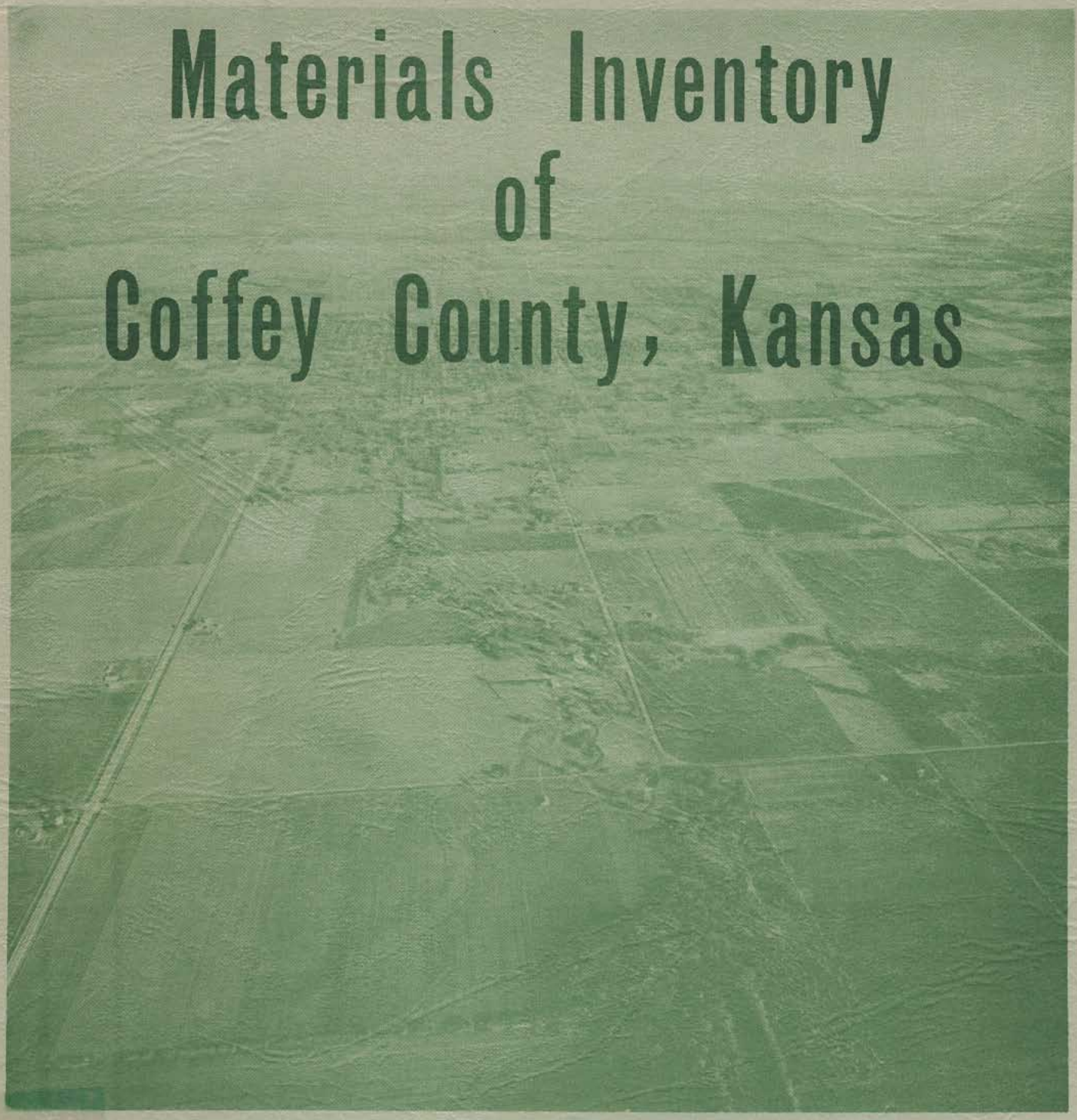
Materials Inventory of Coffey County, Kansas



prepared by

The State Highway Commission of Kansas

in cooperation with

The U.S. Department of Commerce

Bureau of Public Roads

State Highway Commission of Kansas
Research Department - Photronics Department

MATERIALS INVENTORY OF COFFEY COUNTY, KANSAS

BY

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Prepared in Cooperation with
U. S. Department of Commerce
Bureau of Public Roads

1966

Materials Inventory Report Number 2

COVER -- An areal view of Burlington, Kansas, the county seat and principal city of Coffey County.

SUGGESTED USE OF THE REPORT

The Materials Inventory of Coffey County is the second of a series of county materials inventories prepared by the State Highway Commission of Kansas in cooperation with the Bureau of Public Roads. The report includes: 1. an introduction which describes the nature of the report and gives general information concerning Coffey County; 2. an explanation of the procedures used in compiling the information contained herein; 3. a brief explanation of the origin of the geologic units that are source beds for construction materials, and a detailed description of the materials which have been produced from these units; 4. Appendices I through IV which contain site data forms for each open and prospective materials site. Each site data form has a sketch showing the materials site and surrounding landmarks, the name of the landowner, the name of the geologic source bed, and a resume' of all test data available for that site; 5. county materials maps (Plates I, IA, II, III, IIIA, IV, IVA, V, VA, VI, and VIA), which show the geographic locations where various source beds can be found in the county, along with the locations of all open materials sites, and 6. a general description of the geo-engineering problems which may be encountered within the county.

When this report is used as a guide for planning an exploration program or making an assessment of the materials resources of Coffey County, the reader may find the following suggestions helpful.

After becoming familiar with the nature of the report, the reader may wish to refer to the section "Construction Materials Resources of Coffey County". In this portion of the report, a

geologic history of the county is presented which describes the geologic events that led to the deposition of the various source beds and sets forth the geologic nomenclature used throughout the report. The construction materials resources of the county are also inventoried in this portion of the report. A study of the Construction Materials Inventory will reveal the types of material available in the county, their geologic source beds, the localities where they are found, and a description of their engineering properties.

When the reader is interested in material in a given portion of the county, he should determine from Figure 7 (Page 20), which source beds are present in that area. He should then study the description of these beds to determine their physical characteristics. Reference may then be made to the county materials map to find where these units are exposed or near the surface, the locations of sites that have produced material from this source, and the references to site data forms for all open and prospective sites.

For example, when searching for limestone in the east-central part of the county, the reader will find that the Plattsmouth and Toronto Limestone Members are exposed in this area. A study of the report will show that the best quality material can be produced from the Plattsmouth. If he is interested in this unit, the reader may turn to the materials maps (Plate IV, Bedrock) where he will note that sites $\frac{LS+2}{Pop}$, $\frac{LS+28}{Pop}$, and $\frac{LS+32}{Pop}$ produce material from this source. He will also note that two sites, $\frac{LS+30}{Pop}$ and $\frac{LS+31}{Pop}$, are shown as prospective quarry sites. These sites, along with others which may be found along the outcrop by field investigation, should provide the best source of material available in this part of the county.

PREFACE

This is one of a series of county construction materials reports compiled as a product of the Highway Planning and Research Program, Project 64-6, "Materials Inventory by Photo Interpretation", a cooperative effort between the Bureau of Public Roads and the State Highway Commission of Kansas, financed by Highway Planning and Research funds. The materials inventory program was initiated to provide a survey of all existing construction materials in Kansas, on a county basis, to help meet the demands of present and future construction needs.

The objectives of the program are to map and describe all materials source beds in the respective counties and to correlate geologic nomenclature with the materials source beds for classification purposes. The program does not propose to eliminate field investigations, but it should substantially reduce and help to organize field work.

No extensive or county-wide materials investigation has been completed in Coffey County and only a limited amount of geological work has been accomplished, however, a reconnaissance type geological map was compiled in 1962 by the State Geological Survey. Several preliminary soil surveys have been conducted and centerline geological profiles have been prepared for road design purposes by the State Highway Commission of Kansas along the various major highways that traverse Coffey County. Other information on materials suitable for construction purposes has been very meager.

Aggregate quality test results, pertinent information pertaining to materials produced, and geologic data on Coffey County used in this report were supplied by the Materials Department and the

Geology Section of the Design Department. Appreciation is extended to Gerald Hargadine, Photogeologist, who added to the report in many ways. The report was prepared under the guidance of J. D. McNeal, Engineer of Planning and Research, and the project leader, R. R. Biege, Jr., Engineer of Aerial Surveys and Photogrammetry.

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ABSTRACT

Construction material resources in Coffey County are limited to limestone exposures and Quaternary Terrace deposits.

The best producers of good quality rock for aggregate and riprap are the Plattsmouth Limestone Member, exposed in the eastern half of the county, and the Curzon-Hartford Limestone Members, exposed in the western half of the county. Quality test data indicate that material produced from both geologic units meet the specifications for concrete and bituminous aggregate.

Two other geologic units that have been quarried in Coffey County are the Toronto and the Clay Creek Limestone Members. Exposures of the Toronto are as extensive as those of the Plattsmouth in the eastern half of the county, but the physical characteristics of this ledge are inferior to those of the Plattsmouth. The Clay Creek produced good quality rock from a fresh section, but it has a very limited geographic distribution in Coffey County.

The Kereford Limestone, Beil Limestone, Ozawkie Limestone, and Ervine Creek Limestone Members are also exposed in Coffey County. These units have been quarried in nearby counties, but they have not been utilized as a source of construction material in Coffey County because of their thin nature. Even though the thickness of most of these geologic units is marginal for production purposes, they have been included in this report as prospective material source beds on the merits of quality tests conducted on samples taken from nearby counties.

High terrace deposits composed of silt, clay and chert gravel provide a source of light type surfacing material.

Most of the material available in Coffey County for embankment purposes and subgrade construction is derived from shale units exhibiting high swell and liquid limit values as well as high plastic indices.

Ground-water problems can be anticipated on most improvements proposed in Coffey County. Sandstone units, coal beds, and limestone units which are exposed or are near the surface are potential water bearers and could cause extensive ground-water problems.

Even though no information concerning the quality of water produced in Coffey County is available, reports on the water resources of adjacent counties provide a limited amount of data concerning the quality of water produced from some of the aquifers that are found in Coffey County. Based on this information, it is anticipated that most of the water produced in Coffey County can be used for mix water in concrete construction.

INTRODUCTION

The purpose of this report is to present information concerning the availability, location, and nature of deposits of materials for use in highway construction and similiar projects in Coffey County, and to provide a guide for materials prospecting.

Scope

This investigation includes all of Coffey County, and all geological units and deposits that are considered a construction material source are mapped and described. The term "Construction Material", as used in this report, includes limestone units suitable for the production of crushed aggregate and granular material suitable for use in the various phases of road construction.

Nature of the Report

Because all construction material source beds are the product of geologic agents, the materials inventory program is based largely on the geology of the county being investigated. This enables one to ascertain the general engineering properties of the material source unit and to identify and classify each bed according to current geologic nomenclature. By adopting this nomenclature to materials inventories, a uniform system of material source bed classification is established. The quality of material that can be produced from a given source bed may vary from one county to another, especially when dealing with unconsolidated deposits. In most cases, however, the geologic classification assigned to unconsolidated deposits denotes age and not material type. For example, two deposits, laid down during the same geologic period but in different

parts of the state, may have the same geologic name or classification but may vary in composition because of different parent material. The gradation of the material present in either deposit is greatly affected by the mode of deposition and the carrying capacity or energy of the depositing agent.

Consolidated geologic units such as limestone are usually characterized by more consistent engineering qualities throughout a given county; however, a change in material quality and thickness may be noted in some areas because of variations in local depositional environments and weathering conditions.

In essence, the geology of the county provides a basis for mapping material source beds and criteria for evaluating the general qualities of the material.

The mapping of various geologic units is accomplished by using aerial photography of the county. Because of their continuous nature, most consolidated geologic units can be mapped with a minimum amount of field checking. Unconsolidated deposits, such as sand and gravel, are less extensive and more erratic, but they can be located on aerial photographs by having a knowledge of the geology of the county and by interpreting significant terrain features that are discernible on the aerial photographs.

General Information

Coffey County, with an area of approximately 648 square miles, is located in the east-central part of the state in the Osage Cuesta physiographic division of Kansas. The topography is characterized by gentle, rolling plains with moderate to steep slopes adjacent to the major drainage channels.

Figure 1 (Page 3), is a state map of Kansas showing the location of Coffey County and other counties that are currently included in the materials inventory program.

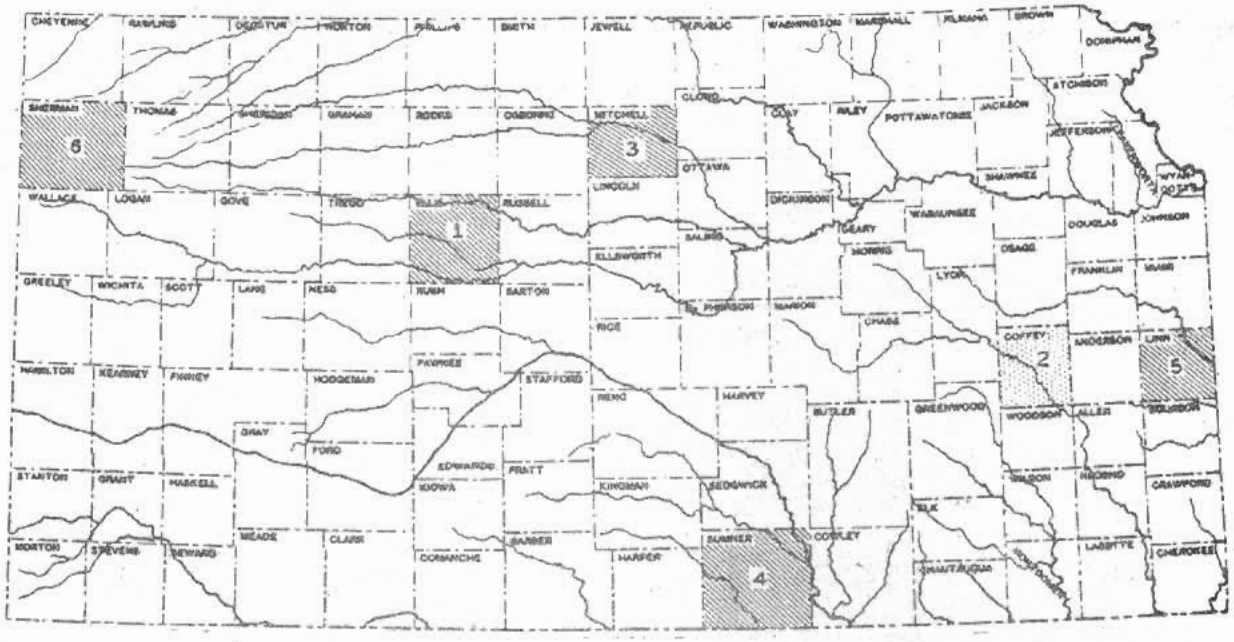

Figure 1. Index map of Kansas showing the location of Coffey County along with the report numbers and location of other counties for which reports have been or are being completed.

The Neosho River and its tributaries drain approximately 80 percent of Coffey County. The remaining 20 percent is drained by tributaries of the Marais des Cygnes River, which traverses Osage County to the north.

Coffey County is served by three railroads. A main line of the Atchison, Topeka, and Santa Fe extends across the northwestern corner of the county and serves the town of Lebo. A spur of the Atchison, Topeka, and Santa Fe enters the county in the northeastern corner, trends to the southwest and terminates at the town of Gridley. Gridley, Burlington (the county seat and principal city), and Waverly are all served by this spur. A main line of the Missouri Pacific traverses the southeastern corner of the county and serves the town of LeRoy.

There is a well developed system of federal, state, and county roads within Coffey County. U. S. Highway 75, a transcontinental north-south route, extends through the center of the county; U. S. Highway 50, an important east-west highway, extends through the northern part of the county and junctions with U. S. Highway 75 in the north-central part of the county; State Highway 57, an all weather east-west highway, extends through the southern one-third of the county and junctions with U. S. Highway 75 in the south-central part of the county. Most of the county and township roads follow section lines, and many have all weather surfaces.

PROCEDURES

The investigation for this report was carried out essentially in four phases as follows: first, research and review of available information; second, photo interpretation; third, reconnaissance; and fourth, final correlation of data, map compilation, and report writing. With the exception of the first, the phases of this investigation were not handled as separate operations but were completed contemporaneously as each section of the report required.

Research of Available Information

All available data and information pertaining to the geology, soils, and construction materials of Coffey County were reviewed. The general geology of the county, relative to construction materials, was determined. During this process, the results of quality tests already completed on samples taken in Coffey County were correlated with the various geologic units and deposits present in Coffey County.

Photo Interpretation

The second phase of the investigation consisted of study and interpretation of aerial photographs taken by the State Highway Commission of Kansas at a scale of 1:24,000 (one inch represents 2,000 feet). Figure 2 (Page 6), is a photographic coverage map of Coffey County on which index numbers have been placed to indicate the actual areas covered by individual photos.

Initially, the whole county was studied on aerial photographs. During this process all open material sites which had been sampled and tested were located on the aerial photographs and on a base map of the county. The locations of all open material sites which had not been sampled or reported were also transferred to the base map. All material sites were then correlated with the geology of the county, and the source beds that were discernible on aerial photographs were mapped and classified. Prospective sites were tentatively selected on the basis of the geology of the county and aerial photographic pattern elements. Figures 3, 4A and 4B (Page 7), illustrate this correlating and mapping procedure.

Figure 3 (Page 7), is a portion of an aerial photograph taken in southwestern Coffey County, showing high terraces composed of silt, clay, and chert gravel which were deposited during early Quaternary time. The gravel produced from these terraces is used predominantly for light type surfacing material. These terraces are easily detected when viewed stereoscopically on aerial photographs. A distinct break in the slope of the topography and a dark band along the fringes of the deposits are the most distinctive clues. The dark bands are the result of surface water draining through and along the basal part of the deposit during and shortly

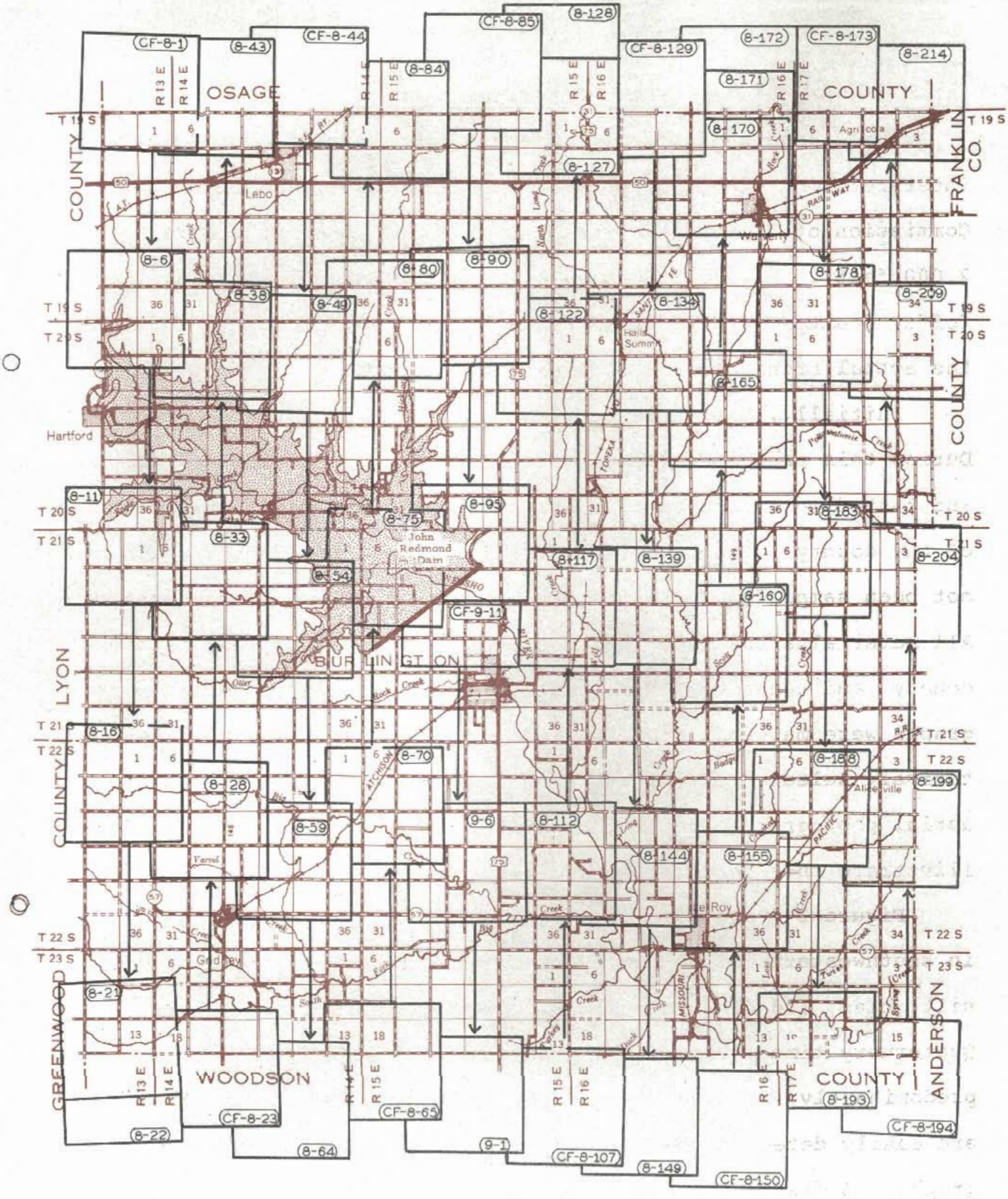

Figure 2. Aerial photographic coverage map for Coffey County. The numbers which are in brackets indicate print numbers of aerial photography obtained by the Photogrammetry Section, State Highway Commission of Kansas. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

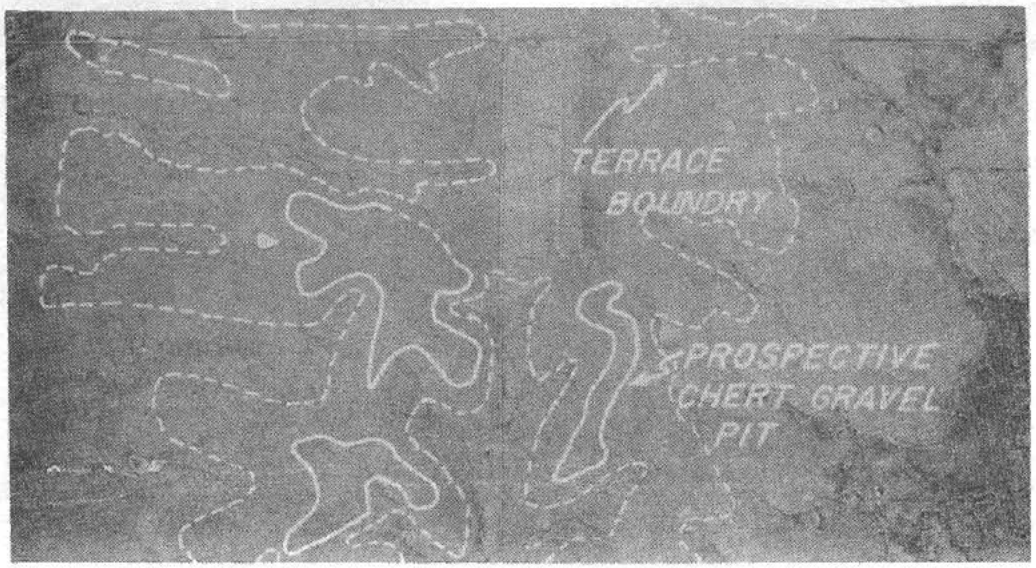

Figure 3. High terraces of early Quaternary age in southwestern Coffey County. Clay bound chert gravels are produced from these terraces and are often used for surfacing material on low traffic volume roads.

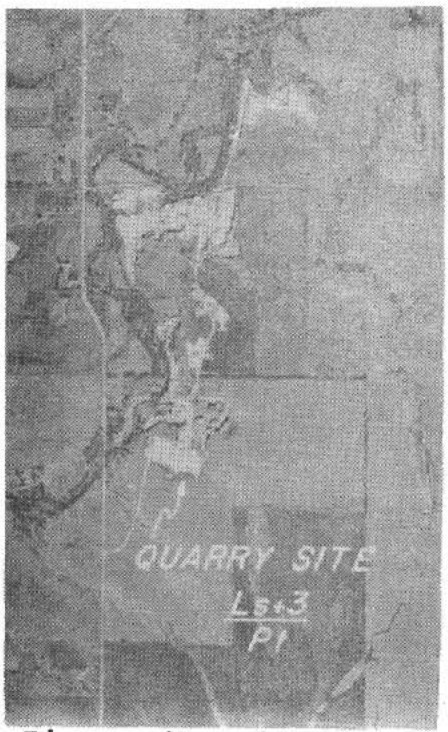

Figure 4A. A quarry site producing material from the Curzon-Hartford Limestone Members.

Figure 4B. A prospective quarry site located in the Curzon-Hartford Limestone Members.

after wet seasons there-by producing favorable growing conditions for vegetation. Inasmuch as the presence of a high percentage of gravel is detrimental to farming operations, most of the land underlain by these terraces is used for grazing.

Figure 4A and 4B (Page 7), are portions of aerial photographs taken in the west-central part of Coffey County, showing a producing quarry and a prospective quarry site located in the Curzon-Hartford Limestone Members. Figure 4A (Page 7), depicts a quarry that has produced aggregate for road construction and riprap for use in the newly completed John Redmond Dam in Coffey County. By using the information obtained during the research phase of this project and by studying known exposures of the Curzon-Hartford Limestone Members on aerial photographs, surface or near surface ledges of this rock were mapped in Coffey County as prospective quarry sites. Figure 4B (Page 7), depicts an exposure of the Curzon-Hartford Limestone Members located several miles from the quarry site shown in Figure 4A (Page 7).

After an initial field check, the mapping process was completed and a more detailed description of the geological source units was written. The quality of the material that might be produced from a particular source bed was ascertained, in most instances, by correlating the quality test results with the geological unit from which the test samples were obtained, and by field study of the producing unit. The general description of the material should be used as a guide for selecting geologic units for production purposes when planning an exploration program. A more detailed sampling and testing program will have to be accomplished for production purposes.

Field Reconnaissance

A field reconnaissance of the county was conducted after the first study of the aerial photographs had been completed. This enabled the photo interpreter to examine the material with which he was working, to verify doubtful mapping situations, and to acquaint himself better with the geology of the county. All open sites were inspected to verify the geologic classification, and a limited amount of exploratory drilling was accomplished when the prospective sites were field checked.

Map Compilation and Report Writing

The Coffey County materials map was divided into six sections of approximately equal area (Plates I through VI), the index of which appears as Figure 15 (Page 127). Each designated plate represents a specific portion of Coffey County. Most of the sections have both granular material and bedrock maps, each of which is designated with the appropriate plate number and title. (Plate IA "Granular" or Plate I "Bedrock"). Only Plate II has a single map since no granular material of significance was present in that section of the county.

Only geologic units that contribute to the construction material resources of Coffey County were mapped. The map units representing consolidated material source beds (limestone units) were named in accordance with current geologic nomenclature. The engineering characteristics of these units are fairly consistent in Coffey County. Map units representing unconsolidated material source beds are based primarily on material type rather than geologic age.

All existing and prospective sites are identified on the county materials maps by appropriate designations and symbols. The site symbol will convey to the user of the report the material site category; that is, whether it is a prospective or an open site and the amount of sampling and testing accomplished. The site designation will indicate to the reader the type of material available at the site, an estimate of the quantity of material available, the number of the corresponding data form for that site, and the geologic classification of the source bed. The map legend explains all letter and map symbols used in the mapping process.

To furnish the user of the report with all available information, a data form was completed for each material site depicted on the materials maps. The site data forms are included in this report as Appendices I through IV. Appendix I contains site data forms for all sites shown on the Coffey County materials maps that are open and have not been sampled and tested. Appendix II contains site data forms for all prospective sites; not sampled. Appendix III contains site data forms for all prospective locations at which a limited amount of sampling and testing has been accomplished while Appendix IV contains site data forms for all sites that are open and have been sampled and tested.

Geologic data are presented on each form to facilitate future correlation. To aid further in determining the type of material which should be expected in untested sites, references are made to nearby locations where test results on samples from the same source bed are available.

A sketch of each location was drawn illustrating the major cultural and natural features of the immediate area to help in locating the exact site in the field.

Landowner information is presented for each materials site as it is listed in the Coffey County Register of Deeds Office.

The text of the report was completed by presenting the general geology of the county as it pertains to the various material source beds, a general description of the available material, and a general description of geologic units which, in the past, have displayed unsound engineering properties.

CONSTRUCTION MATERIALS RESOURCES OF COFFEY COUNTY

Geological History of Coffey County

Inasmuch as the Coffey County materials inventory is based primarily on the surface geology of the county, a general outline of the geological history of the area is presented. The main purpose of this section of the report is to describe the sequence of events responsible for the construction material resources of the county.

The history is discussed in terms of segments of geologic time during which various rock units were deposited and eroded. The geological history, as discussed in this report, is based primarily on reports by Ball and others (1963) and by Merriam (1963).

Figure 5 (Page 12), is a generalized geologic timetable reproduced with the permission of the State Geological Survey of Kansas, which shows the divisions of geologic time and the approximate length of each division. It should be noted that most time periods represent several million years. To further understand the events which have taken place, it is necessary for the reader to realize that climatic and geographic conditions have been vastly different from those which exist at the present time.

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.*	Water, agricultural soils, sand and gravel, volcanic ash.
	TERTIARY	59,000,000	*River silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.*	Water, sand and gravel, volcanic ash, diatomaceous marl.
MESOZOIC	CRETACEOUS	70,000,000	*Chalk, chalky shale, dark shale, varicolored clay, sandstone, conglomerate. Outcropping igneous rock.*	Ceramic materials; building stone, concrete aggregate, and other construction rock; water.
	JURASSIC	25,000,000	*Sandstones and shales, chiefly subsurface.*	
	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN	25,000,000	*Limestone; shale; evaporites (salt, gypsum, anhydrite); red sandstone and siltstone; chert; some dolomite.*	Natural gas; salt; gypsum; building stone, concrete aggregate, and other construction materials; water.
	PENNSYLVANIAN	25,000,000	*Alternating marine and non-marine shale, limestone, and sandstone; coal; chert.*	Oil, coal, limestone and shale for cement manufacture, ceramic materials, construction rock, agricultural lime, gas, water.
	MISSISSIPPIAN	30,000,000	*Mostly limestone, predominantly cherty.*	Oil, zinc, lead, gas, chat and other construction materials.
	DEVONIAN	55,000,000	*Subsurface only. Limestone, black shale.*	Oil
	SILURIAN	40,000,000	*Subsurface only. Limestone.*	Oil
	ORDOVICIAN	80,000,000	*Subsurface only. Limestone, dolomite, sandstone, shale.*	Oil, gas, water.
	CAMBRIAN	80,000,000	*Subsurface only. Dolomite, 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.

(Not scaled for geologic time or thickness of deposits)

*Committee on Measurement of Geologic Time, National Research Council

State Geological Survey of Kansas

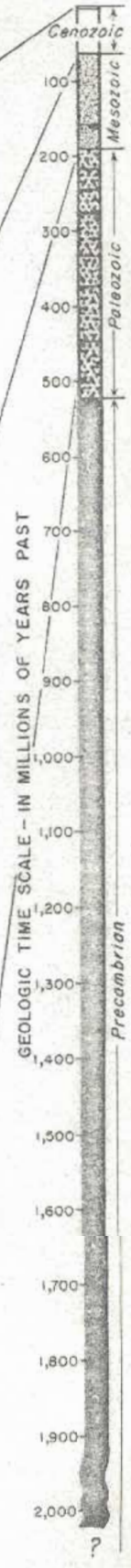

Figure 5. Geologic Timetable

Upon inspecting the timetable shown in Figure 5 (Page 12), one will note that approximately one and one half billion years are assigned to the Pre-Cambrian Era. This era is represented in the subsurface of Coffey County by an undetermined thickness of crystalline rocks. Because these rocks have been altered greatly by heat and other forces, no accurate record of the geologic history exists; therefore, this discussion is limited to the geologic events which have occurred since the beginning of the Cambrian Period, which are recorded in approximately 3,000 feet of sediments which overlie the eroded surface of Pre-Cambrian rocks. The oldest of these sediments, consisting mainly of dolomite, were deposited in seas which covered this area during the Cambrian and Ordovician Period. Most of these rocks, along with any sediments laid down in Silurian and Devonian time, were removed by erosion when a structural high (the Chautauqua Arch) formed in southeastern Kansas prior to Mississippian time causing this area to be elevated above sea level.

This area was again inundated by a sea in Mississippian time and deposits composed mainly of limestone and dolomite were laid down. Several erosional breaks indicate that the area was elevated and subjected to erosion for relatively short intervals of time during this period. The end of the Mississippian depositional period was marked by a general uplift of this region which resulted in varying amounts of rock being stripped away by erosion.

This region subsided and was inundated again in Pennsylvanian time, allowing deposition to occur on the eroded surface of Mississippian rocks. Pennsylvanian age sediments consist of limestone and shale along with minor amounts of sandstone and coal. According

to Moore (1949) the limestone and some shale were deposited under marine conditions, while part of the shales, the coal beds, and most of the sandstones were deposited in a continental depositional environment. This would indicate that the area was alternately elevated and submerged, giving rise to the two types of depositional environment. Late Pennsylvanian limestone beds are the major source of construction materials in Coffey County.

No deposits of Permian, Triassic, Jurassic, or Cretaceous age are known to exist in southeastern Kansas; therefore, no record of the geologic events which occurred in this region during these periods is available. It should be noted, however, that subsequent to the deposition of Pennsylvanian rocks and prior to the deposition of chert gravels (believed to be late Tertiary in age) portions of Pennsylvanian bed rock were removed by erosion.

Presumably, this area was subjected to erosion during most of the Tertiary time; however, some geologists believe that simultaneous to the deposition of the Ogallala Formation in western Kansas, chert gravel derived from Permian bedrock in the Flint Hills region was laid down in this area. According to Seevers and Jungmann (1963), deposits of chert gravel which cap the high terrain of Coffey County are classified as Pliocene (late Tertiary) to Pre-Kansan in age. Because some deposits of this material are found at lower levels, it is believed that deposition continued along the stream valleys of this region throughout much of Quaternary time. In this report and on the county materials maps, these gravels are referred to as Quaternary Terraces.

The alluvial deposits which are found in the valleys of the the present day streams are shown on the materials maps and referred to in this report as Quaternary Alluvium.

Discussion of the Exposed Geologic Units in Coffey County

The Pennsylvanian rocks exposed in Coffey County belong to the Douglas, Shawnee, and Wabaunsee Groups. Figure 6 (Page 17), is a geologic column showing the stratigraphic sequence of the units exposed in Coffey County.

The Douglas Group, which includes the oldest rocks exposed in Coffey County, crops out in the southeastern one quarter of the county. In general it is composed of clayey shales at its base with sandy shale and varying thicknesses of sandstone, which is sometimes cross-bedded in the upper part. Several thin limestones are also included in the group.

The full thickness of the Shawnee Group is exposed in Coffey County. Exposures are county wide except for the southeastern corner and the extreme northwestern corner of the county. This group is characterized by prominent thick limestone units and has a total thickness of approximately 350 feet in Coffey County. Even though the individual formations and members vary considerably from one area to another, the total thickness of the group is fairly consistent. Four of the formations assigned to the Shawnee Group are composed predominantly of limestone, while the three intervening formations consist mainly of shale and lesser amounts of sandstone.

The youngest Pennsylvanian sediments, the Wabaunsee Group, are exposed in the northwestern corner of Coffey County and are characterized by thick shale and thin limestone units.

Tertiary and early Quaternary age terrace deposits are generally widespread, except for the northeastern corner of Coffey County. These deposits of chert gravel, silt, and clay are found

lying on the eroded surfaces of various Pennsylvanian rock units.

Construction Materials Inventory

This section of the report inventories the construction materials in Coffey County. Only those geologic units which are producers or are considered to be potential producers of construction material are included in this report.

The generalized geologic column (Figure 6, Page 17) illustrates the relative stratigraphic position of each geologic source bed. The county materials maps show the geographic areas where construction material source beds are exposed or near the surface. Generally speaking, any given source bed will exhibit similar characteristics throughout the county.

Limestone bedrock and terrace deposits are the main sources of construction material in Coffey County. Eight different limestone units were mapped as producers or potential producers of construction material. The bedrock exposure pattern in the county is such that very little limestone exists in the southwestern or northwestern corners of the county. (See Plates I through VI).

High terraces of Tertiary and early Quaternary age are mapped as sources of chert gravel. If washed, these gravels would meet most of the specifications (Freeze and thaw, wear, etc.) for construction aggregate; however, because of high clay content and limited sources of water for washing purposes at these sites, gravel from these deposits is used only for surfacing material on rural roads in the county.

A third, but somewhat limited source of aggregate is the flood plain of the Neosho River. This Quaternary Alluvium may contain chert gravels of quality similiar to the gravels found in the higher terraces.

SYSTEM	SERIES	GROUP	FORMATIONS	MEMBERS	GRAPHIC LEGEND	MATERIALS USAGE
Quaternary	Pleistocene		Alluvium			Light Type Surfacing Material
			Terrace Deposit			Light Type Surfacing Material
Pennsylvanian	Upper Pennsylvanian	Wabaunsee	Scranton Shale	White Cloud Shale		
			Howard Limestone	Utopia Limestone		
				Winzeler Shale		
				Church Limestone		
				Aarde Shale		
				Bachelor Creek Limestone		
			Severy Shale			
		Shawnee	Topeka Limestone	Du Bois Limestone		
				Turner Creek Shale		
				Sheldon Limestone		
				Jones Point Shale		Crushed Limestone Aggregate Riprap
				Curzon-Hartford Limestone		
			Calhoun Shale			
			Deer Creek Limestone	Ervine Creek Limestone		Crushed Limestone Aggregate Riprap
				Larsh-Burroak Shale		
				Rock Bluff Limestone		
				Oskaloosa Shale		
				Ozawkie Limestone		Crushed Limestone Aggregate Riprap
			Tecumseh Shale			
			Lecompton Limestone	Avoca Limestone		
				King Hill Shale		
				Beil Limestone		Crushed Limestone Aggregate Riprap
				Queen Hill Shale		
				Big Springs Limestone		
				Doniphan Shale		
				Spring Branch Limestone		Crushed Limestone Aggregate Riprap
			Kanwaka Shale	Stull Shale		
				Clay Creek Limestone		Crushed Limestone Aggregate Riprap
				Jackson Park Shale		
			Oread Limestone	Kereford Limestone		Crushed Limestone Aggregate Riprap
				Heumader Shale		
				Plattsmouth Limestone		Crushed Limestone Aggregate Riprap
				Heebner Shale		
				Leavenworth Limestone		
				Snyderville Shale		
				Toronto Limestone		Crushed Limestone Aggregate Riprap
		Douglas	Lawrence	Ireland Sandstone		
				Robbins Shale		
				Haskell Limestone		
			Stranger	Vinland Shale		
				Tonganoxie Sandstone		
				Weston Shale		

KEY TO GRAPHIC LEGEND

- Silty clay
- Clay bound gravel
- Limestone
- Shale
- Fissle shale
- Limy shale
- Sandstone
- Coal with underclay

Figure 6. Generalized geologic column of the geology of Coffey County.

No known mineral filler deposits (volcanic ash or silt) have been reported in Coffey County. Prospective sites for such material would probably be limited to the Neosho River flood plain.

A tabulation of the various types of material available in Coffey County is shown in Figure 7 (Page 20). The source beds from which each material type can be produced are listed, along with the page number where the engineering characteristics are described. The locality where each of the geologic source beds is located is also included in this tabulation.

Pennsylvanian System, Upper Pennsylvanian Series

Toronto Limestone Member: The Toronto Limestone is the basal member of the Oread Limestone Formation and is the oldest geologic unit mapped in Coffey County. It is illustrated as a single map unit on Bedrock Plates II, IV, V, and VI. The Toronto is a light gray, fairly massive, straight bedded limestone that weathers buff to brown in color. This limestone is generally eight to nine feet thick; however, it is reported to be as much as 16 feet thick south of Burlington along US-75 Highway. Figure 8 (Page 21), shows an exposure of the Toronto in central Coffey County.

Several quarries produce rock from the Toronto in Coffey County. Two of these quarries had thin overburden (Sites $\frac{LS+4}{Pot}$ and $\frac{LS+27}{Pot}$) and a third site, $\frac{LS+26}{Pot}$ had younger geologic units (Snyderville Shale and Leavenworth Limestone Members) capping the producing ledge. Laboratory results on samples taken from site $\frac{LS+4}{Pot}$ indicate that the water absorption of the rock produced from this quarry would be too excessive to meet specifications for use as aggregate in bituminous construction. The aggregate produced from the Toronto Limestone

Construction Material	Source Bed	Description	Availability
Limestone	Toronto Limestone Member	Page 19	Plentiful; Eastern one half of the county. Bedrock Plates II, IV, V, and VI.
	Plattsmouth Limestone Member	Page 22	Plentiful; Eastern one half of the county. Bedrock Plates II, III, IV, V, and VI.
	Kereford Limestone Member	Page 23	Scarce; Northeastern one fourth of the county. Bedrock Plate II.
	Clay Creek Limestone Member	Page 24	Scarce; Central part of the county. Bedrock Plates III and IV.
	Avoca-Beil Limestone Members	Page 26	Limited; Western one half of the county. Bedrock Plates I, II, III, and V.
	Ozawkie Limestone Member	Page 26	Limited; Western one half of the county. Bedrock Plates I, II, III, and V.
	Ervine Creek Limestone Member	Page 28	Limited; Western one half of the county. Bedrock Plates I, II, III, and V.
	Curzon-Hartford Limestone Members	Page 29	Plentiful; Western one half of the county. Bedrock Plates I, III, and V.
Chert Gravel	Quaternary Terraces	Page 30	All of the county except the northeastern one fourth. Source sites plentiful, quantity limited. Granular Plates I, III, IV, V, and VI.
	Quaternary Alluvium	Page 30	Limited; Along the Neosho River valley. Granular Plates III, IV, V, and VI.

Figure 7. A recapitulation of the construction material types and their availability in Coffey County.

Figure 8. Exposure of the Toronto Limestone Member in Coffey County, NW¼, Sec. 31, T21S, R16E.

Member is inferior in quality to that produced from the Plattsmouth and the Curzon-Hartford Limestone Members. A better quality material is derived from the Toronto north of Coffey County.

The following are some results of laboratory tests completed on samples taken from the Toronto in Coffey County.

Sample Number	1	2	3
Specific Gravity (saturated)	2.51	2.48	2.45
Specific Gravity (dry)	2.41	2.36	2.33
Los Angeles Wear Test (Grading "B")	31.4 %	38.18%	34.6 %
Absorption	4.46%	4.90%	5.26%
Soundness Loss Ratio	.96	.95	.91

Plattsmouth Limestone Member: The Plattsmouth Limestone Member is located in the upper portion of the Oread Limestone Formation and is a major contributor to the construction material resources of the county. The unit consists of light bluish-gray, dense, fine grained, wavy bedded, limestone with scattered nodules of blue-gray chert. Thin shale partings are common and are quite conspicuous in a weathered section. Figure 9 (Page 22), shows the Plattsmouth in an abandoned quarry.

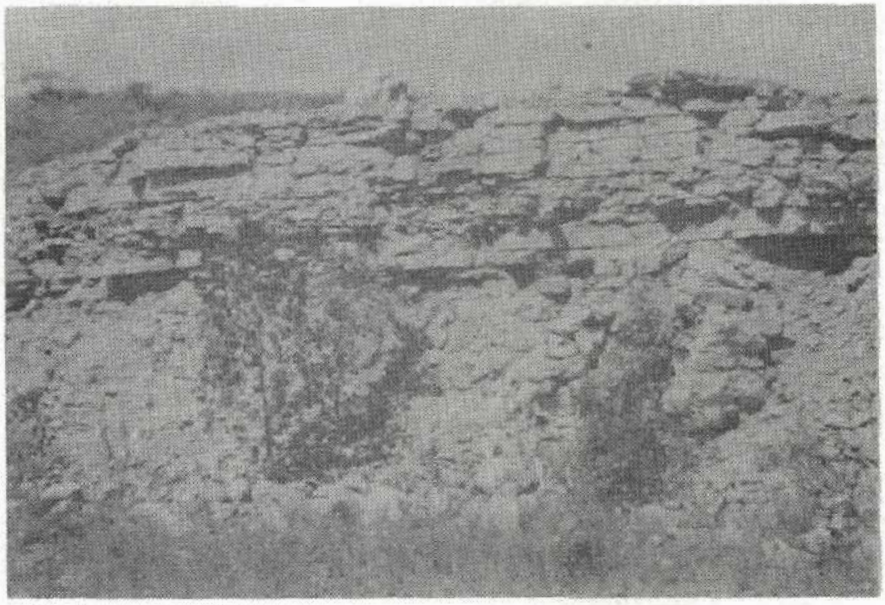

Figure 9. Face of an open quarry in the Plattsmouth Limestone Member in Coffey County, NE¼, Sec. 32, T20S, R16E.

The Plattsmouth can be traced from the southeastern corner of Osage County, where it has a thickness of approximately 17 feet, southwestward along its strike to approximately the junction of US Highway 75 and Kansas Highway 57, at which point it is approximately four feet thick. Southwestward from this point the unit is missing

in Coffey County. Presumably, the Plattsmouth was removed by the erosive action of ancient channels that were active in this area. Sandstones, believed to have been deposited in these ancient channels, are located in a stratigraphic position comparable to that of the Plattsmouth Limestone in this part of the county.

Good quality aggregate can be produced from the Plattsmouth Limestone Member. Laboratory tests completed on samples taken from this unit in counties to the north (Doniphan, Atchison, Leavenworth, Jefferson, Douglas, and Osage) indicate a poorer quality of material than that found in Coffey County. Plates II (Bedrock), III (Bedrock), IV (Bedrock), V (Bedrock), and VI (Bedrock) depict the exposure pattern of the Plattsmouth Limestone Member in this county. Three quarries have produced material from the Plattsmouth Limestone (Sites $\frac{LS+1}{Pop}$, $\frac{LS+2}{Pop}$, and $\frac{LS+32}{Pop}$). The following are the results of a limited number of quality tests completed on samples taken from the Plattsmouth in this county:

Sample Number	1	2	3
Specific Gravity (saturated)	2.56	2.63	2.66
Specific Gravity (dry)	2.48	2.59	----
Los Angeles Wear Test (Grading as shown)	35.8 %(B)	27.5 %(B)	26.5 %(A)
Absorption	3.15%	1.56%	1.19%
Soundness Loss Ratio	.92	.96	.96

Kereford Limestone Member: The Kereford Limestone, which is the top member of the Oread Limestone Formation, is a blue-gray, fairly dense, flaggy limestone with thin shale partings. Although this unit has a maximum thickness of approximately 25 feet in north-

eastern Kansas, it does not exceed six or seven feet in Coffey County.

The Kereford caps the high terrain in the northeastern part of the county, but it is buried by younger beds in the central part and has been removed by erosion in the southern part of the county. Plate II (Bedrock) delineates the exposure pattern of the Kereford Limestone Member.

The Kereford has been quarried in Osage County for riprap and crushed stone, but it is usually not considered to be a good quarry stone in eastern Kansas because of its susceptibility to weathering. This limestone has not been quarried in Coffey County, and because of its weathering characteristics and limited area of exposure, as well as the availability of better quarry limestones, the Kereford will probably not be utilized as a source of construction material in the near future.

Clay Creek Limestone Member: The Clay Creek is a blue-gray, fine grained, dense limestone which varies in thickness from approximately two to six feet. Only a limited number of exposures of the Clay Creek Limestone Member exist in Coffey County, and for the most part, these are restricted to a small area in the central part of the county. Figure 10 (Page 25), shows the Clay Creek in a quarry located in central Coffey County. Plates III (Bedrock) and IV (Bedrock) show the exposure pattern of the Clay Creek Limestone Member.

A limited number of quarries have been opened in the Clay Creek in northeastern Kansas, but normally it is not considered a potential source bed because of its thin nature. Crushed aggregate and riprap were produced from the Clay Creek at quarry site $\frac{LS+5}{Pdc}$

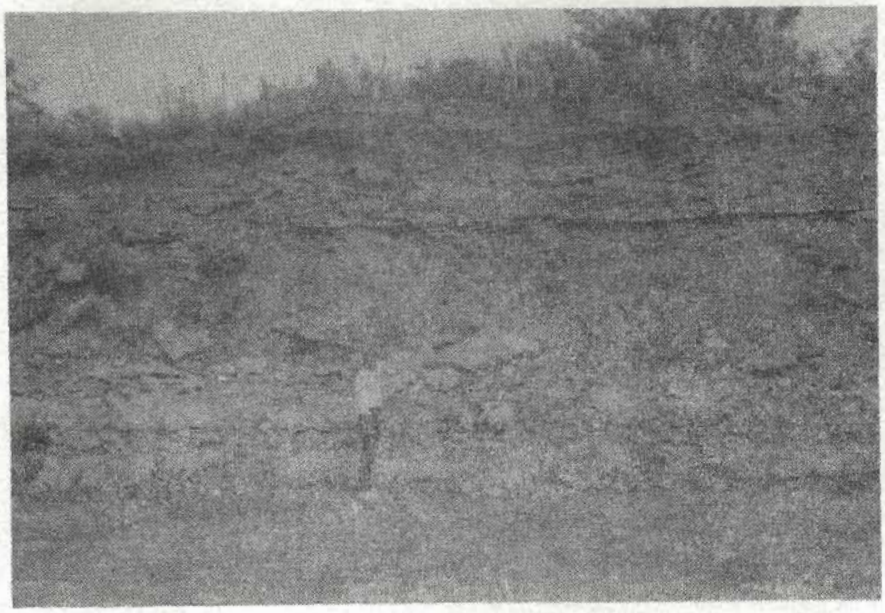

Figure 10. Clay Creek Limestone quarry in Coffey County, SW¼, Sec. 2, T21S, R15E.

in Coffey County; however, the member has an abnormal thickness of approximately five to six feet in this locality. Much of the crushed stone and riprap used in the construction of John Redmond Dam by the U. S. Army Corps of Engineers were produced from the quarry mentioned above.

Even though the Clay Creek will produce high quality aggregate and riprap, the thin nature of the unit and the large amount of overburden generally encountered may make it economically unfeasible to quarry. The following are quality test results completed on samples taken from site $\frac{LS+5}{Pkc}$ in Coffey County:

Sample Number	1	2
Specific Gravity (saturated)	2.64	2.64
Specific Gravity (dry)	2.60	2.60

Sample Number (con't)	1	2
Los Angeles Wear Test (Grading D)	23.4 %	22.1 %
Absorption	1.67%	1.58%
Soundness Loss Ratio	.98	.97

Avoca and Beil Limestone Members: The Avoca and Beil Limestone Members are shown on the materials maps, Plates I (Bedrock), II (Bedrock), III (Bedrock), and V (Bedrock) as one unit. However, the Avoca is not a material producer and is included only for correlation purposes. The Avoca and Beil together form a prominent ridge which is easily traced on aerial photography.

The Beil is a gray, massive, irregular to wavy bedded limestone which is considered to be a prospective source bed of construction material. Its thickness ranges from two feet in the central portion of the county to approximately six feet in the north part. Figure 11 (Page 27), shows the Beil in a road cut in northern Coffey County.

No quality tests have been completed on the Avoca and Beil Limestone Members in Coffey County. However, material produced from these units elsewhere in the state usually meets specifications for riprap and concrete and bituminous aggregate.

Ozawkie Limestone Member: The Ozawkie Limestone is the basal member of the Deer Creek Limestone Formation. In Coffey County the Ozawkie is composed of two limestone ledges separated by a shale zone, and has an overall thickness ranging from 10 to 20 feet. The basal limestone varies in thickness from two to seven feet while the average thickness of the upper ledge is approximately three feet.

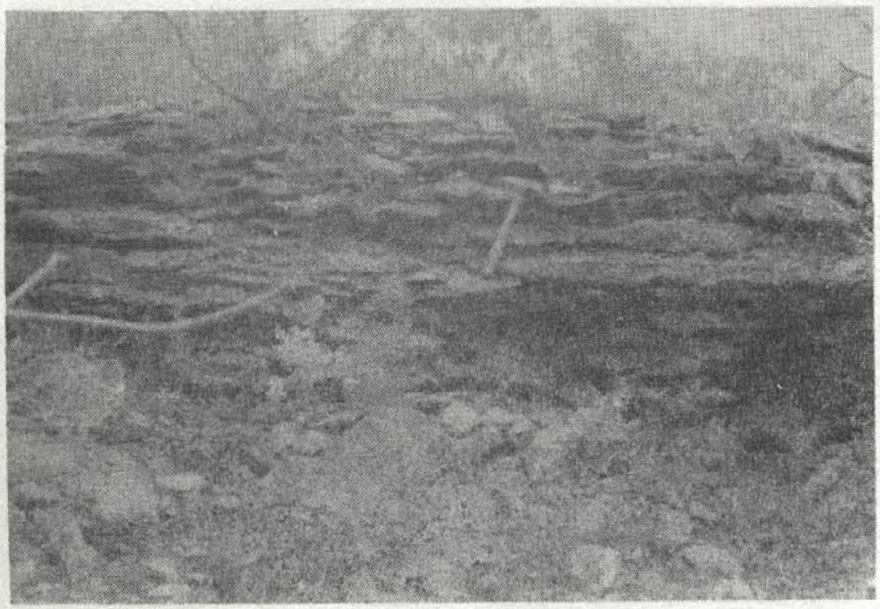

Figure 11. Exposure of the Beil Limestone Member in Coffey County, SE¼, Sec. 11, T19S, R15E.

The lower limestone of the Ozawkie is a light gray, massive, dense limestone which will normally meet specifications for concrete and bituminous construction aggregate. The upper ledge of the member is a buff to brown, impure limestone which produces a more inferior construction material.

In central Coffey County both limestones of this member are exposed near the bottom of the valleys; however, the Ozawkie caps the high terrain in the northern part of the county. Plates I (Bedrock), II (Bedrock), III (Bedrock), and V (Bedrock) show the exposure pattern of the unit.

No records exist of any quality tests having been completed on samples of the Ozawkie taken in Coffey County.

Ervine Creek Limestone Member: The Ervine Creek Limestone is the top member of the Deer Creek Limestone Formation. It is a light gray, wavy bedded, dense limestone with thin shale partings. The unit ranges in thickness from four to eight feet. Figure 12 shows an exposure of the basal part of the Ervine Creek.

Figure 12. Exposure of the Ervine Creek Limestone Member in Coffey County, NW¼, Sec. 15, T20S, R14E.

The Ervine Creek has been a source of construction material in other counties in Kansas, but production has been somewhat limited in Coffey County. No test data are available for the Ervine Creek for this area; however, results of test conducted on samples obtained in other counties indicate a highly variable material. Plates I (Bedrock), II (Bedrock), III (Bedrock), and V (Bedrock) outline the exposure pattern of the Ervine Creek Limestone Member.

Curzon-Hartford Limestone Members: The Curzon and Hartford Limestone Members of the Topeka Limestone Formation are the major contributors to the construction materials resources of Coffey County. The Curzon is a gray, fairly dense limestone with some interbedded limy shale, while the Hartford is a gray to blue-gray, massive limestone. These two members are separated by a thin shale member (Iowa Point Shale) to the north of the county; however, this shale is missing in Coffey County. The two limestone members have a total thickness of approximately 16 feet. An exposure of the Curzon-Hartford is shown in Figure 13 (Page 30).

The Curzon-Hartford Limestone Members are widespread in the western half of Coffey County and are the best source of construction material in this area. Plates I (Bedrock), III (Bedrock), and V (Bedrock) delineate the exposure pattern of the two members in Coffey County.

Sites $\frac{LS+3}{Pt}$ and $\frac{LS+6}{Pt}$ are quarries in the Curzon-Hartford Members. Both produce high quality crushed aggregate, riprap, and light type surfacing material. The results of quality tests that have been completed on samples taken from these units in Coffey County are as follows:

	Sample Number		
Specific Gravity(saturated)	2.58	2.58	2.57
Specific Gravity(dry)	2.53	2.53	2.52
Los Angeles Wear Test (Grading "B")	27.0 %	28.9 %	33.0 %
Absorption	2.12%	2.16%	2.25%
Soundness Loss Ratio	.98	.98	.97

Figure 13. A quarry in the Curzon-Hartford Limestone Members in Coffey County, SW¼, Sec. 33, T20S, R14E.

Quaternary System, Pleistocene Series

Quaternary Terraces: Early Quaternary age, high terrace deposits composed of chert gravel, silt, and clay are widespread over the southern two-thirds of Coffey County. See Granular Plates IA, IIIA, IVA, VA, and VIA for the geographic locations of terrace deposits containing a high percentage of chert gravel.

Some granular material has been obtained from relatively low terraces along the northern wall of the Neosho River valley in the southeastern portion of the county. However, these terraces have produced only limited quantities and are considered relatively insignificant as sources of construction material.

Quaternary Alluvium: Even though chert gravel has been produced from only one pit in the alluvium of the Neosho River valley,

it is probable that additional sources may be found in the flood plain of this river. Figure 14 illustrates the texture of these gravels.

Figure 14. Chert gravel of early Quaternary age in Coffey County, SW¼, Sec. 36, T19S, R13E.

Inasmuch as these deposits are completely masked by silt and clay, they must be located by exploratory drilling. Granular Plates IIIA, IVA, VA and VIA outline the location of the Quaternary Alluvium deposits.

Most of the flood plain (alluvium) upstream from John Redmond Dam lies above conservation water level and below flood pool level; therefore, production operations in this area would be subject to periodic flooding by water impounded in the reservoir.

Geo-Engineering

This section of the report discusses the quality of the material available in Coffey County for normal or selected embankment

purposes and for subgrade construction. In addition, ground-water problems that may be encountered on construction projects and the availability of water suitable for concrete mixing purposes are discussed briefly.

Inasmuch as the main objective of this section of the report is to familiarize the reader with some of the adverse field conditions to be expected and the engineering properties of the material that may be encountered in Coffey County, the information presented is general in nature. Detailed field investigations will be required to ascertain the severity of any specific problem and to make recommendations concerning design and construction procedures.

Material Usage Considerations

Most of the material available for embankment and subgrade construction in Coffey County consists of clay shales or soil mantle derived from thick shale units. This material, along with alluvium derived predominantly from the shale units, displays undesirable engineering properties.

Most of the soil mantle derived from shale in this area is characterized by a large fraction passing the No. 200 sieve, high liquid limits, and plastic indices that range from 15 to 45. The material is classified as a silty clay loam, silty loam, and as a clay in the more severe cases according to the Kansas texture classification system. Most of the material would be classified as A-6 or A-7 according to the American Association of State Highway Officials (AASHO) Soil Classification System.

The clay shales are undesirable for construction purposes because of a high volume change between wet and dry states. Swell values of many of the shale units exceed four percent. (Swell

values referred to in this report are the result of tests conducted by the State Highway Commission of Kansas). Swell values of two percent are considered the maximum permissible for subgrade soils and shale beneath a rigid pavement if roughness is to be avoided.

Through past experience it is known that clay shales, such as those found in Coffey County, are practically impossible to pulverize with ordinary construction equipment to a state where they can be effectively stabilized with lime. Unweathered sandstone that might be encountered in the shale units would be equally as hard to pulverize for use in subgrade construction.

Most of the material described in this section of the report would not ordinarily be recommended for shoulder construction. Such material may be useful for slope protection because of its resistance to erosion; however, if the development of turf is desired, it should be avoided. If used for embankment construction, such material should be placed in the lower portion, and its shear strength should receive special attention if considered for use in high fills.

Possible Hydrology Problems in Road Construction

Many road failures are associated with the movement and accumulation of ground-water. Subsurface water problems are usually confined to definite zones within consolidated geologic units or in unconsolidated material where conditions are favorable for ground-water movement. Occasionally, small geologic units, which many times are considered insignificant from the construction point of view, may be the source of subsurface water problems. If water bearing zones or beds are encountered on construction projects, special drains may be required to intercept the ground-water to

prevent it from entering the road structure. Detailed field investigations would be required to ascertain the location and severity of the ground-water problem in relation to the proposed improvement.

Potential subsurface water problems exist throughout Coffey County. Such situations have been encountered on improvements constructed in the southeastern quarter of the county in rocks assigned to the Douglas Group. Free water and seeps occur along the base of thin limestone, sandstone, and coal beds that are exposed or near the surface in this area.

The majority of the geologic units exposed in Coffey County belong to the Shawnee Group. Ground-water problems have been encountered at the base of many of the limestone and sandstone beds assigned to this group, such as the Toronto Limestone, the sandstone in the Snyderville Shale, the Ozawkie Limestone, and the Topeka Limestone. Most improvements constructed in Coffey County will come in contact with units assigned to the Shawnee Group and in most cases, ground-water problems can be anticipated.

Pollution of Water Resources

Because of the possible detrimental affects that highly mineralized mix water can have on the performance of concrete, emphasis is being placed on the quality of the water used for this purpose. Only limited information of this nature is available for water produced in Coffey County; however, reports completed on Lyons County to the west by O'Connor and others (1953) and on Osage County to the north by O'Connor and others (1955), provide information concerning the quality of water produced from geologic units which may

also be sources in Coffey County.

According to available data, most producing zones provide good quality mix water. Excessively mineralized water has, on occasion, been produced from the thick shale and sandstone units exposed or near the surface in Coffey County.

In Osage County to the north, highly mineralized water has been produced from the Ireland Sandstone and the Tonganoxie Sandstone of the Douglas Group, and from the Severy Shale and the White Cloud Shale of the Wabaunsee Group. Water produced from these and similiar geologic units should be analyzed before being used in concrete mixes.

Terrace deposits have also produced highly mineralized water; however, this may be due to pollution by man. In most instances, good quality mix water can be obtained from terraces along the Neosho River, but possible pollution by oil wells or other means should always be checked.

GLOSSARY OF SIGNIFICANT TERMS

Absorption: Determined by tests performed in accordance with A.A.S.H.O. Designation T 85.

Alluvium: A deposit of clay, silt, sand, or gravel laid down by flowing water.

Consolidated geologic units: Usually refers to strata older than Pleistocene where there is some cementation of the individual grains. (i.e. shale, sandstone, and limestone).

Continental deposits: Deposits laid down on land by rivers, wind, glaciers, etc.

Dip of geologic units: Angle of incline of the bed with respect to horizontal and the direction in which these beds are inclined.

Geologic period: A unit of geologic time. Mississippian, Pennsylvanian, and Permian are examples.

Geologic unit: This term is used in this report to denote (1) a geologic formation, (2) a geologic member, or (3) an unconsolidated deposit of Tertiary or Pleistocene age.

Ground-water: Water in the zone of saturation, that is, below the water table. In a more general and popular sense, any water that is standing in or passing through the ground may be called "ground-water."

Light type surfacing material: Chert gravel or crushed limestone placed on roads to provide an all weather surface or more commonly " a gravel road."

Liquid limit: Determined by tests performed in accordance with Section Y 4 of the State Highway Commission of Kansas Standard Specification, 1960 edition.

Los Angeles Wear: Determined by tests performed in accordance with A.A.S.H.O. designation T 96 as modified by Section Y 14 of the State Highway Commission of Kansas Standard Specifications, 1960 edition.

Marine deposits: Deposits laid down in the sea as contrasted with those laid down on land or in lakes.

Material source bed: A geologic unit from which usable construction material can be produced or is being produced.

Open materials site: A pit or quarry which has produced or is producing material suitable for some phase or phases of road construction.

Plastic index: Determined by tests performed in accordance with Section Y 4 of the State Highway Commission of Kansas Standard Specifications, 1960 edition.

Pleistocene age: A period of geologic time representing approximately the last one million years on the geologic time scale.

Pliocene age: The last and youngest major subdivision of the Tertiary Period.

Prospective materials site: A geographic location where the geological conditions are favorable for the discovery of construction material.

Soundness: Determined by tests performed in accordance with Section Y 15 of the State Highway Commission of Kansas Standard Specificiations, 1960 edition.

Specific gravity: Determined by test performed in accordance with A.A.S.H.O. Designation T 84 for sand and gravel and A.A.S.H.O. Designation T 85 for crushed stone.

Stratigraphic position: The vertical position of a geologic unit in relation to other geologic units.

Terrace: A plain located above the present flood plain, which is usually made up of older stream laid deposits.

Unconsolidated deposits: A geologic unit where the basic constituents of the material have not been cemented or do not adhere together as a unit bed. Silt, clay, sand, and gravel are the main constituents of unconsolidated deposits. Most unconsolidated deposits were laid down in Pleistocene time.

Wash: (Material passing the No. 200 sieve) Determined by tests performed in accordance with A.A.S.H.O. Designation T 11.

Weight per cubic foot: Determined by tests performed in accordance with A.A.S.H.O. Designation T 19-45.

SELECTED REFERENCES

1. Ball, S. M. and others (1963) Geology of Franklin County, Kansas: Kansas Geol. Survey Bull. 163, 57 p.

2. Eardley, A. J. (1951) Structural Geology of North America: Harper and Brothers, New York, pp. 4-23.

3. Frye, J. C. and Leonard, A. B. (1952) Pleistocene Geology of Kansas: Kansas Survey Bull. 99, pp. 1-230.

4. Merriam, D. F. (1963) The Geologic History of Kansas: Kansas Geol. Survey Bull. 162, pp. 13-254.

5. Moore, R. C. (1949) Divisions of the Pennsylvanian System in Kansas: Kansas Survey Bull. 83, 203 p.

6. O'Connor, H. G. and others (1953) Geology, Mineral Resources, and Ground-water Resources of Lyon County, Kansas: Kansas Geol. Survey, Vol. 13, Parts 1, 2, and 3, 59 p.

7. ---------- (1955) Geology, Mineral Resources, and Ground-water Resources of Osage County, Kansas: Kansas Geol. Survey, Vol. 13, Parts 1, 2, and 3, 50 p.

8. Seevers, W. J. and Jungmann, W. J. (1963) Terrace Development along Marais des Cygnes and Neosho River Valley, Kansas: Transactions of the Kansas Academy of Science, Vol. 66, pp. 393-396.