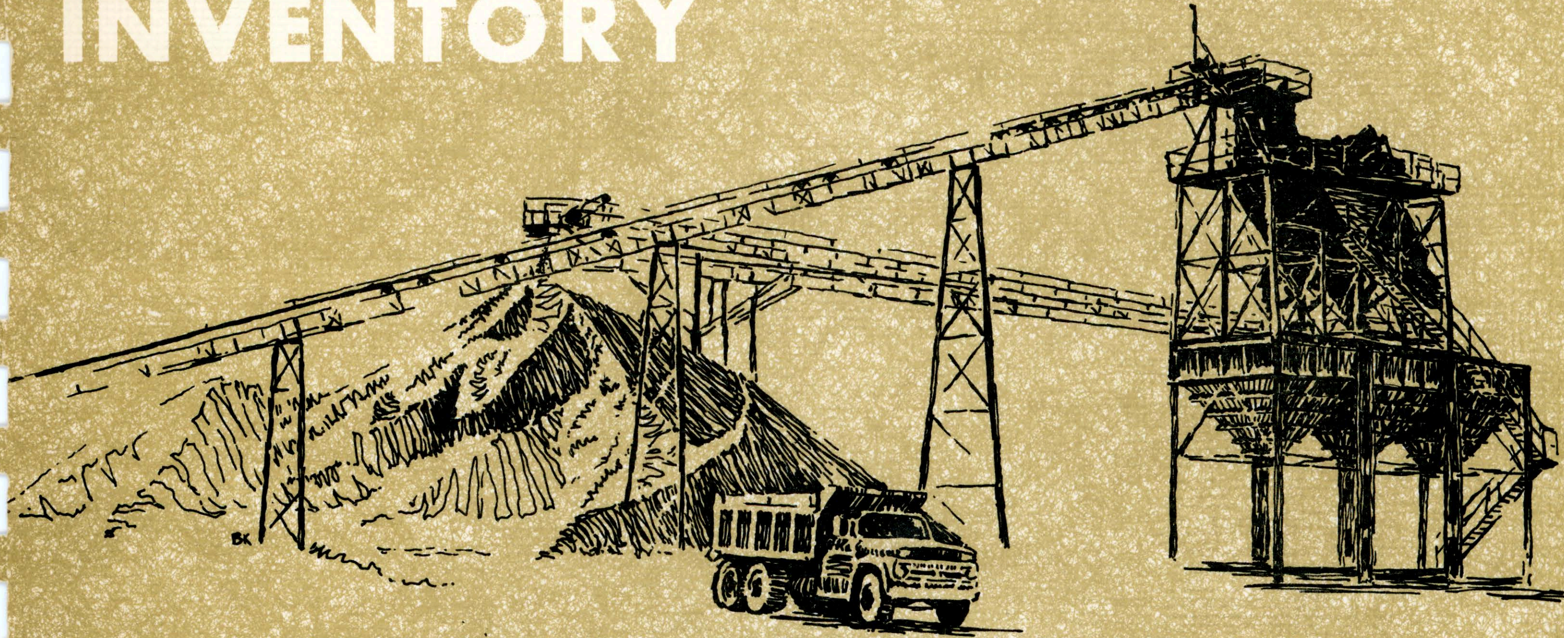
REPORT NO. 27

CONSTRUCTION MATERIALS INVENTORY



MIAMI COUNTY, KANSAS

STATE HIGHWAY COMMISSION OF KANSAS

State Highway Commission of Kansas
Location and Design Concepts Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY
OF
MIAMI COUNTY, KANSAS

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Prepared in Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

1975

Construction Materials Inventory Report No. 27

Copies are available from the Planning & Development Department
State Highway Commission

the **WHY?**

WHAT?

and **HOW?**

of This REPORT

This report was compiled for use as a guide for locating construction material in Miami County.

> ***Construction materials include all granular material, consolidated rock, and mineral filler suitable for use in highway construction.***

Known open and prospective sites, both sampled and unsampled, and all geologic deposits considered to be a source of construction material are described and mapped.

> ***Prospective sites are select geologic locations where construction materials may be found.***

The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to evaluate and locate ***mapped sites.***

The individually mapped sites certainly do not constitute the total construction materials resources of the county. And, the data outlined in the diagram may be used for purposes other than the evaluation and location of these sites.

Beginning on page 5 is a section explaining the geology of the county. This information (along with the maps, descriptions, and test data) provides the means of evaluating and locating additional construction materials sources in the geologic units throughout Miami County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN MIAMI COUNTY

TURN TO THE MATERIALS INVENTORY SECTION
See
TABULATION OF CONSTRUCTION MATERIALS
Figure 7 Page 15

for material
BY TYPE
USE COLUMN 1

For Quality Data
See Figure 17
Page 25

for material
BY INTENDED USE
USE COLUMN 2

for **DESCRIPTION** of material

Column 3 gives page of DESCRIPTION which includes engineering characteristics, approximate locations, and references to materials map.

for **AVAILABILITY** of material

Column 4 gives relative amounts available, general location, and references to materials map.

MATERIALS MAP
SEE PINK SHEET, PAGE 27

Material source units, as well as all open sites, are mapped. Each site is referenced to an individual data form.

SITE DATA FORMS

OPEN SITES; SAMPLED	GREEN SHEET, PAGE 30
OPEN SITES; NOT SAMPLED	GREEN SHEET, PAGE 44
PROSPECTIVE SITES; SAMPLED	GREEN SHEET, PAGE 58

Each site data form includes a map for site location and provides information concerning landownership, material quality (if available), geologic age, and site accessibility.

CONTENTS

PREFACE

This report is one of a series compiled for the Highway Planning and Research Program, 'Materials Inventory by Photo Interpretation'. The program is a cooperative effort of the Federal Highway Administration and the State Highway Commission of Kansas, financed by highway planning and research funds. The objective of the project is to ***provide a statewide inventory of construction materials***, on a county basis, to help meet the demands of present and future construction and maintenance needs.

Several publications issued by the State Geological Survey of Kansas, concerning Miami and surrounding counties, provided the basic geologic information used in this investigation. Detailed geologic and soil data were obtained from soil surveys and centerline geologic profiles prepared for design of major highways in the county by the State Highway Commission.

Appreciation is extended to Mr. James L. Farrell, Fourth Division Materials Engineer, Mr. Carl F. Crumpton, Assistant Engineer of Planning and Development - Research, and Mr. Roger Johnson, U.S. Army Corps of Engineers, Kansas City, Missouri, for verbal information concerning construction materials discussed in this report.

This report was prepared under the guidance of the project leader, R. R. Biege, Jr., P.E., Engineer of Location and Design Concepts, and A. H. Stallard, Chief, Remote Sensing Section, Location and Design Concepts Department.

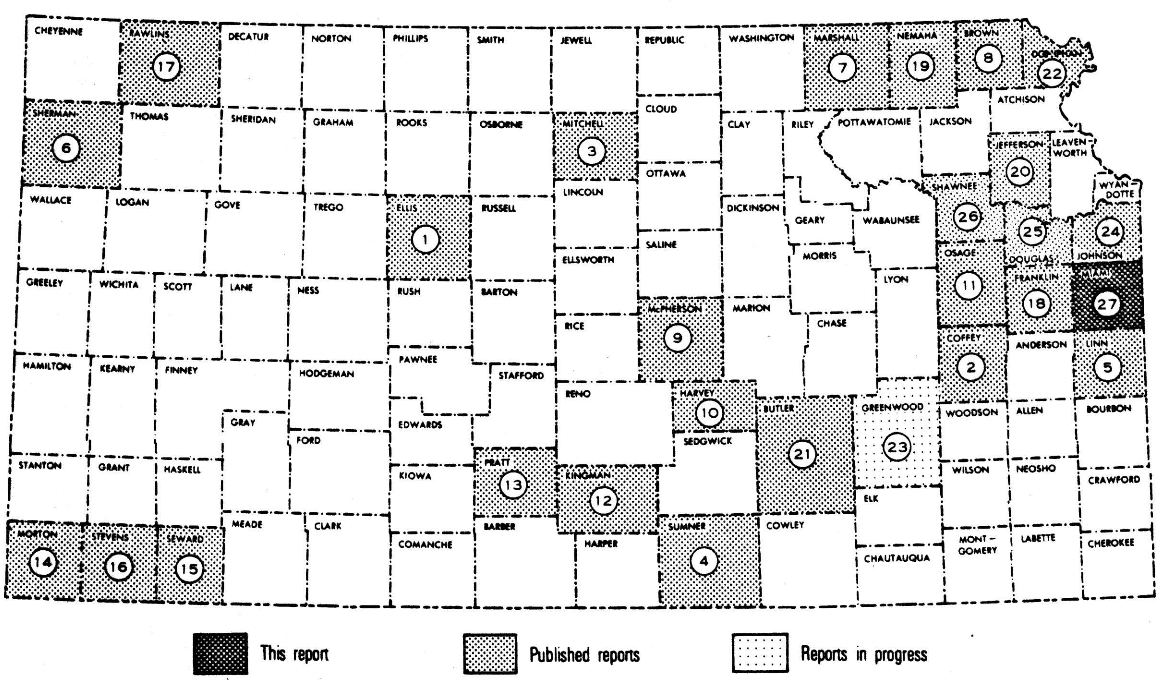


Figure 1. Index map of Kansas showing the location of Miami County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Miami County lies within the Osage Plains section of the Central Lowlands physiographic province. Major topographic features include gently sloping upland-plains and steep valley walls formed by the erosion of thick limestones and shales along major drainage channels.

The Marais des Cygnes River and its tributaries drain most of the county; however, the northeast corner is drained by small streams flowing northeastwardly into the Missouri River.

Sources of construction material in Miami County are limited to the thicker limestone units of Pennsylvanian age. Limestones of the Kansas City and Lansing Groups of Pennsylvanian age are the most abundant and important materials source units in Miami County. The quality and thickness of each unit vary within the county and quality tests should be completed before production is started at a new location.

Scattered pre-Kansan chert gravel deposits veneer higher elements of topography in the southwestern corner of the county but are too thin to be of economic value as construction aggregate. Production of sand and gravel from the channel or alluvial plain of the Marais des Cygnes River or its tributaries has been very limited. In 1955, 8,638 short tons of sand and gravel were produced (K.G.S. Bull. 181). These deposits were composed of quartz and chert, but include large percentages of silt and clay.

Water supplies are available in moderate quantities from Recent alluvium and terrace deposits in the Marais des Cygnes River valley; however, it is characterized by a high calcium bicarbonate and iron content. A very limited supply of water of similar quality can be produced from the alluvium of the tributaries of the Marais des Cygnes River. Water from consolidated rock aquifers yield minimal quantities and is generally satisfactory for domestic use; however, the water is excessively hard and contains a high iron content.

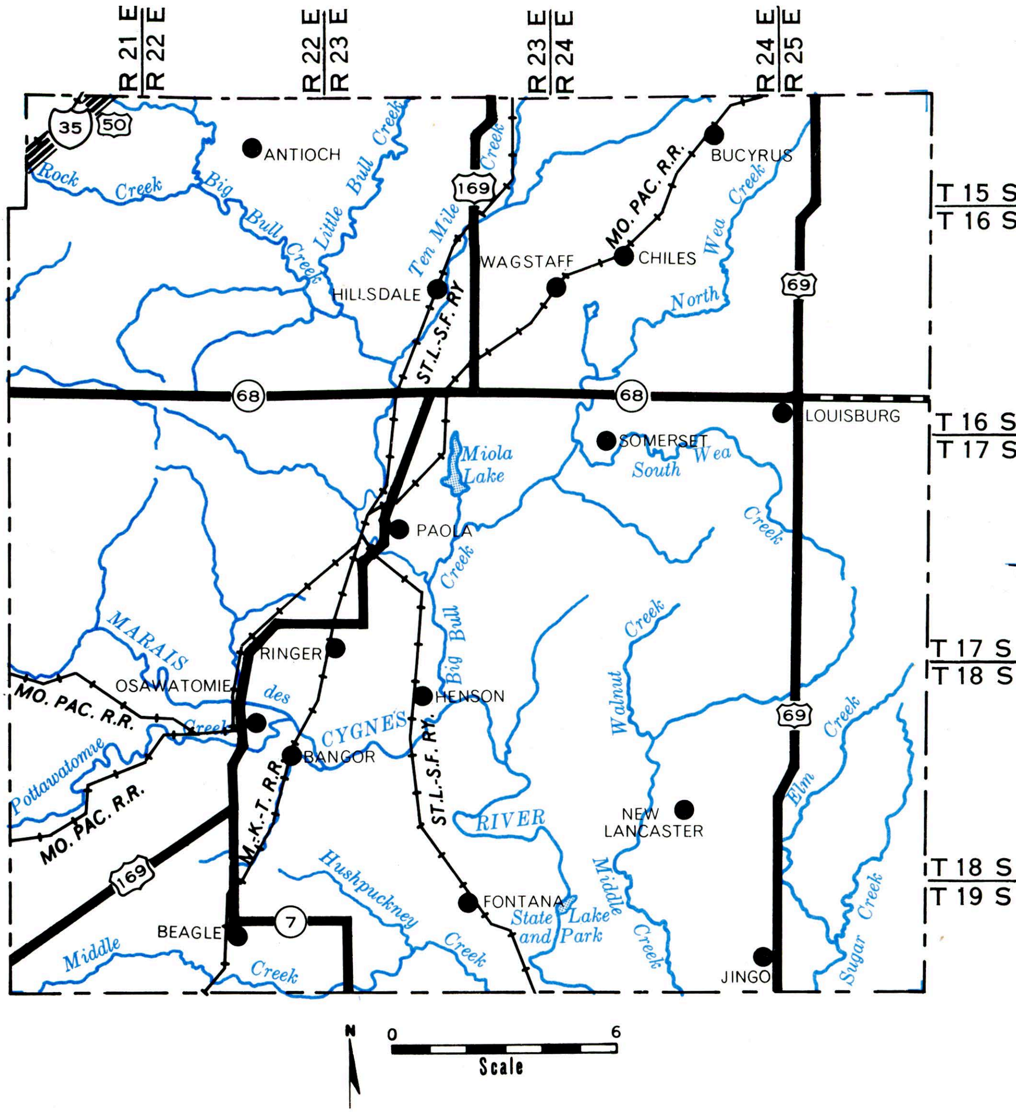


Figure 2. Drainage and major transportation facilities in Miami County.

FACTS ABOUT MIAMI COUNTY

Miami County is located on the Missouri border in east central Kansas (figure 1, page v), has an area of 592 square miles, and a population of 20,750, according to the 1973 records of the Kansas State Board of Agriculture. The highest terrain in the county is found approximately two miles southeast of Louisburg where the elevation is 1,150 feet above mean sea level. The lowest point is 970 feet above mean sea level where the Marais des Cygnes River leaves the south edge of the county.

A primary road system connects all major communities, and a well developed secondary road system provides access to small communities. Figure 2 illustrates major drainage and transportation facilities in the county.

METHODS OF INVESTIGATION

Investigation and preparation of this report consisted of three phases: (1) research and review of available information, (2) photo interpretation, and (3) field reconnaissance.

Phase One: Relevant information concerning geology, soils, and construction materials of the county was reviewed and the general geology determined. Quality test results of samples taken in Miami County were then correlated with the various geologic units and unconsolidated deposits.

Phase Two: A study and interpretation of aerial photographs taken by the Kansas Highway Commission at a scale of one inch equals 2,000 feet, was accomplished. Figure 3 illustrates aerial photographic coverage of Miami County. Geologic source beds and all open materials sites were mapped and classified on aerial photographs. All materials sites were then correlated with the geology of the county.

Phase Three: This phase was conducted after the initial study of aerial photographs. A field reconnaissance was conducted by the authors to examine construction materials, to verify doubtful mapping situations, and to acquire supplemental geologic information. Geologic classification of open sites was confirmed, and prospective sites were observed.

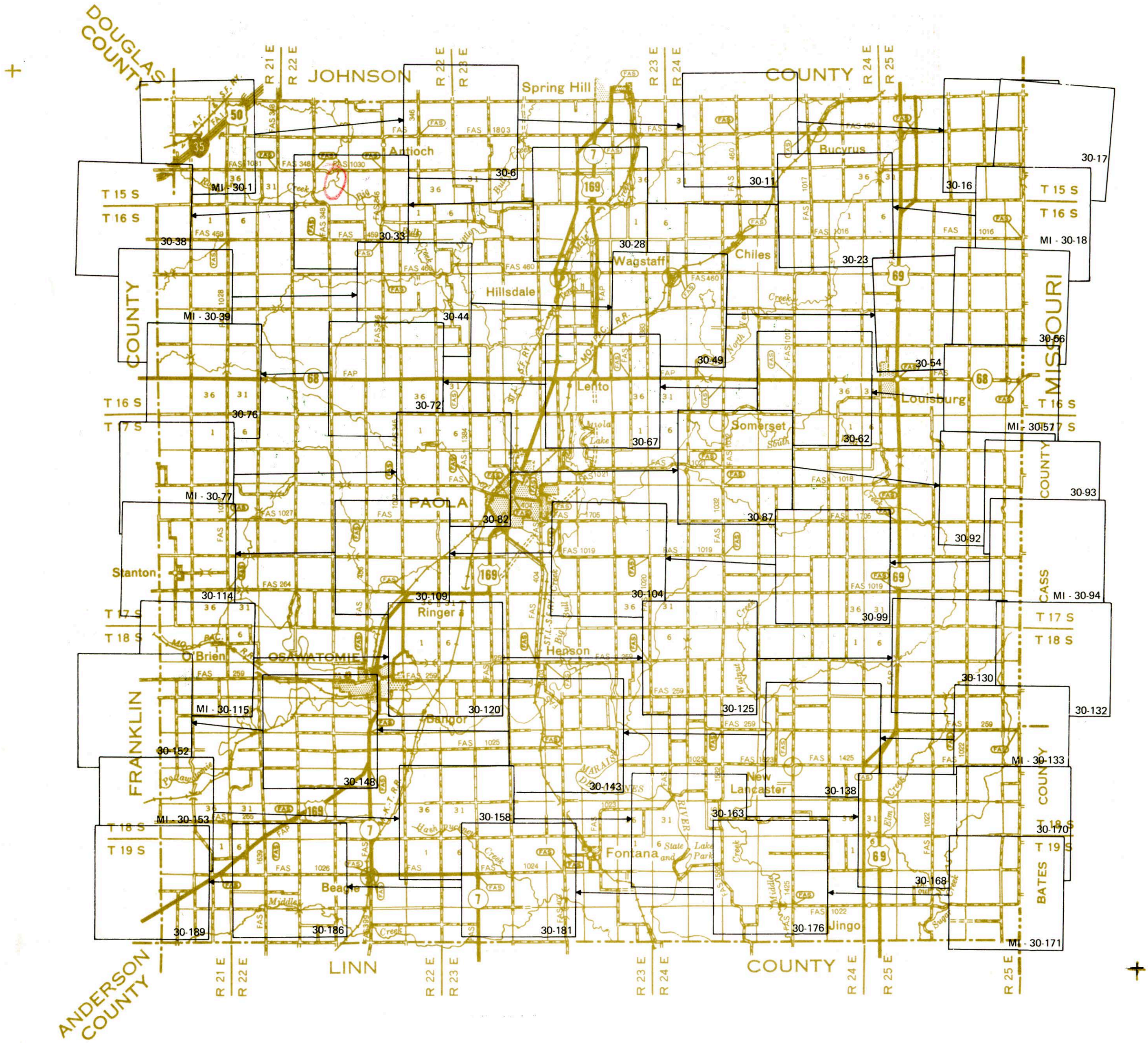
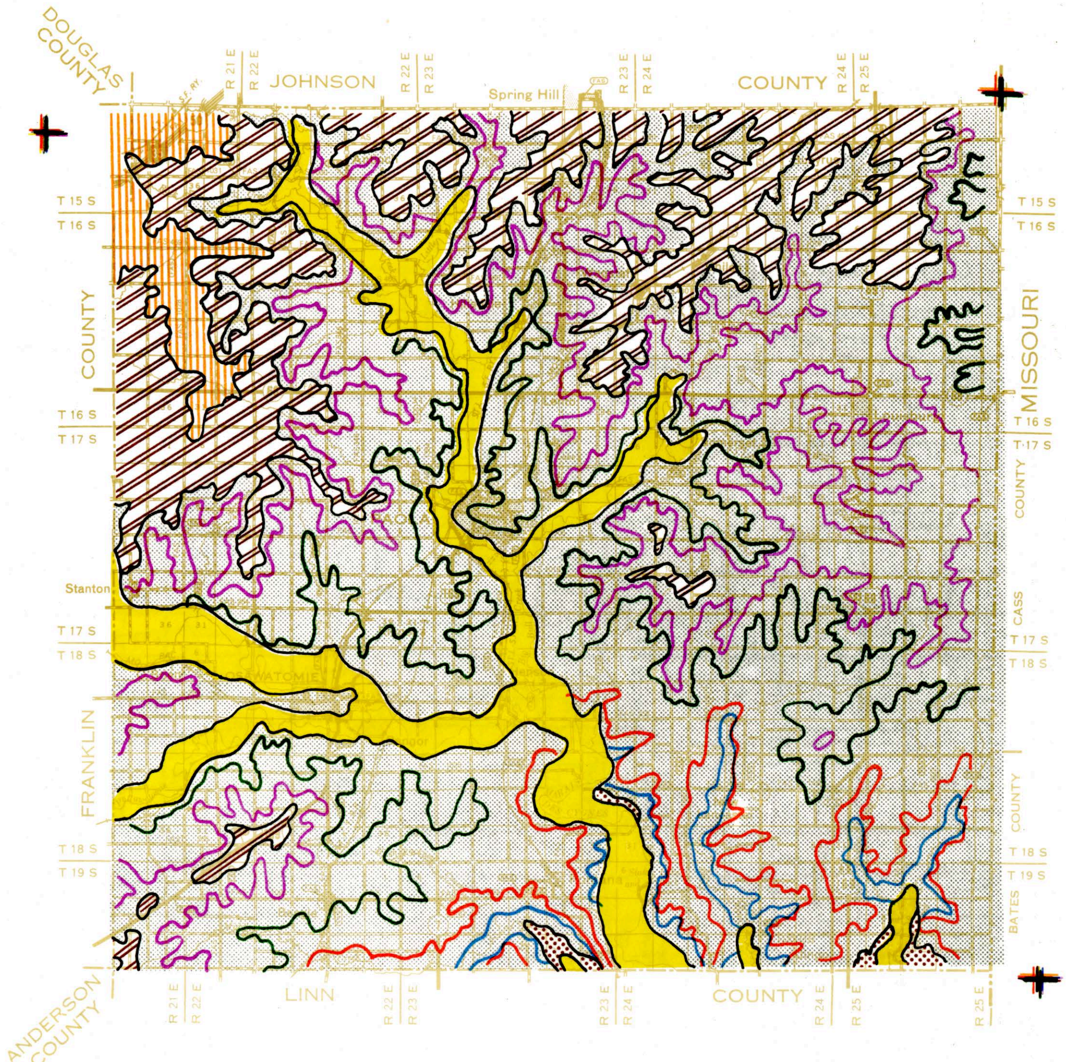
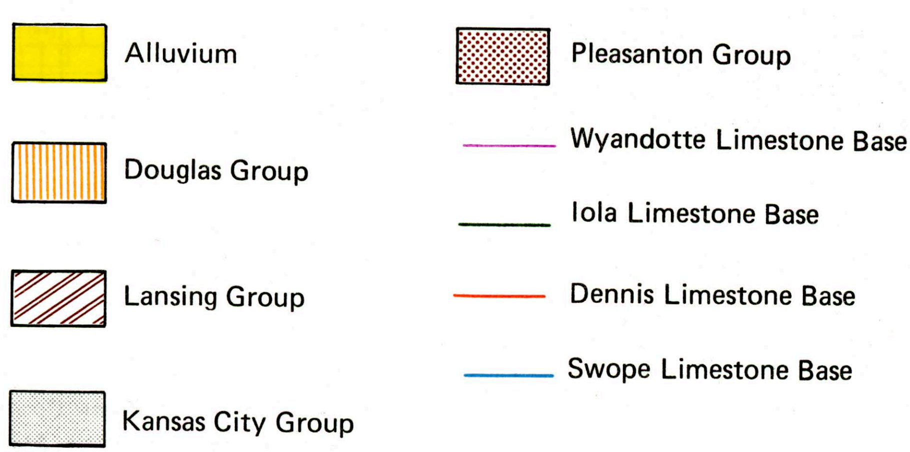


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Miami County. The numbers refer to photographs taken by the Photogrammetry Section, State Highway Commission of Kansas, on 4-15-71 at a scale of 1″=2000′. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION



LEGEND



GENERAL GEOLOGY

GEOLOGY is the basis for this materials inventory. Knowledge of the geology makes it possible to: (1) ascertain the general properties of the material source, (2) identify and classify each source according to current geologic nomenclature, and (3) establish a uniform system of material-source-bed classification. By knowing the geologic age, origin, landform, and quality information of the source units, one can derive general information for untested materials sites and prospective locations.

It is very important to note that the quality of material from a given source may vary from one location to another, especially in unconsolidated deposits.

Material for this discussion is based on information obtained from the State Geological Survey of Kansas, Bulletin 181, 'Geology and Groundwater Resources of Miami County, Kansas,' by Don E. Miller, 1966, 66 pp. The geologic timetable, figure 4 (page 6), shows in graphic form the major time periods and the approximate duration of each; however, the materials source units which are exposed or near the surface represent only a small part of geologic time. Figure 5 (page 7), illustrates the surface geology and stratigraphic position of each material source unit in Miami County.

According to Miller, Precambrian granites form the basement rock in Miami County. The surface of these granites varies in elevation from 1,200 feet below sea level in the southeast corner of the county to about 1,400 feet below sea level in the northwest corner.

Unexposed sedimentary rocks range in age from late Cambrian to Middle Pennsylvanian and vary in thickness from 2,000 feet in the southeast corner of the county to 2,500 feet in the northwest corner. These rocks include limestones, shales, and dolomites of marine origin, and sandstones and coal beds of marine and non-marine deposition. Sandstones were often deposited by streams flowing across low relief surfaces and coal beds were formed in low lying swampy areas.

Marine deposits of Pennsylvanian age are the oldest rocks exposed in Miami County. Limestones of the Kansas City and Lansing Groups of the Pennsylvanian are the most abundant and important materials source units in the county. The Chanute Shale Formation, lying immediately below the Iola Limestone Formation (Figure 7), contains the Thayer Coal which is continuous over Miami County and much of eastern Kansas. Relatively thin coal beds are found locally in the Wea, Lane, and Bonner Springs Shale Members. These coal deposits indicate a retreat of the seas and a period of time when marine and non-marine swamps existed over large areas. Plant life was most abundant and there was little or no agitation of the water; however, these conditions represent a short time duration on the geological time scale as evidenced by the limited thicknesses and extent of the coal beds.

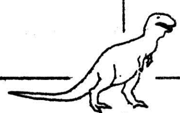
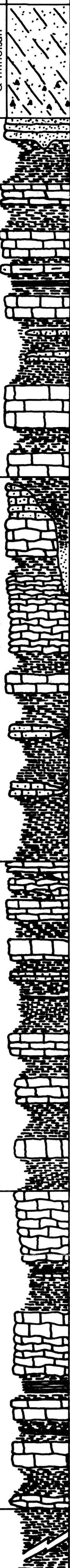
ERAS	PERIODS	ESTIMATED LENGTH IN YEARS	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE) 	1,000,000	Glacial drift; river silt, sand, and gravel; dune sand; wind-blown silt (loess); volcanic ash.	Sand and gravel; volcanic ash; agricultural soils; water.
CENOZOIC	TERTIARY 	59,000,000	Silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.	Sand and gravel; volcanic ash; diatomaceous marl; water.
MESOZOIC	CRETACEOUS	70,000,000	Chalky shale, dark shale, vari-colored clay, sandstone, conglomerate; outcropping igneous rock.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; ceramic materials; water.
MESOZOIC	JURASSIC	25,000,000	Sandstone and shale, chiefly subsurface.	
MESOZOIC	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN 	25,000,000	Limestone, shale, evaporites (salt, gypsum, anhydrite), red sandstone and siltstone, chert, and some dolomite.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; natural gas, salt, gypsum, water.
PALEOZOIC	PENNSYLVANIAN 	25,000,000	Alternating marine and non-marine shale; limestone, sandstone, coal, and chert.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and limestone and shale for cement; ceramic materials; oil, coal, gas, and water.
PALEOZOIC	MISSISSIPPIAN 	30,000,000	Mostly limestone, predominantly cherty.	Chat and other construction materials; oil, zinc, lead, and gas.
PALEOZOIC	DEVONIAN	55,000,000	Subsurface only. Limestone and black shale.	Oil.
PALEOZOIC	SILURIAN	40,000,000	Subsurface only. Limestone.	Oil.
PALEOZOIC	ORDOVICIAN	80,000,000	Subsurface only. Limestone, dolomite, sandstone, and shale.	Oil, gas, and water.
PALEOZOIC	CAMBRIAN 	80,000,000	Subsurface only. Dolomite and sandstone.	Oil.
PRE-CAMBRIAN	(Including PROTEROZOIC and ARCHEOZOIC ERAS)	1,600,000,000 +	Subsurface only. Granite, other igneous rocks, and metamorphic rocks.	Oil and gas.

Figure 4. Geologic Timetable



System	Series	Stage or Group	Formations	Members	Map Symbol	Thickness	General Description	Construction Materials
Quaternary	Pleistocene	Recent Wisconsinan & Illinoisan	Alluvium & Terrace Deposits		Qal	0'to 55'	Sand, silt, and lenses of clay are found underlying the floodplains of the major streams. Sparse gravels are occasionally found in alluvial and terrace deposits.	Light type surfacing material.
Pennsylvanian	Upper Pennsylvanian	Douglas Group	Lawrence Formation	Ireland Sandstone Mbr.		13'		
			Stranger Formation	Weston Shale Mbr.		30'		
		Lansing Group	Stanton Limestone Formation	South Bend Ls.Mbr.		3'-5'		
				Rock Lake Sh. Mbr.		4'-6'		
				Stoner Ls. Mbr.	₱s	0'-19'	A medium gray, medium-grained, medium-bedded, fossiliferous limestone , with thin shale partings.	Concrete and bituminous aggregate, light-type surfacing, riprap.
				Eudora Sh. Mbr.		5'-11'		
				Captain Creek Ls. Mbr.		5'-11'	Medium gray, dense, thick bedded limestone. Contains scattered chert nodules near middle in some outcrops.	Concrete and bituminous aggregate, light type surfacing, riprap.
			Vilas Shale Formation			5'-30'		
			Plattsburg Limestone Formation	Spring Hill Ls. Mbr.		4'-20'	Light gray, fossiliferous, fine to coarse grained, medium bedded limestone and contains some shale partings.	Concrete and bituminous aggregate, light type surfacing, riprap.
				Hickory Creek Sh. Mbr.	₱p	0'-2'		
				Merriam Ls. Mbr.		1'-10'	Light gray, massive limestone that weathers to yellow-brown. It contains a shale parting in some areas and is fossiliferous.	Concrete and bituminous aggregate, light type surfacing, riprap.
		Kansas City Group, Zarah Subgroup	Bonner Springs Shale Formation			1'-32'		
			Wyandotte Limestone Formation	Farley Ls. Mbr.		0'-15'		
				Island Creek Sh. Mbr.		0'-2'		
				Argentine Ls. Mbr.	₱w	0'-32'	Light gray to orange gray, medium grained, fossiliferous, thin bedded, locally cherty limestone. It weathers into thin fragments.	Concrete aggregate, light type surfacing, riprap.
				Quindaro Sh. Mbr.		0'-3'		
				Frisbie Ls. Mbr.		0'-4'		
			Lane Shale Formation			16'-108'		
		Linn Subgroup	Iola Limestone Formation	Raytown Ls. Mbr.		5'-24'	A light gray, medium to coarse-grained fossiliferous, medium to thin bedded limestone containing numerous shale partings.	Concrete and bituminous aggregate, light type surfacing, riprap.
				Muncie Creek Sh. Mbr.	₱i	.5'		
				Paola Ls. Mbr.		0'-4'		
			Chanute Shale Formation			8'-38'		
			Drum Limestone Formation			2'-8'		
			Cherryvale Shale Formation	Quivira Sh. Mbr.		3'-5'		
				Westerville Ls. Mbr.		1'-2'		
				Wea Sh. Mbr.		16'-28'		
				Block Ls. Mbr.		3'-4'		
				Fontana Sh. Mbr.		15'		
		Bronson Subgroup	Dennis Limestone Formation	Winterset Ls. Mbr.		27'	A light gray, moderately dense, finely crystalline, fossiliferous limestone. Lower and middle parts contain thin shale partings and some chert. Upper 3 feet Oölitic.	Concrete and bituminous aggregate, light type surfacing, riprap.
				Stark Sh. Mbr.	₱dw	1'-6'		
			Galesburg Shale Formation			4'-12'		
			Swope Limestone	Bethany Falls Ls. Mbr.		13'-28'	A light gray, medium grained, medium to thick-bedded limestone containing thin shale partings. Upper part contains some chert and exhibits cross-bedding.	Concrete and bituminous aggregate, light type surfacing, riprap.
				Hushpuckney Sh. Mbr.	₱sb	4'-7'		
				Middle Creek Ls. Mbr.		2'-3'		
			Ladore Shale			1'-11'		
			Hertha Limestone	Sniabar Limestone Mbr.		6'		
				Mound City Shale Mbr.		0'-.5'		
				Critzer Limestone Mbr.		1'		
		Pleasanton Group	Tacket Formation			25'+		

Figure 5. Generalized geologic column of the surface geology in Miami County.

Mesozoic sediments are absent in Miami County. During most of Mesozoic time (Triassic and Jurassic Periods) it is assumed that Miami County was part of a landmass where large amounts of older Paleozoic rocks were removed by erosion. During Cretaceous time, the sea made its final advancement into Kansas; however, if any sediments were deposited in Miami County during this time, they were subsequently removed by erosion during Cenozoic time.

Geologic processes active during Cenozoic time have had a very significant effect on the present day construction materials resources in Miami County. Pennsylvanian limestones, the main materials resource in the county, were degraded and exposed and antecedent streams of present day drainage deposited limited amounts of chert gravel. Remnants of these gravel deposits veneer many of the higher elevations in the western part of the county. Erosion during the Pleistocene has thinned these chert gravel deposits and they are of little or no economic value as construction aggregate.

Divisions of the Quaternary Period

Period	Epoch	Age	Estimated length of age duration in years	Estimated time in years elapsed to present
Quaternary	Pleistocene	Recent		10,000
		Wisconsinan Glacial	45,000	55,000
		Sangamonian Interglacial	135,000	190,000
		Illinoisan Glacial	100,000	290,000
		Yarmouthian Interglacial	310,000	600,000
		Kansan Glacial	100,000	700,000
		Aftonian Interglacial	200,000	900,000
		Nebraskan Glacial	100,000	1,000,000

Figure 6. Geologic Timetable of the Quaternary Period.

During Pleistocene and Recent time alluvial and terrace deposits were laid down in stream valleys of the present day drainage system. Due to difficulties in identification, terrace deposits of Kansan and Illinoisan Age were mapped with Quaternary Alluvium deposits. These alluvial deposits are of little or no economic value as a source of construction material.

GEO-ENGINEERING

This section provides a general appraisal of the geo-engineering problems that may be encountered in Miami County during highway construction. Potential groundwater problems and the quality of water available for concrete are briefly reviewed along with engineering soil types present in the area. ***Detailed field investigations may be necessary to ascertain the severity of specific problems and to make recommendations in design and construction procedures.***

Geo-engineering problems encountered in Miami County are associated with the alluvium of major drainage channels, limestone and shale units along the valley walls, and clay soils capping the upland areas.

Limestone outcrops vary from thin limestones such as the Block and Drum to thick, massive limestones of the Swope, Dennis, Iola, Wyandotte, Plattsburg, and Stanton Formations. Moderate to heavy amounts of rock excavation can be expected in areas where limestones, unweathered shales, and sandstones are encountered in deep cuts. Thicker limestones are mapped on plates 1 through 6. The stratigraphic relationship of shales and sandstones to these thick limestones is shown on figure 5, page 7. Generally, extensive rock excavation will be limited to cuts in the steeper valley walls along the major drainage channel of the Marais des Cygnes River and its tributaries. The steepness of the valley walls and thus the amount and difficulty of rock excavation is largely determined by the relative thickness of the limestone units. Stability problems will be present in areas where weathered Fontana Shale is encountered. This shale has a very clayey nature and a low shear strength when wet. Potential problem areas of this nature can be generally located on plates 5 and 6 inasmuch as the Fontana overlies the Winterset Limestone Member. The Wea-Quivira Shale (figure 5, page 7) is unstable in areas where water has been induced into existing shear planes, causing it to be very prone to sliding. The St. Louis and San Francisco Railroad tracks north of Paola along Bull Creek have required constant maintenance because of slippage in areas where fill sections rest on the Wea-Quivira. Extensive stability studies should be conducted before attempting any construction in or on this shale.

Hydrology problems are anticipated at the bases of most limestones. Additional groundwater problems may occur where the Thayer Coal is encountered and in sandstones and black fissile shales found in most of the shale units.

Karst topography has developed in Miami County where the Winterset, Wyandotte, and basal Stanton Limestones form the main element of topography. These areas generally lie in the northern and eastern parts of the county, including the area around Louisburg where many sinks can be observed. Internal drainage is also well developed in the Wyandotte Limestone in the Louisburg area. Sinkholes in the Captain Creek Limestone were reported south of Spring Hill by the Geology Section of the State Highway Commission in a study on US-169.

The alluvium of the Marais des Cygnes River and its major tributaries is composed of silt and clay with scattered lenses of fine quartz and chert sand as well as small limestone gravel. Numerous cut-off meanders containing unconsolidated material are located in the flood plains and terraces. When fill sections are contemplated, these areas will require detailed study to determine construction procedures that will minimize the effect of differential consolidation. The need for borrow for fill construction in alluvium will require exploration to acquire sufficient material above the water table.

In upland areas well developed soils with a thick 'C' horizon are generally found overlying thicker shale beds. These soils range in thickness from 3 to 15 feet and have an average plasticity index of 30. Soils developed over limestone units rarely exceed 3 feet in thickness and have an approximate plasticity index of 40. As a general rule soils developed from shales display better characteristics for earthwork construction than those derived from limestones.

Limited water supplies yielding less than 10 gpm are available from limestone and shale sequences, and alluvial aquifers yield from 1 to 45 gpm. However, the quality of water from both sources is impaired by a high content of iron and calcium bicarbonate.

Oil and gas has been produced from wells east of Paola since 1860. According to Jewett (1949), production was county wide by 1948. Producing zones are at a depth of 500 to 600 feet in sands of the Cherokee Group of Pennsylvanian age. Many early wells were not cased and their locations were not recorded. If wells are encountered during construction, they should be plugged to prevent inducement of water into fill sections in areas where secondary recovery repressuring operations exist.

The Thayer Coal Bed located within the Chanute Shale Formation, has a limited economic value due to its thin nature. The coal does carry water and the underclay may be a construction hazard due to its highly plastic nature.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Pennsylvanian limestones make up the major portion of the construction materials resources of Miami County. Very limited amounts of sand and gravel may be produced from the floodplain of the Marais des Cygnes River, although most river sand and gravel must be imported from Johnson County to the north. Minor amounts of chert gravel have been produced from Quaternary deposits located in the western part of the county; however, chert gravel may be imported from more extensive deposits located in Franklin County to the west.

Construction materials types, their uses, and availability are tabulated in Figure 7. Test results from a limited amount of sampling and testing are presented in Figure 17 (page 25).

CONTENTS
MATERIALS INVENTORY SECTION

TYPE material and geologic source	USE	page	AVAILABILITY
LIMESTONE			
Bethany Falls Limestone Member	Concrete and bituminous aggregate, light type surfacing, riprap.	16	Limited source in southeastern part of the county. Plates 5 & 6.
Winterset Limestone Member	Concrete and bituminous aggregate, light type surfacing, riprap.	17	Moderate source in southern and southeastern part of the county. Plates 5 & 6.
Raytown Limestone Member	Concrete and bituminous aggregate, light type surfacing, riprap.	19	Good source in central and southern part of the county. All plates.
Argentine Limestone Member	Concrete aggregate, light type surfacing, riprap.	20	Good source in all but southeastern part of the county. All plates.
Plattsburg Limestone Formation	Concrete and bituminous aggregate, light type surfacing, riprap.	20	Moderate source in northern and western part of the county. Plates 1-5.
Captain Creek Limestone Member	Concrete and bituminous aggregate, light type surfacing, riprap.	22	Limited source in northwestern part of the county. Plates 1, 2, & 3.
Stoner Limestone Member	Concrete and bituminous aggregate, light type surfacing, riprap.	23	Limited source in northwestern part of the county. Plates 1, 2, & 3.
SILICEOUS SAND AND GRAVEL			
Quaternary Alluvium	Light type surfacing.	23	Very limited source in stream and river valleys. All plates.
Chert Gravels	Light type surfacing	24	Very limited source on higher elevations in western third of the county. Not mapped.

Figure 7. Tabulation of the construction materials types and their availability in Miami County.

DESCRIPTION OF CONSTRUCTION MATERIALS

Limestone

Swope Limestone Formation

The Swope Limestone Formation is composed of two limestone members and one shale member, which are, in ascending order, the Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone. The Swope Limestone has an average thickness of 34 feet in Miami County. It is well exposed along steep valley walls formed by the Marais des Cygnes River, the Middle Creeks, North Sugar Creek, and their tributaries. In this formation only the Bethany Falls Limestone Member is considered a source of construction materials aggregate.

Bethany Falls Limestone Member

The Bethany Falls is a light-gray to light-brownish-gray, medium-grained, medium-to thick-bedded limestone containing thin shale partings. It has a thickness that ranges from 13 feet in sec. 34, T18S, R 24E, to approximately 28 feet in sec. 10, T19S, R23E. The member is commonly divided into a lower unit which is 12 to 16 feet thick and contains fusilinids, and an upper unit which varies from 0 to 14 feet, exhibits cross bedding, and contains chert and oolites in the upper part.

Quality test data are not available for the Bethany Falls Limestone in Miami County; however, test data for quarries in Linn County to the south indicate the unit meets highway specifications for construction aggregate. However, absorption, wear, and soundness qualities are marginal in some areas; therefore, care should be exercised in selection of a quarry site. Although the Bethany Falls has been considered as one of the better sources of limestone for construction purposes in Kansas, aggregate from the Bethany Falls has been associated with 'D' cracking that occurs in concrete.

The exposure pattern of the Bethany Falls is shown on plates 5 and 6. Even though the unit has sufficient thickness and acceptable quality, it has not been quarried in Miami County due to the good quality and thickness of the overlying Winterset Limestone.

Figure 8. Bethany Falls Limestone exposed in a road cut in the SE¼, sec. 10, T19S, R23E.

Dennis Limestone Formation

In Miami County the Dennis Limestone Formation is composed of two members, which are, in ascending order, the Stark Shale and the Winterset Limestone. A third member the Canville Limestone, which is the lowermost member of the formation, is absent in the county but is present a short distance to the south in Linn County. The Dennis Limestone has an average thickness of 32 feet and forms a prominent escarpment in southern Miami County. However, the Winterset Member of the Dennis Limestone is the only acceptable source of construction aggregate from the formation.

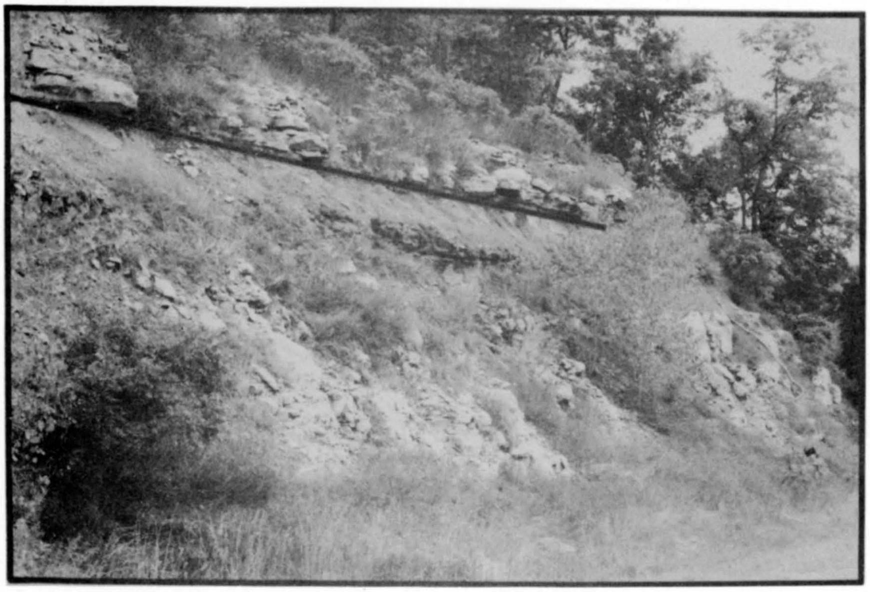


Figure 9. Upper Bethany Falls Limestone, Stark Shale, basal Winterset Limestone, exposed in a road cut in the SE¼, sec. 31, T18S, R25E.

Winterset Limestone Member

The Winterset is a light-gray to bluish-gray, moderately dense, finely-crystalline, fossiliferous limestone. The lower and middle parts of the member contain thin shale partings and some chert. The upper part is separated from the lower parts by a thin gray shale which has a thickness of 1½ feet. The upper part is 10 to 15 feet in thickness and is a dense, fine-grained, massive limestone characterized by oölites in the top 1 to 3 feet. The average thickness of the Winterset in Miami County is 29 feet.

Limited quality test data for the Winterset in Miami County show that the material tested will meet highway specifications for construction aggregate. However, wear and absorption values are marginal in some locations. In Linn County to the south, extensive testing of the Winterset shows that wear and absorption values are very marginal. Because of these marginal qualities, care should be taken in the selection of quarry sites. The outcrop pattern of the Winterset Limestone is shown on plates 5 and 6.

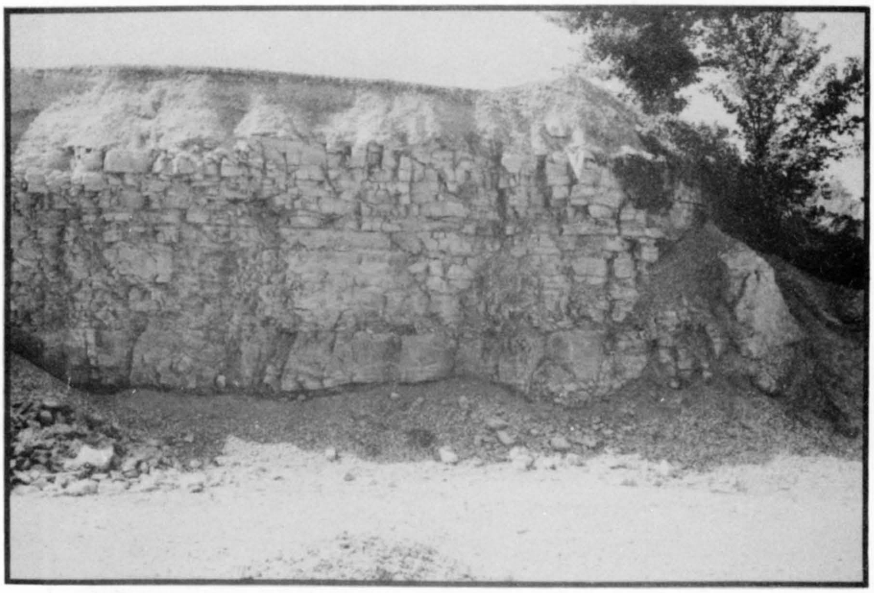


Figure 10. Winterset Limestone exposure in a quarry located in the SW¼, sec. 28, T18S, R25E.

Iola Limestone Formation

The Iola Limestone is composed of two limestone members and one shale member. They are, in ascending order, the Paola Limestone, the Muncie Creek Shale, and the Raytown Limestone. In some areas of Miami County the Paola Member is missing, as in sec. 6, T17S, R23E. It has an average thickness of 10 feet north of the Marais des Cygnes River and 12 feet south of the river. The outcrop pattern of the Iola Limestone is shown on all plates.

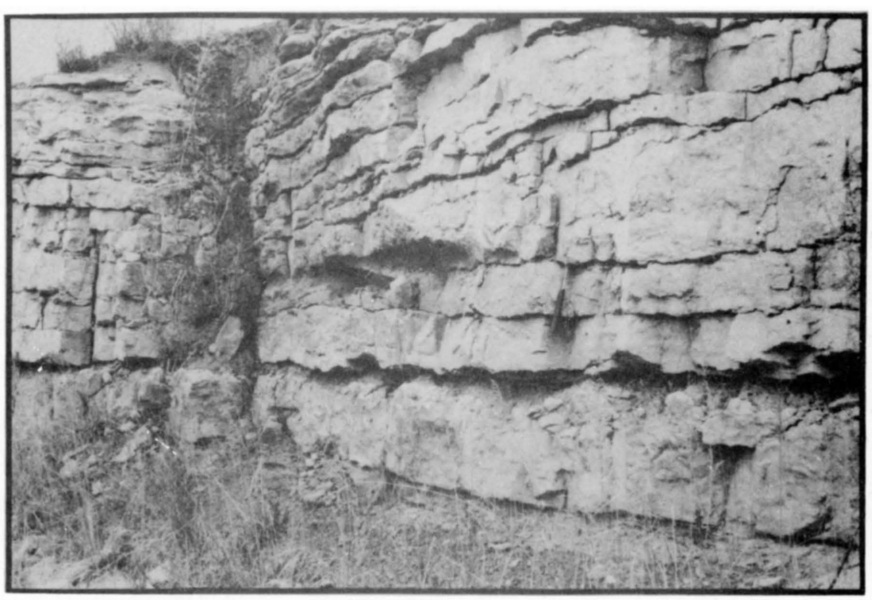


Figure 11. The Iola Limestone exposed in a road cut in the SE¼, sec. 15, T17S, R23E.

Raytown Limestone Member

The Raytown is a light-gray, medium-to coarse-grained, fossiliferous limestone containing numerous shale partings. It varies in thickness from 5 to 24 feet. The member is medium-bedded in northern Miami County and becomes thin-bedded to the south. In quarries near Paola and Osawatomie, the authors observed an upper limestone bed which was approximately 3 feet thick. This limestone was separated from the main member by approximately 7 feet of shale at one location.

The Raytown has been quarried on a limited basis in the county. Quality test results are available for only three locations in Miami County and no data are available for surrounding counties. Available test data indicate that the material meets current highway specifications for construction aggregate; however, high rates of deterioration have been evident in concrete constructed with aggregate having similar L.A. wear values. Material quality may vary due to changes in lithology; therefore, tests should be run on samples from each prospective site before use. The Raytown has been mapped as a part of the Iola Limestone Formation in this report and is shown on all plates.

Figure 12. Raytown Limestone Member exposed in a quarry face in sec. 20, T18S, R22E.

Wyandotte Limestone Formation

The Wyandotte Limestone is composed of five members which are, in ascending order, the Frisbie Limestone, the Quindaro Shale, the Argentine Limestone, the Island Creek Shale, and the Farley Limestone. The thickness of the formation varies from 10 to 80 feet in Miami County due to variations in the thickness of the individual members. Cuesta-type topography characterizes the outcrop area due to the thick nature of the formation combined with a gentle dip to the northwest. The Argentine is the only member of the formation that has been produced for construction aggregate in the county.

Argentine Limestone Member

The Argentine is a light-gray to grayish-orange, medium-grained limestone that contains numerous fossils. It is thin-bedded, weathers into thin fragments and locally contains chert nodules. The thickness of the unit varies from 0 to 37 feet.

Limited quality test data available for the Argentine Limestone in Miami County show absorption values range from 3.52% to 4.65% and wear values are in excess of 30%. Test results taken on samples in Johnson County show absorption values below 2.8% and L.A. wear values do not exceed 30%. Test data for samples from Franklin County show no absorption values below 4.25% or L.A. wear values below 30%. Lab tests show the Argentine will meet all highway specifications for concrete and light type surfacing aggregate, riprap, and, *if taken from selected outcrops,* bituminous aggregate. The outcrop pattern of the Wyandotte Limestone, of which the Argentine is a member, is shown on all plates.

Figure 13. Argentine Limestone Member exposed in a quarry in the SW¼, sec. 7, T16S, R25E.

Plattsburg Limestone Formation

The Plattsburg Limestone Formation is composed of two limestone members and one shale member. These members are, in ascending order, the Merriam Limestone, the Hickory Creek Shale, and the Spring Hill Limestone. The Plattsburg has an average thickness of 16 feet and is separated from the Wyandotte Formation by as much as 32 feet of Bonner Springs Shale.

Figure 14. Bonner Springs Shale pinchout in road cut in the SE¼ sec. 25, T16S, R22E.

During the time this investigation was conducted, the Plattsburg was being produced at only one quarry located northwest of Paola (LS+2, plate 3). Both the Merriam and Spring Hill Limestone Members were being produced because the intervening Hickory Creek Shale is abnormally thin in this area.

The Merriam is a light-to bluish-gray, continuous, massive limestone that weathers to a light-yellowish-brown color. In some areas of the county the Merriam is divided into two units by a thin shale division. The member is fossiliferous in the lower part and contains chert in the upper part. It has an average thickness of 3.5 feet with variations ranging from 1 to 9.5 feet in the county.

Limited quality test data are available for the Plattsburg Formation in Miami County which show marginal values for absorption, wear, and soundness. However, material from selected outcrops will meet all highway specifications for construction aggregate.

A limited number of test results for the Spring Hill in Franklin County show prohibitive wear and absorption values for use as bituminous stabilized aggregate.

The outcrop pattern of the Plattsburg Limestone Formation is shown on plates 1 through 5.

Figure 15. Merriam and Spring Hill Limestones exposed in a quarry in the SW¼ sec. 27, T16S, R22E.

Stanton Limestone Formation

The Stanton Limestone is composed of five members which are, in ascending order, the Captain Creek Limestone, the Eudora Shale, the Stoner Limestone, the Rock Lake Shale, and the South Bend Limestone. The total thickness in surrounding counties is approximately 35 feet; however, due to erosion and poor exposures thickness for the Stanton could not be determined in Miami County.

The most important source units of the formation are the Captain Creek and Stoner Limestone Members. Both units have been produced extensively in eastern Kansas and in many areas aggregate from both beds is produced at the same location. Material from selected outcrops is acceptable for all phases of highway construction. The outcrop pattern for the base of the Stanton Formation is shown on plates 1, 2, and 3.

Captain Creek Limestone Member

The Captain Creek is a medium-to light-gray, dense, fossiliferous limestone that weathers to a yellow brown. In some areas the unit contains sand-sized grains of blue and red chert in the upper part which gives the outcrop a mottled appearance. The upper portion of the member weathers into large angular blocks, and is locally sandy. The thickness of the unit varies from 5 to 11 feet.

There are no quality test data available for the Captain Creek in Miami County; however, in Franklin County test results show the material is acceptable for construction aggregate. Although rock quality is marginal, material taken from selected locations in Miami County should meet all highway specifications.

The Captain Creek Limestone is the basal member of the Stanton Formation which is shown on plates 1, 2, and 3.

Stoner Limestone Member

The Stoner is a yellowish-gray to grayish-orange, medium-grained, medium-bedded, fossiliferous limestone. It contains a shale bed one half foot thick approximately 13 feet from the base of the member. The lower 13 feet contains fusilinids, crinoids, and algae, while the upper part contains abundant gastropods, pelecypods, and brachiopods. The total thickness of the Stoner in the county is approximately 19 feet; however, due to poor exposures, an accurate measurement of the total thickness was not possible.

Quality test data on samples from the only Stoner Quarry, LS+1 (plate 1) in Miami County indicate the material tested will meet all highway specifications for construction aggregate. Numerous quality tests run on the Stoner in Johnson and Franklin Counties also show that the aggregate will meet all highway specifications. In Miami County, the Stoner Limestone is characterized by marginal absorption, wear, and soundness values because of changes in lithology and weathering conditions. Quality tests should be completed on aggregate before use from any location in Miami County.

The Stoner is a member of the Stanton Formation which is shown on plates 1, 2, and 3.

Figure 16. Stoner Limestone in a road cut in the SW¼ sec. 30, T16S, R22E.

Sand and Gravel

Quaternary Alluvium

Alluvium of the Marais des Cygnes River and its tributaries is composed primarily of silts and clays with scattered thin deposits of fine sand and gravel lenses. These lenses of sand and gravel are of such limited extent that production for construction aggregate is generally uneconomical. The last reported production was in 1955 (K.G.S. Bulletin 181) when 8,638 short tons of sand and gravel were produced. Available deposits were described as containing 20-40 percent silt and clay. Sand and gravel for construction aggregate for use in Miami County was produced from the Kansas River near Bonner Springs. Quality test results of this aggregate may be obtained from report No. 24, 'Construction Materials Inventory of Johnson County, Kansas', published by the State Highway Commission of Kansas.

Chert Gravels

Although chert gravel deposits are found over much of the western third of Miami County, they are rarely more than two feet thick and are characterized by a high percentage of silts and clays. Chert gravel has been produced on a very limited basis for local use from some areas along the Marais des Cygnes River; however, no test results are available for Miami County.

Site Data Form No.	Material Type	Date of Test	Sp. Gr. Sat.	Sp. Gr. Dry	% Wear	Soundness	Absorption	Source of Data	Type of Sample
Source of Material: Stanton Limestone Formation (Stoner) IPs									
Ls+1	Limestone	2-09-60	2.59	2.52	28.2	0.97	2.62	S.H.C. Lab No. 579	Crushed
		3-06-62	2.58	2.52	28.4	0.98	2.35	S.H.C. Lab No. 21203	Crushed
Source of Material: Plattsburg Limestone Formation IPp									
Ls+2	Limestone	9-28-64	2.64	2.60	24.3	0.97	1.52	S.H.C. Lab No. 36754	Crushed
		10-07-64	2.57	2.51	25.6	0.94	2.49	S.H.C. Lab No. 36824	Crushed
		11-04-64	2.56	2.49	29.6	0.96	2.99	S.H.C. Lab No. 37300	Crushed
		7-08-71	2.56	2.47	35.0	0.90	3.55	S.H.C. Lab No. 71-1794	Crushed
			2.58	2.52		-	2.15	S.H.C. Lab No. 71-1794	Crushed
		8-31-73	2.52	2.41	40.0	0.90	4.30	S.H.C. Lab No. 73-2330	Crushed
			2.56	2.49		-	2.80	S.H.C. Lab No. 73-2330	Crushed
Source of Material: Wyandotte Limestone Formation (Argentine) IPw									
Ls+3	Limestone	7-31-72	2.57	2.51	34.0	0.98	2.63	S.H.C. Lab No. 72-2177	Crushed
			2.60	2.56	-	-	1.73	S.H.C. Lab No. 72-2177	Crushed
Ls+4	Limestone	1-03-64	2.46	2.36	36.1	0.96	4.25	S.H.C. Lab No. 32196	Crushed
		1-28-65	2.49	2.40	35.8	0.99	3.63	S.H.C. Lab No. 38454	Crushed
		5-10-66	2.46	2.35	41.2	0.97	4.65	S.H.C. Lab No. 66-1448	Crushed
		5-02-69	2.53	2.44	32.7	0.98	3.52	S.H.C. Lab No. 69-979	Crushed
		12-22-70	2.49	2.40	33.7	0.98	3.83	S.H.C. Lab No. 70-3919	Crushed
Ls+7	Limestone	5-27-68	2.58	2.51	30.7	0.97	2.48	S.H.C. Lab No. 68-1622	Crushed
Source of Material: Iola Limestone Formation (Raytown) IPi									
Ls+5	Limestone	2-09-60	2.60	2.55	29.8	0.95	2.12	S.H.C. Lab No. 10350	Crushed
Ls+6	Limestone	2-04-74	2.61	2.54	31.0	0.95	2.60	S.H.C. Lab No. 74-74	Crushed
			2.62	2.58	-	-	1.60	S.H.C. Lab No. 74-74	Crushed
Ls+8	Limestone	4-18-74	2.61	2.55	30.0	0.97	2.14	S.H.C. Lab No. 74-630	Crushed
			2.62	2.59	-	-	1.50	S.H.C. Lab No. 74-630	Crushed
Source of Material: Dennis Limestone Formation (Winterset) IPdw									
Ls+10	Limestone	4-07-69	2.59	2.53	28.6	0.95	2.51	S.H.C. Lab No. 69-761	Crushed
Ls+11	Limestone	8-02-65	2.55	2.49	31.6	0.96	2.68	S.H.C. Lab No.65-2811	Crushed
		9-01-65	2.57	2.50	28.1	0.98	2.71	S.H.C. Lab No.65-3413	Crushed
		9-02-65	2.56	2.49	31.7	0.97	2.91	S.H.C. Lab No.65-3549	Crushed
		9-14-65	2.55	2.48	35.0	0.97	3.01	S.H.C. Lab No.65-3823	Crushed
		11-14-73	2.60	2.56	29.0	0.97	2.50	S.H.C. Lab No.73-3099	Crushed

Figure 17. Results of tests completed on samples of material from the various geologic source beds in Miami County.