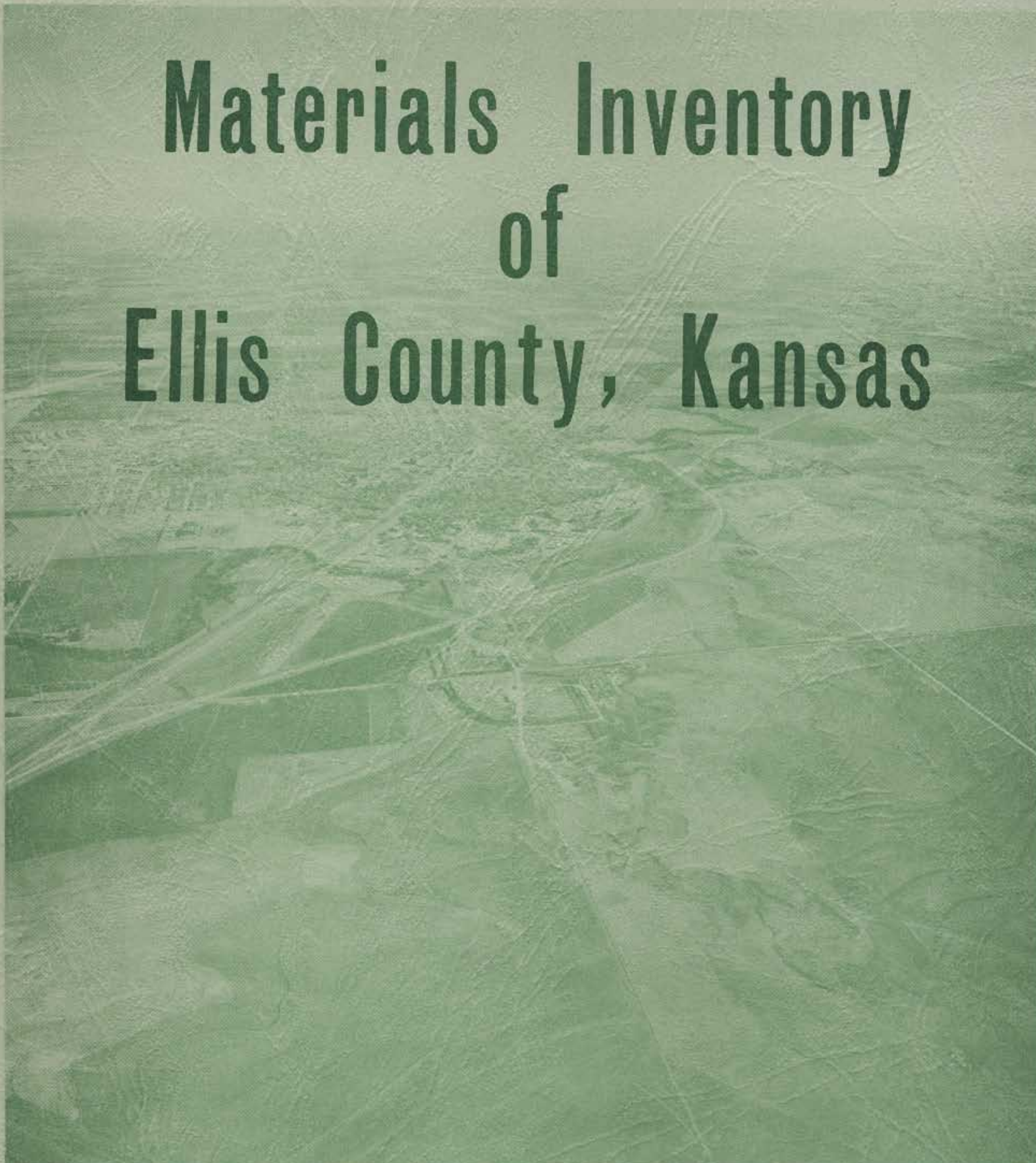
Materials Inventory of Ellis County, Kansas



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 ELLIS COUNTY, KANSAS

by

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Photogrammetry Section

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

1963

Materials Inventory Report No. 1

SUGGESTED USE OF THE REPORT

The Ellis County materials inventory report includes: 1. an introduction which describes the nature of the report and gives general information concerning Ellis 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 material in the county, and a detailed description of the materials which have been produced from these units; 4. county materials maps (PlatesI through VI) which show the geographic locations where the various source beds can be found in the county, along with the locations of all open and prospective material sites; 5. appendices I through V which contain site data forms for each open and each prospective material site. Each site data form has a sketch showing the 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 location.

When this report is used as a guide for planning an exploration program or making an assessment of the materials resources of Ellis 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 entitled, "Construction Materials Resources of Ellis County". In this portion of the report a geologic history of Ellis County is presented which describes the geologic events which led to the deposition of the various source beds and which sets forth the geologic nomenclature used throughout the report. The construction materials resources of Ellis County are also inventoried in this section. 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 has determined which geologic source may contain material that will meet his requirements, he should then refer to the county materials maps. From these he can find the areas in which this geologic source bed is present, the locations of sites which have produced material from this source, the locations of prospective material sites in this source bed, and references to site data forms for each open or prospective site.

For example, the reader determines from the study of the Construction Materials Inventory section that sand and gravel from the Meade Formation may fulfill the materials specifications for a project in the central part of the county. The materials map (Plate VI) shows several open pits along the Smoky Hill River in southeastern Ellis County. If the reader is interested in site $\frac{Sg+79}{Qm}$, he refers to Appendix II, where detailed information about this particular location is given on a site data form. This information will enable him to plan his exploration program in an orderly fashion.

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 material source beds in Ellis County and to correlate geological nomenclature with the material source beds for classification purposes. The materials inventory program does not propose to eliminate field work, but it should substantially reduce and help to organize field investigations.

Several previous surveys completed in Ellis County and Central Kansas provided the basic geologic and materials data used in this investigation. Information issued by the United StatesGeological Survey and the Materials Department of the State Highway Commission of Kansas provided quality test results and other general facts pertaining to the construction materials resources of the county. Several publications issued by the State Geological Survey of Kansas, regarding specific geologic units exposed in Ellis County and the general geology of Central Kansas, furnished information pertaining to the geological history and stratigraphy of Ellis County. Numerous preliminary soil surveys and geologic investigations have been conducted for road design purposes by the State Highway Commission of Kansas along the various major highways that traverse Ellis County. These surveys provided detailed information concerning the location and thickness of the various geologic units exposed in Ellis County.

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 Section.

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ABSTRACT

In Ellis County, construction materials can be produced from unconsolidated terrace deposits of Pleistocene age, the Ogallala Formation of Tertiary age, and the Fort Hays Limestone of Cretaceous age.

The Fort Hays Limestone provides an economical source of surfacing material and is used on lightly traveled rural roads. Aggregate from this source forms a fairly stable all weather surface, but its "dusty" nature is a disadvantage during dry weather.

The Ogallala Formation provides a limited source of silt and fine sand in the northwestern corner of the county; however, it is difficult to obtain because most of the Ogallala Formation is capped by mortar bed in Ellis County. To date, only a limited amount of this material has been produced for use as surfacing material for rural roads.

Deposits classified as Pleistocene-Recent Undifferentiated, which are located on high terrain in the central part of the county, provide a limited supply of low quality fine sand which has been used as surfacing material on rural roads.

The best quality construction material available in Ellis County is produced from the Meade Formation. Terraces included in this map unit are located above the flood plains of the Saline and Smoky Hill Rivers and are a source of good quality siliceous sand and gravel. Material produced from this unit is suitable for most phases of road construction, i.e., concrete, bituminous and light type surfacing aggregates. Some mineral filler may also be produced from this source unit.

The Sanborn Formation provides a source of limestone gravel often used for the surfacing of rural roads. Deposits included in this map unit form high terraces along the Smoky Hill and Saline Rivers. A limited amount of volcanic ash, used for mineral filler, is found in this unit.

Siliceous sand and gravel are produced from terraces of Wisconsinan age found in the flood plain of the Smoky Hill River; however, significant deposits of this age are not present along the Saline River. A pumping operation is required to produce material from these deposits because they are below the water table. Material from this source (which is included in the Quaternary Alluvium map unit) is suitable for bituminous aggregate and light type surfacing material.

Fine siliceous sand and limestone gravel can be produced from the Recent deposits along the Saline and Smoky Hill Rivers. Material from these deposits must also be produced by pumping operations because they, like the material from Wisconsinan terraces, lie below the water table.

Several geologic units that are exposed in Ellis County display undesirable engineering properties. The two most striking examples are the Graneros and Blue Hill Shale units.

The Graneros Shale, which is exposed in the extreme eastern part of the county along the major river valleys, is composed of a highly plastic material exhibiting high swell tendencies. The Blue Hill Shale underlying most of Ellis County is characterized by engineering properties similar to those of the Graneros Shale.

Many of the geologic units exposed in Ellis County have properties which are conducive to ground water problems under adverse climatic conditions. Because of the relatively low annual rainfall in Ellis County, these problems are not as severe as those encountered in the eastern part of the state.

The Smoky Hill and Saline Rivers and their associated flood plains and terraces provide the principal source of water in Ellis County. Water is also produced from Big Creek flood plain and from various geologic units in the subsurface. All water to be used in concrete mixes should be tested for sulfate and chloride concentrations because the presence of these ions may have a detrimental effect on the concrete.

INTRODUCTION

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

Scope

This investigation includes all of Ellis County. All geological units and deposits that are considered to be sources of construction material are mapped and described. The term "construction material", as used in this report, includes soft limestone which can be crushed and used as light type surfacing aggregate as well as granular material suitable for road construction purposes. A geo-engineering section is also included to discuss the geologic units which exhibit undesirable engineering properties.

This report contains detailed information obtained from laboratory test results for many of the open sites, and general information for the remaining sites, gained by correlating the sampled to the unsampled locations. All available and pertinent information is presented to aid in the development of the described material source beds.

Nature of the Report

Because all material source beds are the product of geologic agents, the materials inventory program is based, primarily, on the geology of Ellis County. By using geology as the basis of the materials inventory, one may ascertain the general engineering properties of the material source units and identify and classify each source bed according to geologic nomenclature. 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, the geologic classification assigned to unconsolidated deposits denotes age and not material type. For example, two deposits which were laid down during the same time period, but located in different parts of the state, may have the same geologic classification but may vary in composition because of different parent material. The gradation of the material present in unconsolidated deposits 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 properties 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 quality of the material.

The mapping of various geologic units for this report has been accomplished on aerial photography of the county. Because of their continuous nature, most consolidated units can be mapped with a minimum amount of field checking. Unconsolidated deposits of sand and gravel are less extensive and more difficult to detect; however, they can be located on aerial photographs through the interpreter's knowledge of the geology of the county and by his interpretation of significant terrain features that are discernible on the aerial photographs.

One can derive general information concerning the material in a prospective site by determining the source bed and by studying the results of quality tests completed on samples taken from the same geologic unit. Consequently, prospective sites can be selected for development on the general merits of the material.

General Information

Ellis County, with an area of approximately 900 square miles, is located on the western extremity of the Smoky Hill physiographic division of Kansas. The county is bounded by parallels 39° 39' and 39° 8' north latitude and meridians 98° 58' and 99° 38' west longitude. Ellis County is bordered on the east by Russell County, on the north by Rooks County, on the west by Trego County, and on the south by Rush County.

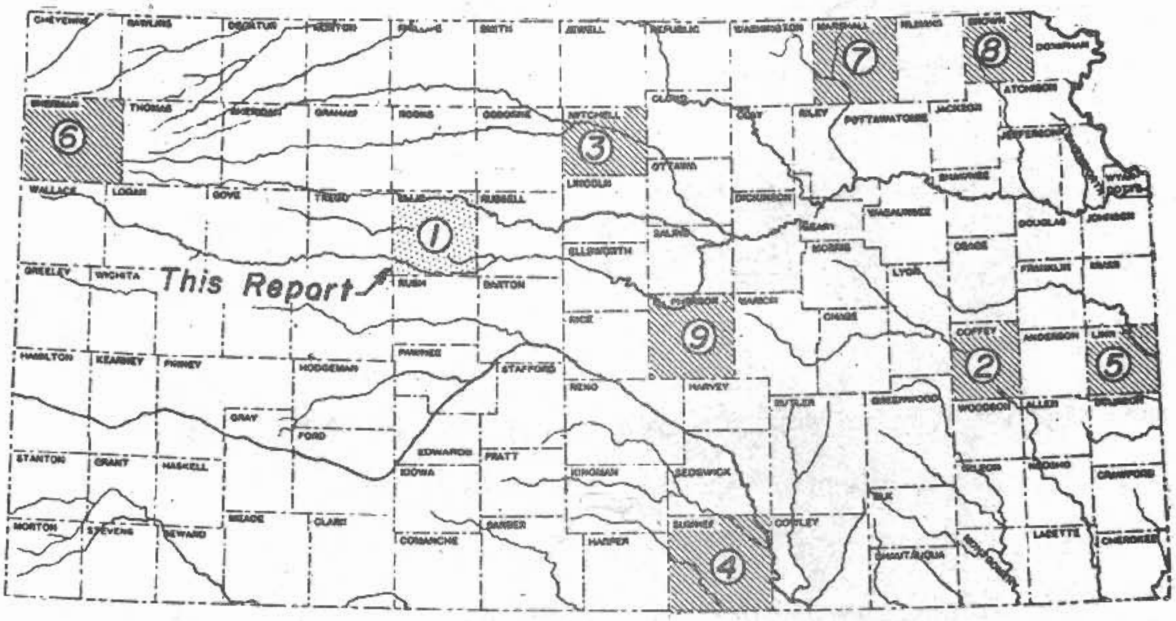


Figure 1. Index map of Kansas showing the location of Ellis County along with the report number and location of other counties for which reports have been or are being completed.

Three perennial streams flow eastward across the county. The Smoky Hill River, which originates in eastern Colorado, enters near the southern border of Ellis County and flows eastward on a course paralleling the southern boundary of the county. The Saline River, originating in Thomas

County, enters the northwestern corner and nearly parallels the northern border of Ellis County. Big Creek originates in Gove County, 70 miles to the west. It enters Ellis County about midway between the northern and southern borders and trends southeast across the county to a confluence with the Smoky Hill River in the southwestern corner of Russell County.

Ellis County is served by the Union Pacific Railroad, one of the main railroads traversing the state. Hays, the county seat and principal city, Ellis, and Victoria are all located along this railroad. There is a well-developed system of federal, state, and county roads in Ellis County. U.S. Interstate 70, when completed, will parallel the Union Pacific Railroad; U.S. Highway 40, a transcontinental route, also parallels the Union Pacific Railroad across the county; and U.S. Highway 183, an important north-south highway, extends through the center of the county. Most of the county and township roads follow section lines and many have all-weather surface.

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, field reconnaissance; fourth, final correlation of data, map compilation, and report writing. With the exception of the first, the phases of this investigation were not approached as separate operations, but were completed contemporaneously as each section of the report required. A detailed discussion of the procedures employed in each phase is included in this portion of the report.

Phase I Research of Available Information

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

Phase II Photo Interpretation

The second phase of the investigation consisted of study and interpretation of aerial photographs flown by the State Highway Commission of Kansas during January, 1963, at a scale of 1:24,000 (1 inch represents 2,000 feet). Figure 2, page 6, is a photographic coverage map of Ellis County.

Initially, the entire county was studied on aerial photographs. During this process all open material sites which had been sampled and tested were located on the photographs and plotted on a cronar 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. The geologic source beds that were discernible on the aerial photographs were mapped and classified on the base map. Prospective sites were tentatively selected on the basis of the geology of the county and aerial photographic pattern elements.

As a result of an initial field check, a more detailed description of the geologic source units was written and the mapping process was completed. The quality of the material that might be produced from a particular source bed was ascertained by correlating the results of quality tests with the geologic unit from which the test samples were obtained and by field study of the producing units. This correlation process is illustrated in a general way by Figures 3 and 4 and by the following discussion.

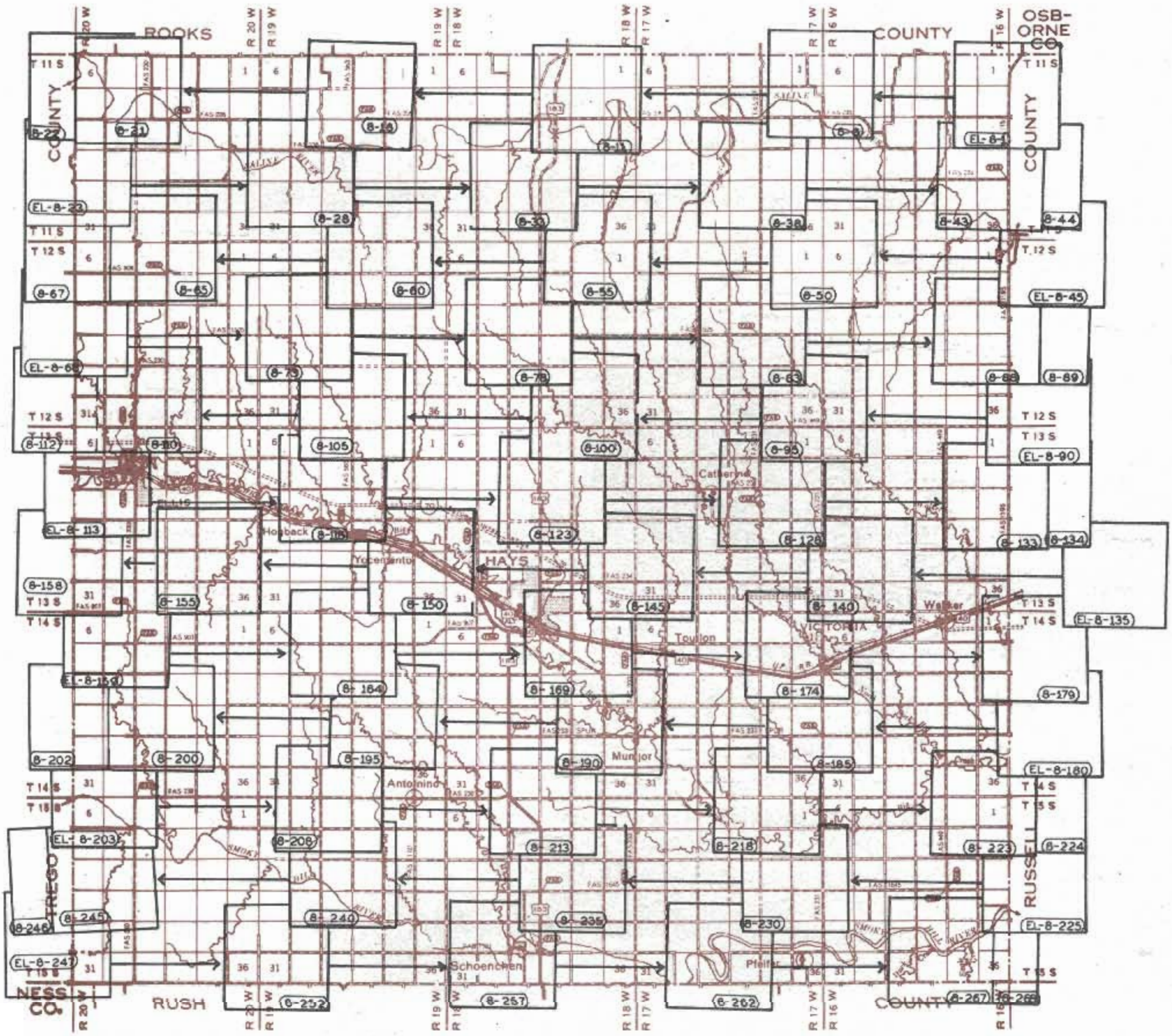


Figure 2. Aerial photographic coverage map. The numbers which are in brackets indicate photograph numbers on flights taken by the Photogrammerty Section of the State Highway Commission of Kansas on January 9, 1963. Aerial photographs are on file in the Photogrammerty Laboratory, State Office Building, Topeka Kansas.

Figure 3 is a portion of an aerial photograph taken in southeastern Ellis County showing part of the Smoky Hill River valley. In this area, Meade terraces and the Greenhorn Limestone form the northern valley wall. Site $\frac{Sg-105}{Qm}$, located in a Meade terrace, was detected and mapped as an open, sampled site during the initial photo interpretation process. (See Plate VI and Appendix III, page 156.)

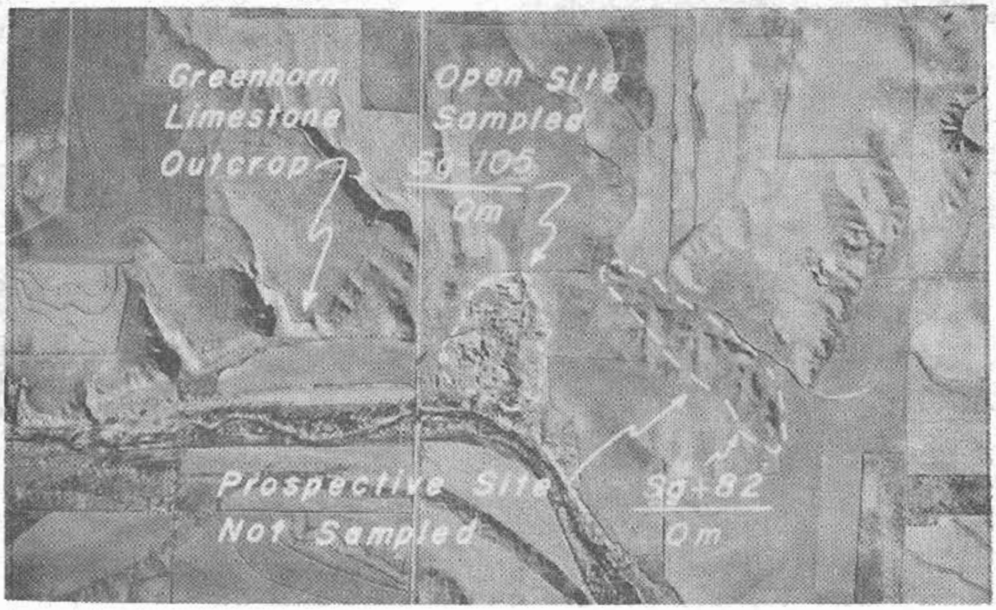


Figure 3. Meade terraces along the Smoky Hill River in southeastern Ellis County. Note exposed Greenhorn Limestone.

Site $\frac{Sg+82}{Qm}$, also located in a Meade terrace, was detected and mapped as a prospective materials site during the photo interpretation process. (See Plate VI and Appendix II, page 130.) This site was selected as a prospective materials site on the basis of topographic expression, internal drainage characteristics, vegetation type, and knowledge of local geological conditions. The material in prospective site $\frac{Sg+82}{Qm}$ was deposited at the same time and by the same mode of deposition (river deposit) as the material in open and sampled site $\frac{Sg-105}{Qm}$. Consequently, the general engineering characteristics of the material in the two sites should be similar.

Figure 4 is a portion of an aerial photograph taken in northwestern Ellis County depicting mortar bed in the Ogallala Formation along with chalky shale and limestone in the underlying Smoky Hill Chalk and Fort Hays Limestone Members of the Niobrara Formation.

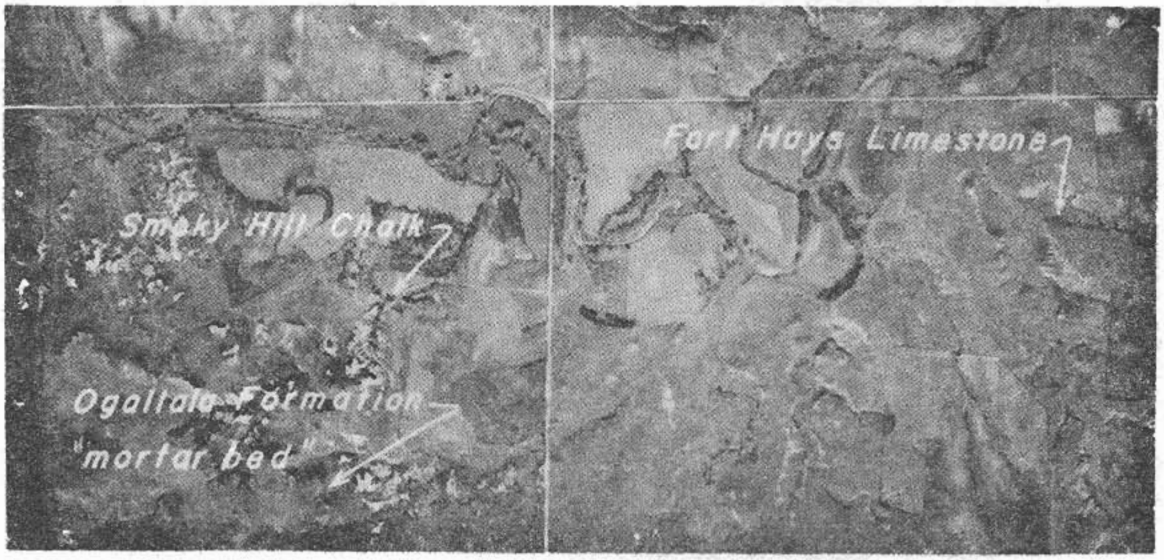


Figure 4. Mortar bed in the Ogallala Formation capping the underlying Smoky Hill Chalk and Fort Hays Limestone Members in northwestern Ellis County, Kansas.

Because of its highly resistive nature, the Ogallala mortar bed is a prominent feature of the rough topography that characterizes parts of western Ellis County. Here, the Ogallala is detected by its topographic form and by a light gray band which is typical of the resistant ledge formed by the mortar bed. One may expect to find approximately 20 to 30 feet of fine sand, silt, and caliche beneath the mortar bed in this area.

Phase III 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. During a second field check a representative number of the prospective sites was inspected.

Phase IV Map Compilation and Report Writing

The fourth phase consisted of correlating all new information with that previously gathered, writing the report, completing the site data forms, and compiling the county construction materials maps.

The county construction materials map was divided into six sections (Plates I through VI).

Only geologic units or deposits that contribute to the construction materials resources of Ellis County were mapped. In this report, the map units representing material source beds are based primarily on material type and not geologic age. Current geologic nomenclature was used as a guideline for the mapping operation; however, some map units depart from current usage in order to group two or more geologic units together as a single construction material source unit.

In general, the type of material represented by each map unit is fairly consistent throughout the county; however, even though the same map unit is used, the gradation of the material found in the fluvial deposits, located in the Smoky Hill and Saline River valleys, may vary because of the geologic history of the respective river channels.

All existing and prospective sites are identified on the county materials maps by appropriate designations and symbols. The site symbol will indicate the status of the materials site to the user of this report; that is, whether it is a prospective or an open site, and whether it has been sampled or not. The site designation will convey to the reader the type of material which can be found at the location, the estimated quantity of material available, the number of the corresponding data form for that site, and the geologic age and name of the source bed. The map legend associated with each plate explains all letter and map symbols used in the site designations.

To furnish the user of the report with all available information, a data form was completed for each materials site depicted on the materials maps. The site data forms are included as Appendices I through V in this report. Appendix I contains forms for all sites depicted on the Ellis County materials maps that are open, but have not been tested by the State Highway Commission of Kansas. Appendix II contains site data forms for all locations shown on the materials maps as prospective sites which have not been sampled. Appendix III contains a site data form for each area depicted on the materials maps as an open site which has been sampled and tested. Test data is presented on the form for each site. Appendix IV contains site data forms for those locations shown on the materials maps as being prospective sites at which extensive exploration has been accomplished. Appendix V contains site data forms for areas shown on the materials maps as being prospective sites at which a limited amount of exploration has been accomplished.

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

A sketch of each site was drawn, illustrating major cultural and natural features, to help locate the exact area in the field

Landowner information is presented for each material site as it is listed in the Ellis County Register of Deeds office.

The text of the report presents the general geology of the county as it pertains to the various material source beds present, 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 ELLIS COUNTY

Geological History of Ellis County

This section of the report presents a brief and general review of the geological history of Ellis County. The main objective of this discussion is to provide the reader with a general understanding of the geological events that were responsible for the deposition of the present day construction materials resources of Ellis County. The history is discussed in terms of geologic time and therefore, a major portion of the nomenclature used in this report consists of terms representing segments of geologic time. The generalized geologic time scale (Figure 5, page 12) shows in graphic form the major time periods and an estimate of the amount of geologic time represented by each division. One should note that the length of most of the periods exceeds one million years. In order to understand better the history of the area, it is imperative that the reader comprehends the magnitude of geologic time and realizes that climatic and geographic conditions have been vastly different from those which exist today.

The geologic history as discussed here is based primarily on a report by Frye and Brazil (1943). Inasmuch as the materials source units are exposed or near the surface, only a small part of the discussion pertains to the subsurface geology of the county. Because of the significance of the deposits laid down during Cenozoic time, a more detailed geologic history of that period is presented.

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, vari-colored 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

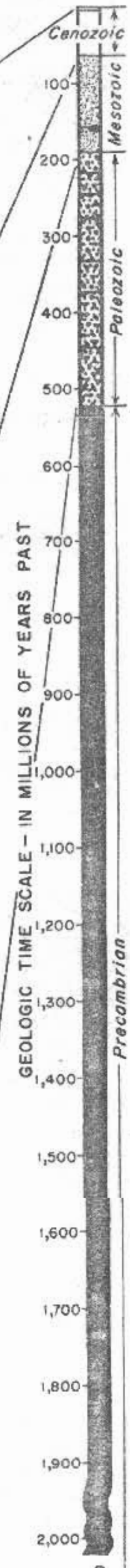


Figure 5. Generalized geologic time scale

Throughout the Paleozoic Era, the sea repeatedly invaded the area that includes Ellis County and deposited sequences of limestone, dolomite, sandstone, and shale. However, varying quantities of these deposits were eroded away during periods of time when the area was above sea level and was subjected to erosional processes. Most of the sediments deposited during the early part of the Paleozoic Era were eroded away prior to the deposition of Mississippian rocks.

Mississippian, Pennsylvanian, and Permian rocks found in the subsurface of Ellis County are composed mainly of limestone, dolomite, and shale, with lesser amounts of sandstone, coal, and salt. The seas withdrew completely from the region at the close of the Paleozoic Era and the Permian deposits were subjected to erosion. This degrading of the land continued throughout the Triassic and Jurassic Periods.

During the early part of Cretaceous time Ellis County remained above sea level. As the early Cretaceous sea approached from the south, beach deposits, off-shore bars, and delta deposits accumulated near the shore line. These, along with near-shore deposits compose the Cheyenne Sandstone. As the sea inundated this area, the Kiowa Shale was deposited under deep-sea conditions.

The close of early Cretaceous time was marked by the withdrawal of the sea and the return of a continental depositional environment to the area. It was during this time that the Dakota Formation, consisting of silty to clayey shale with lenses of interbedded sandstone, was deposited. The Dakota Formation is the oldest geologic unit exposed in Ellis County.

The continental environment which existed throughout the deposition of the Dakota Formation gave way to marine conditions in which the Graneros Shale and overlying formations were deposited. In Ellis County this period is represented by the Graneros Shale, Greenhorn Limestone Formation, Blue Hill Shale, and Niobrara Formation. The Fort Hays Limestone Member of the Niobrara Formation is discussed in this report as a source of soft limestone aggregate.

The end of the Cretaceous Period and the beginning of the Tertiary Period was marked by the final withdrawal of the sea from this region. As the sea receded, the area was subjected to erosion, and varying amounts of Cretaceous rock were stripped away. Near the end of the Tertiary Period (Pliocene time) eastward flowing streams began to aggrade their channels in western Kansas. A thick blanket of alluvial material, (Ogallala Formation) derived from the newly formed Rocky Mountains, was deposited over the eroded bedrock surface in the western part of the state. This mantle of material had a maximum thickness of approximately 300 feet, but thinned sharply toward its eastern extremity. Subsequent erosion has removed all of the Ogallala from Ellis County except for scattered remnants which overlie Cretaceous bedrock in the western part of the county. The possible use of the Ogallala as a source of construction material is discussed later in this report.

The Quaternary Period represents a time of repeated glacial and interglacial cycles in North America. Glacial activity in Kansas was restricted to the extreme northeastern corner of the state; however, the sequence of glaciation which occurred during this time has played a controlling role in the development of Quaternary nomenclature. Figure 6, page 15, is a geologic timetable which shows the divisions of the Quaternary Period and the approximate length of each. The glacial ages (Nebraskan, Kansan, Illinoisan, and Wisconsinan) represent the advance of the glaciers, while the three interglacial ages (Aftonian, Yarmouthian, and Sangamonian) represent periods of

Divisions of 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.

major glacial recession. The Recent Age represents the time which has elapsed since the last retreat of the Wisconsinan glacier.

The geologic history of the Quaternary Period, as it is discussed here, is based primarily on reports by Frye and Leonard (1952) and Leonard and Berry (1961).

Geological events that took place during Pleistocene time (Quaternary Period) are largely responsible for the abundance of high quality construction material in Ellis County. Terraces composed of sand and gravel, which were deposited by the action of major streams during this time, provide high quality aggregate for construction purposes in Ellis and adjacent counties. Because of the various erosional and depositional peculiarities that characterized drainage channels during the many geological times, different age terraces within the Pleistocene classification provide varying qualities and quantities of construction materials.

The Smoky Hill and Saline Rivers are the two main drainage channels developed during Pleistocene time that have been responsible for the transportation and deposition of construction material in Ellis County. The history of the two rivers, with regard to the deposition of construction materials, was virtually the same up to the end of the Yarmouthian Interglacial Age. From this point in geological time, the two rivers had different patterns of development which affect the quantity of aggregate that can be found in Ellis County.

During late Pliocene time and early Pleistocene time, streams in western Kansas began cutting into the Ogallala Formation and the underlying Cretaceous bedrock. Deposition of material derived from the Ogallala and Niobrara Formations took place along two major drainage channels in Ellis County, which were antecedent channels of the present Smoky Hill and Saline Rivers. According to Leonard and Berry (1961), these deposits are Nebraskan (?) age. Subsequent to the deposition of these terraces, the streams continued to degrade their channels leaving the terraces on relatively high terrain.

Because of the masking of these deposits by younger material (colluvium and wind deposits), the reworking by recent stream action, and the difficulty in differentiating between these deposits and younger ones, these terraces have been included in the Pleistocene-Recent Undifferentiated map unit. These and younger deposits are discussed under this classification in the "Construction Materials Inventory" section of this report.

During Aftonian time, both the Smoky Hill and Saline Rivers degraded their channels, and no significant deposition occurred.

Throughout most of Kansan time, degradation of the stream channels continued; however, deposits of siliceous sand and gravel were laid down by both rivers in late Kansan time. During the Yarmouthian Age, the Smoky Hill River and, presumably, the Saline River aggraded their channels, and material similar to that deposited in Kansan time was laid down on top of the Kansan terraces in Ellis County.

During Yarmouthian time, ash was thrown into the air by volcanic action somewhere in the Rocky Mountain belt (Carey and others, 1952), and was carried by winds over Kansas and adjacent areas. This material settled to the ground or was carried down by rains, resulting in a thin layer of fine textured ash being spread extensively over the surface. Subsequently, local stream action transported this material into undrained depressions. This mode of accumulation accounts for the irregular size and thickness of the deposits and their contamination with silt and clay size particles. Even though the stratigraphic position of several ash beds in Kansas can be determined, the deposits in Ellis County are highly irregular and occur at different elevations. Only two ash deposits of this age have been found in the county. They are widely separated from fluvial deposits of similar age and are covered by younger silts and, therefore, have been included in the Sanborn Formation map unit which is discussed later in this report.

At the end of Yarmouthian time, the Saline River was located in northern Ellis County as it is now. However, near the eastern Russell County line, the channel cut diagonally to the southeast across Ellsworth County to junction with the Smoky Hill River near the site of Ellsworth, Kansas, instead of flowing north and then east through Lincoln County as it does today. Material similar to that found in the Kansan and Yarmouthian terraces along the Saline River to the west was deposited in this ancestral channel, which is referred to as the Wilson buried valley (Frye, 1945).

A period of erosion and downcutting took place during late Yarmouthian or early Illinoisan time. During this erosional period, a stream flowing in the present lower Saline valley cut down and captured the Saline River in the southeastern part of Russell County causing it to flow approximately in its present channel. Presumably, the piracy of the Saline River increased its erosional and transporting power and resulted in an acceleration of its degrading action. This cycle of erosion continued throughout Illinoisan and much of Wisconsinan time in this general area. Consequently, no significant terraces of Illinoisan or Wisconsinan age were deposited by the Saline River in Ellis, Russell or Lincoln Counties. Terraces composed of siliceous sand and gravel of Illinoisan age are found in Ottawa County further downstream (Mack, 1962). Presumably, the streams' energy had dissipated to such an extent that some deposition was possible in this area.

During the Illinoisan Age, the Smoky Hill River was aggrading its channel and Illinoisan deposits were laid down.

In this report the Kansan, Yarmouthian, and Illinoisan terraces that were deposited in the Smoky Hill and Saline River valleys have been included in the Meade Formation map unit, which denotes material type, not age. These terraces are located above the present flood plain and below the Nebraskan (?) terraces.

During early Illinoisan time, deposits were laid down in Ellis County other than those in the Smoky Hill River valley. Limestone gravel derived predominantly from the Fort Hays Limestone, and a limited amount of siliceous sand derived from the Ogallala Formation were deposited by the tributaries of the Smoky Hill and Saline Rivers. In this report most of these deposits have been included in the Sanborn Formation map unit; however, in some regions within the county, they have been mixed with other material by Recent stream action and have been covered by younger windblown silts. Under these circumstances, these early Illinoisan deposits have been included in the Pleistocene-Recent Undifferentiated map unit.

Contemporary with and following the early Illinoisan fluvial cycle, was the deposition of wind blown silt in this area. Flood plains resulting from aggrading streams were probably the source of the silt.

It is believed that during early Wisconsinan time the Smoky Hill River degraded its channel; however, aggradation of the channel took place late in the Wisconsinan Age. Terraces composed of coarse sand and gravel grading upward into sand and silt, with an aggregate thickness of 65 feet in some places, were formed during the aggradation process. Inasmuch as these deposits lie beneath the present Smoky Hill River flood plain, they have been included in the Quaternary Alluvium map unit. Silt and clay deposits laid down in the Big Creek flood plain during Wisconsinan time are similarly covered by Recent deposits and have been included in this same map unit.

The flood plains and lower terraces of the Smoky Hill River, Saline River, and Big Creek have been formed during Recent time. The Smoky Hill River, which dissects the Ogallala Formation in western Kansas and eastern Colorado, is presently carrying siliceous sand and gravel. This material is finer than that deposited in the past because of a decrease in the carrying capacity of the stream.

The Saline River flood plain is more shallow than that of the Smoky Hill River and consequently contains a smaller volume of material. Presently, the Saline is carrying fine siliceous sand and limestone gravel. The source of this material is the Ogallala Formation to the west and north of the county, and the Fort Hays Limestone which caps the Saline River valley walls in this region.

Big Creek is presently carrying predominantly silt and clay sized material similar to that which composes Recent age terraces. Lateral erosion of Big Creek's channel has exposed lower and older deposits of fine sand and silt, but no granular material of any significance has been deposited in the Recent terraces or flood plain.

During Recent time, tributaries of the Smoky Hill and Saline Rivers have deposited minor quantities of limestone gravel derived from the Fort Hays Limestone, and siliceous material derived from the Ogallala Formation and Nebraskan (?) terraces on higher terrain. Such deposits are included in the Pleistocene-Recent Undifferentiated map unit.

Construction Materials Inventory

This section of the report inventories the construction materials in Ellis County. Only geologic units which are producers or are considered to be potential material sources are discussed. Figure 7, page 21 is a generalized column of the surface geology of Ellis County which illustrates the relative stratigraphic position of each source bed and indicates the map unit which represents each source unit. It should be noted that the mapping nomenclature used for Quaternary deposits in Ellis County does not follow current geologic classification, but is based primarily on material type; (i.e., some map units represent material of different age but of similar quality). The county materials map which is divided into six equal portions, Plates I through VI, shows the geographic areas where construction materials source beds are exposed or near the surface.

Information concerning the quality of the source beds was obtained from laboratory tests that were completed on samples taken from previously reported sites and from field observations.

A tabulation of the various types of material available in Ellis County is shown in Figure 8, page 23. The source beds from which each material type can be produced are listed along with the page number where the engineering characteristics of each of these units are described. A thorough study of these descriptions will be helpful in making a preliminary assess-

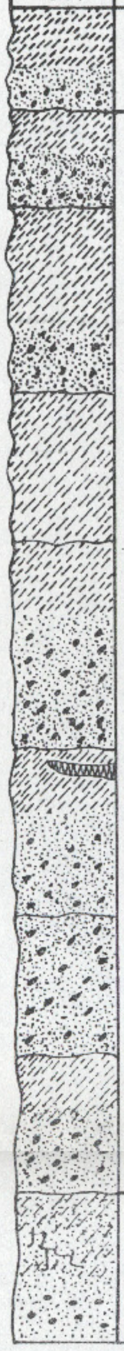
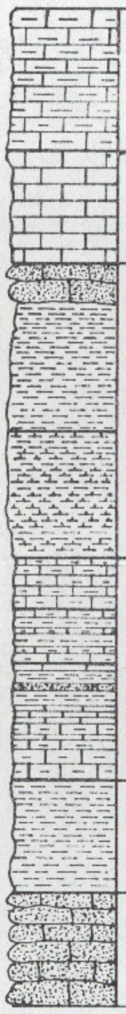
Graphic Legend	Outcrop Thickness	System	Series	Stage	Formation, Member, or Deposit Type	Description of Material	Map Unit	Construction Material
	0' to 60'	Quaternary	Pleistocene	Recent	Alluvial-lower terraces and flood plains in and along major drainage channels	Sand, fine sand, limestone gravel, and silt.	Alluvium Qal	Fine aggregate and mineral filler
					Alluvial-terraces and flood plains of tributaries of major drainage channels	Limestone gravel, fine sand, and silt	Pleistocene-Recent Undifferentiated Pr	Light Type Surfacing Material
	0' to 100'			Wisconsinan	Eolian	Loess deposit	Not mapped	
					Alluvial-flood plain of Smoky Hill River	Sand, coarse sand, and gravel	Alluvium Qal	Aggregate, when processed suitable for bituminous and concrete construction.
				Sangamonian	Eolian	Loess deposit	Not mapped	No significant construction material deposited.
				Illinoisan	Eolian	Loess deposit	Not mapped	
					Alluvial-terraces along Smoky Hill River	Siliceous sand and gravel and some limestone	Meade Formation Qm	Aggregate, when processed, suitable for bituminous and concrete construction
					Alluvial-high terraces along tributaries of Saline River	Limestone gravel, fine sand and silt	Sanborn Formation Qs	Light Type Surfacing Material
				Yarmouthian	Eolian	Volcanic Ash	Sanborn Formation Qs	Mineral filler
					Alluvial-terraces along Smoky Hill and Saline Rivers	Sand and gravel, some limestone gravel.	Meade Formation Qm	Aggregate, when processed, suitable for bituminous and concrete construction.
				Kansan	Alluvial-terraces along Smoky Hill and Saline Rivers	Sand and gravel, some limestone gravel.	Meade Formation Qm	Aggregate, when processed, suitable for bituminous and concrete construction.
				Nebraskan	Alluvial-high terraces along Smoky Hill River valley	Fine siliceous sand and silt.	Pleistocene-Recent Undifferentiated Pr	Light Type Surfacing Material and mineral filler
	0' to 75'	Tertiary	Pliocene		Ogallala Formation	Mortar beds, sand and silt, locally cemented, tan-brown and gray. The Ogallala Formation is in contact with upper Cretaceous beds	Ogallala Formation To	Fine sand and mineral filler
Pleistocene or Pliocene may be in contact with all other exposed geologic units.								
	0' to 100'	Cretaceous	Upper Cretaceous		Niobrara Chalk Formation: Smoky Hill Chalk Member	Chalky shale, interbedded with shale, gray to blue-gray, weathers yellow and orange	Not mapped	
	0' to 50'				Fort Hays Limestone Member	Massive cream to buff limestone separated by thin gray shales	Fort Hays Limestone Member Knf	Structural stone and surfacing material.
	0' to 304'				Carlile Shale Formation: Codell Sandstone Member	Sandstone, gray-tan silty	Not mapped	
					Blue Hill Shale Member	Shale, blue-gray, clayey to silty. Weathers olive-green to gray.		
					Fairport Chalk Member	Light gray to yellow buff, silty, calcareous and clayey shale, slightly fossiliferous	Not mapped	
	0' to 90'				Greenhorn Limestone Formation: Pfeifer Shale Member	Chalky shales and thin chalky limestone	Not mapped	
					Jetmore Chalk Member	Brown-gray shales and thin chalks		
					Hartland Shale Member	Black shales, thin limestone and sandstone		
					Lincoln Limestone Member	Chalky shales and crystalline limestone		
	0' to 35'				Graneros Shale Formation	Dark shales and thin sandstones with bentonite beds in upper portion	Not mapped	
	20'+				Dakota Formation	Fine-grained gray to brown sandstone	Not mapped	

Figure 7. Generalized geologic column of the surface geology in Ellis County.

ment of the construction materials resources of the county. To further aid in making this assessment, the number of the plate on which each unit is mapped is also shown.

Fort Hays Limestone Member

The Fort Hays is a massive, chalky limestone with a gray to cream color that weathers tan gray. There are dark gray chalky clay shales separating the massive beds. The full thickness of the Fort Hays Limestone is approximately 50 feet in Ellis County.

Information taken from the results of quality tests completed on samples of the Fort Hays in Ellis County indicates that the limestone is soft and somewhat erratic in engineering characteristics. It is, however, found to harden when exposed to the elements over a period of time. This observation is verified by comparing the results of Los Angeles wear tests for fresh and weathered samples.

The following are representative results of some of the quality tests completed on the Fort Hays Limestone in Ellis County.

	Sample A	Sample B	Sample C	Sample D	Sample E
Specific Gravity					
(Saturated-surface dry)	2.16	2.12	2.09	2.02	1.98
Los Angeles Wear Test	58%	60%	56.7%	66.8%	75.3%
Soundness			Unsound at 25 cycles		
Water Absorption	22.23%	13.8%	17.4%		

Limestone aggregate produced from the Fort Hays is extremely dusty, but is used extensively as an all weather surfacing material for rural roads. Figure 9 shows the Fort Hays Limestone and the underlying Blue Hill Shale

Material Type	Geologic Source (map unit)	Description	Locality where available
Soft limestone	Fort Hays Limestone	Page 24	County wide except in the southeast quarter. Plates I, II, III, IV, and V.
Siliceous sand and gravel	Pleistocene-Recent Undifferentiated	Page 34	Limited source, mainly in central part of the county. Plates III, IV, and VI.
	Meade Formation	Page 27	Along the Smoky Hill and Saline Rivers. Plates I, II, V, and VI.
	Quaternary Alluvium	Page 35	In the Smoky Hill River, Saline River, and Big Creek flood plains. All Plates
Fine Sand	Ogallala Formation	Page 27	Limited source, western Ellis County. Plates I, III, and V.
	Pleistocene-Recent Undifferentiated	Page 34	Limited source, central Ellis County. Plates III, IV, and VI.
	Quaternary Alluvium	Page 35	In Smoky Hill River, Saline River, and Big Creek flood plains. All plates.
Limestone gravel	Sanborn Formation	Page 32	Best source is along the Saline River valley. Plates I, II, III, and V.
	Pleistocene-Recent Undifferentiated	Page 34	Limited source, mainly in central part of the county. Plates III, IV, and VI.
Mineral Filler	Sanborn Formation	Page 32	Volcanic ash, limited source. Plates III and V.
	Quaternary Alluvium	Page 35	Silt and fine sand. Flood plains and Recent terraces of major drainage channels. All plates.
	Ogallala Formation	Page 27	Silt and fine sand. Limited source, western Ellis County. Plates I, III, and V.

Figure 8. A recapitulation of the construction material types and their availability in Ellis County.

in a cut section in Ellis County. Refer to Plates I through VI for specific locations of Fort Hays outcrops and quarries.

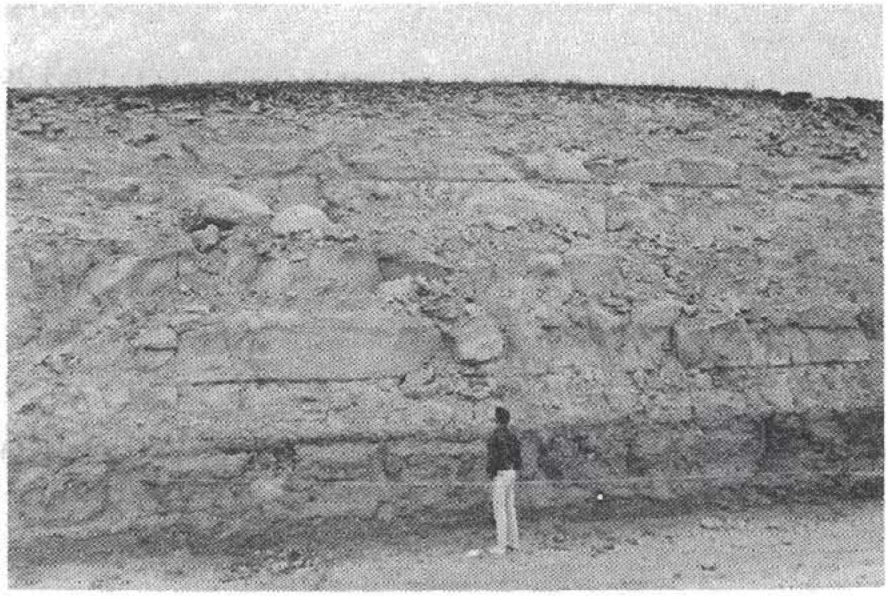


Figure 9. An exposure of the Fort Hays Limestone, Sec. 28, T13S, R19W. The lower portion of this exposure is the Blue Hill Shale.

Ogallala Formation

In Ellis County the Ogallala Formation is characterized by lenses of fine sand, silt, and clay, with zones of lime-cementation referred to as mortar bed. The resistive nature of the mortar bed gives rise to high ridges that characterize the western portion of the county. Sedimentary quartzite [1/] ledges are found in this unit in adjacent counties (for example, Sec. 11, T16S, R21W in Ness County), but are absent in Ellis County. The Ogallala ranges in thickness from 0 to 75 feet.

Although sand and gravel have been produced from the Ogallala in other counties for use in bituminous construction and for light type sur-

1/ For the purpose of this report the term "sedimentary quartzite" refers to sandstone cemented by silica.

facing aggregate, the material from this unit in Ellis County is too fine for such use. The abundance of better quality sources has inhibited production from the Ogallala; however, silt and fine sand from this formation may be used as mineral filler. No quality tests have been conducted on material from this unit in Ellis County.

Figure 10 shows an exposure of mortar bed in the Ogallala Formation in this county. Plates I, III, and IV outline the location of both buried and exposed Ogallala.

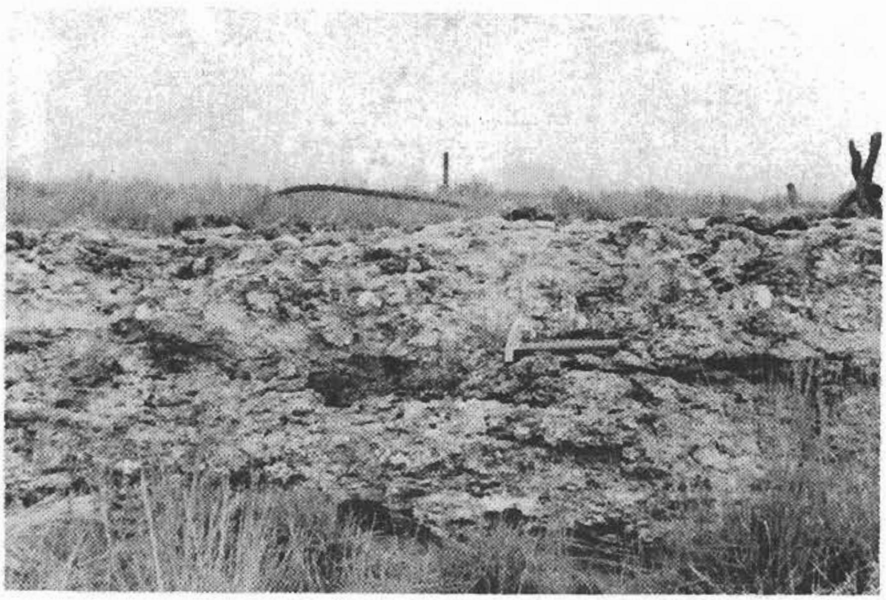


Figure 10. An exposure of mortar bed in the Ogallala Formation in Sec. 19, T12S, R20W.

Meade Formation

As previously described, the Meade Formation map unit represents material laid down during several depositional cycles. For the most part, the material was transported into Ellis County by the Smoky Hill and Saline Rivers. Inasmuch as the Smoky Hill contains better quality material than the Saline River valley, the materials resources of each are discussed separately.

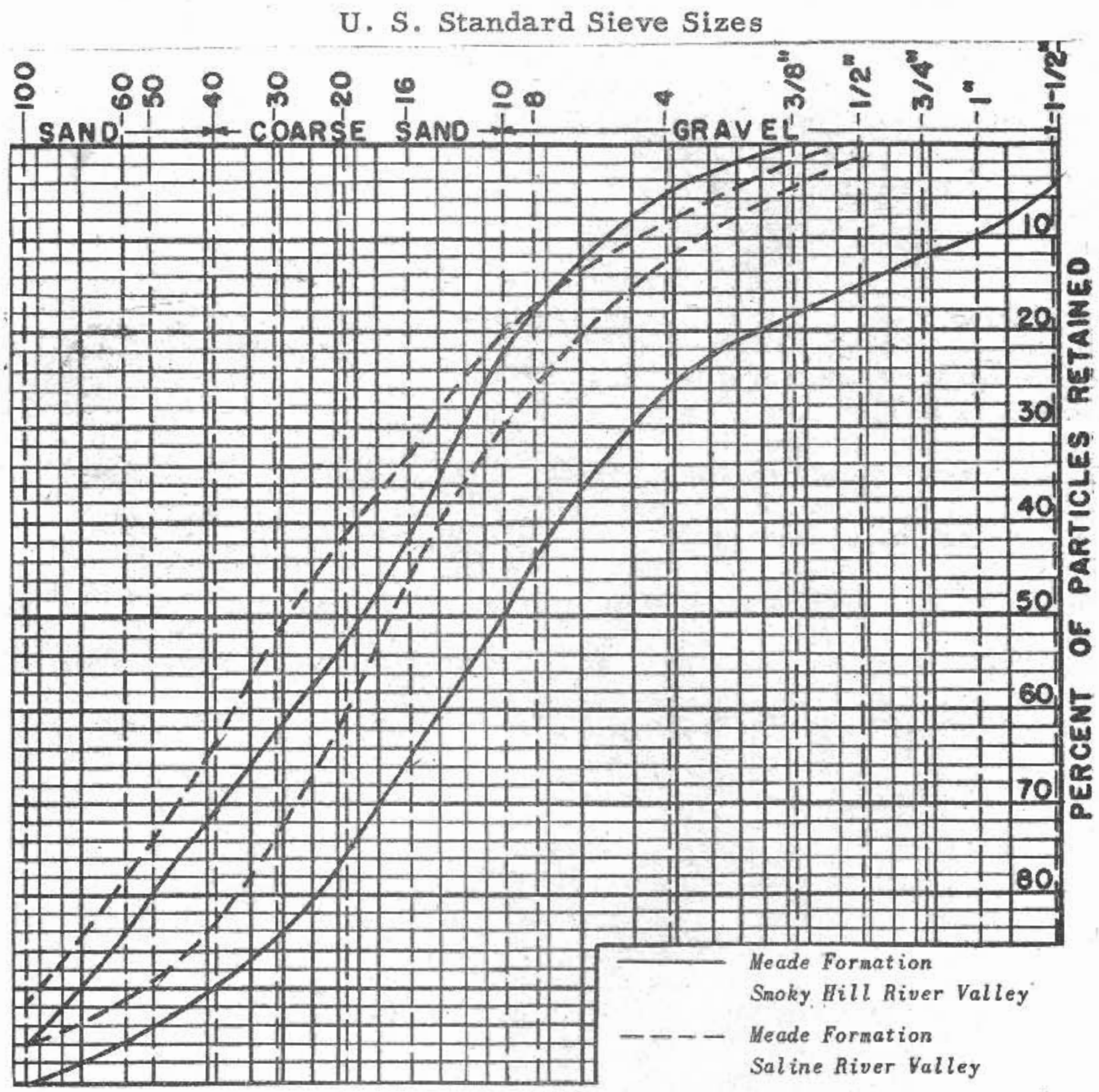


Figure 11. Gradation range of material produced from the Meade Formation in the Smoky Hill and Saline River valleys.

Smoky Hill River Valley: Meade terraces have been deposited extensively on bedrock fifty to seventy feet above the Smoky Hill River flood plain. The terraces are composed of predominantly siliceous material with some deposits containing minor amounts of limestone gravel. With respect to quantity and quality, these terraces are the best source of siliceous aggregate in Ellis County.

A representative number of samples from this source was analyzed. Figure 11, page 26, shows the limits of a range which is typical of the gradation of material produced from the Meade terraces along the Smoky Hill River. The results of quality tests conducted fall within the following ranges:

Specific gravity	2.61 - 2.62
Weight per cubic foot	110 lbs. - 115 lbs.
Percent wear (Los Angeles Wear) Grading D	35% - 40%
Soundness Radio	0.93 - 0.97

These tests indicate that this material will meet most of the specifications for bituminous aggregate.

Figure 12 is a ground view of an exposure of a Meade terrace in the Smoky Hill River valley. Plates V and VI depict the geographic extent of the Meade Formation in the Smoky Hill River valley in Ellis County.

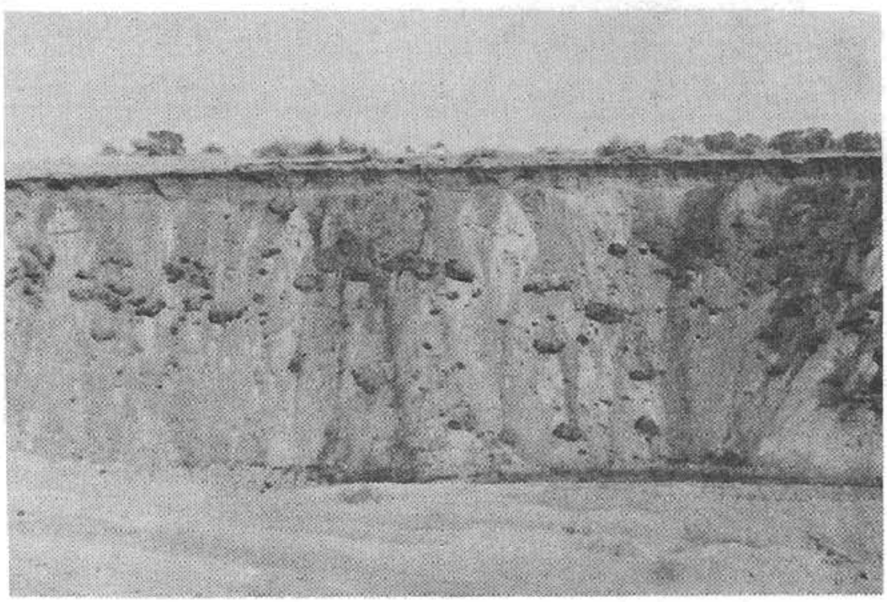


Figure 12. An exposure of a Meade terrace in the Smoky Hill River valley.

Saline River valley: The Meade terraces located along the Saline River valley are primarily composed of siliceous sand. This material is finer and contains a higher percentage of limestone gravel than that found in the Meade terraces along the Smoky Hill River. The detrimental effect of the higher limestone percentage can be seen by comparing the results of the Los Angeles wear test performed on material taken from the two river valleys.

Figure 11, page 26, shows the limits of a range which is typical of the gradation of material produced from Meade terraces along the Saline River valley. One will note that the material in the Saline River valley is finer and has a more uniform gradation than material of comparable age in the Smoky Hill River valley.

The results of quality tests conducted on this material fall within the following ranges:

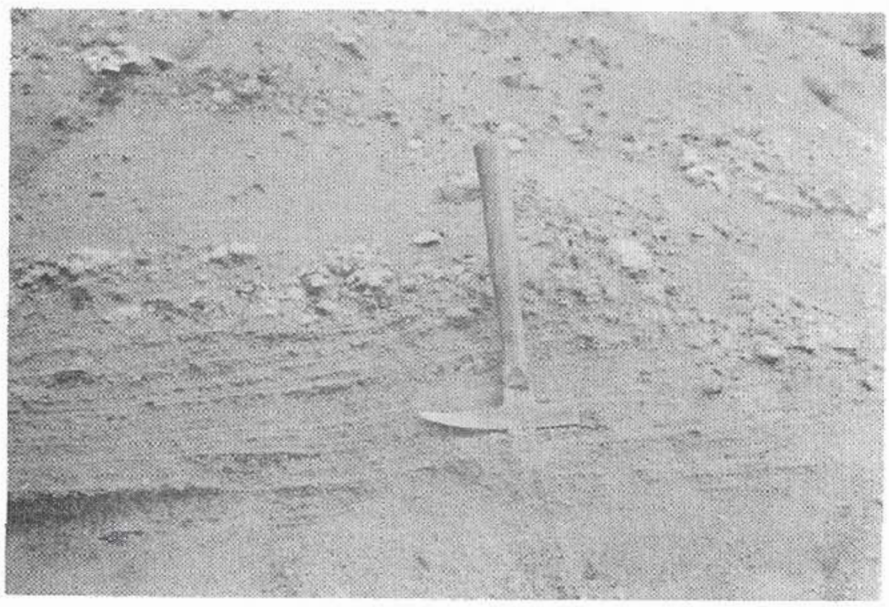


Figure 13. Meade terrace material in the Saline River valley.

Specific gravity (Saturated)		2.55 - 2.60
Weight per cubic foot		106 lbs. - 110 lbs.
Percent wear (Los Angeles Wear test)	Grading B	43% - 50%
	Grading C	40% - 43%
	Grading D	40% - 43%

Figure 13 is a close-up view of a gravel deposit typical of the type of material found in Meade terraces of the Saline River valley. Plates I and II depict the geographical extent of the Meade Formation in the Saline River valley in Ellis County.

Sanborn Formation

The Sanborn Formation map unit predominantly represents limestone gravels laid down by local stream action during Illinoisan time. Locally, silt and clay size particles contaminate this material.

No quality tests have been completed on these deposits; however, the anticipated engineering characteristics of this material would be similar to those of weathered Fort Hays Limestone. These deposits do provide a

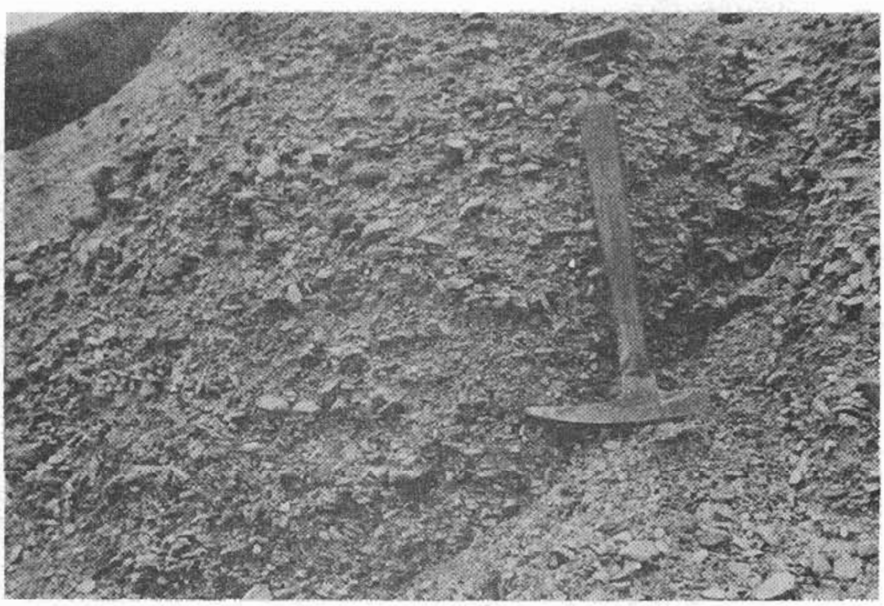


Figure 14. Limestone gravels in the Sanborn Formation.

good source of light type surfacing material, although the gravel exhibits relatively high absorption and wear factors and is not suitable for use as aggregate in bituminous or concrete construction.

Inasmuch as the main parent bed, the Fort Hays Limestone is exposed extensively in the northern part of the county, most of these deposits are located in this area; however, a few isolated deposits are found in the southern part of the county.

Figure 14 is a close-up view of the material found in the Sanborn Formation. Plates I, II, III, and V show the geographical extent of this unit in Ellis County.

As previously mentioned, only two volcanic ash deposits are included in this map unit. Figure 15 is a ground view of site $\frac{VA+123}{Qs}$ (Plate V) located in Sec. 17, T14S, R10W. Another ash deposit, site $\frac{VA+69}{Qs}$ (Plate III) is located in the NW 1/4, SW 1/4, Sec. 5, T13S, R19W. (Carey and others, 1952). According to Carey, a maximum of 10.5 feet of volcanic ash with an over-burden of approximately 8 feet was found in this area by augering. No ash has been produced from this location at the time this report was written.

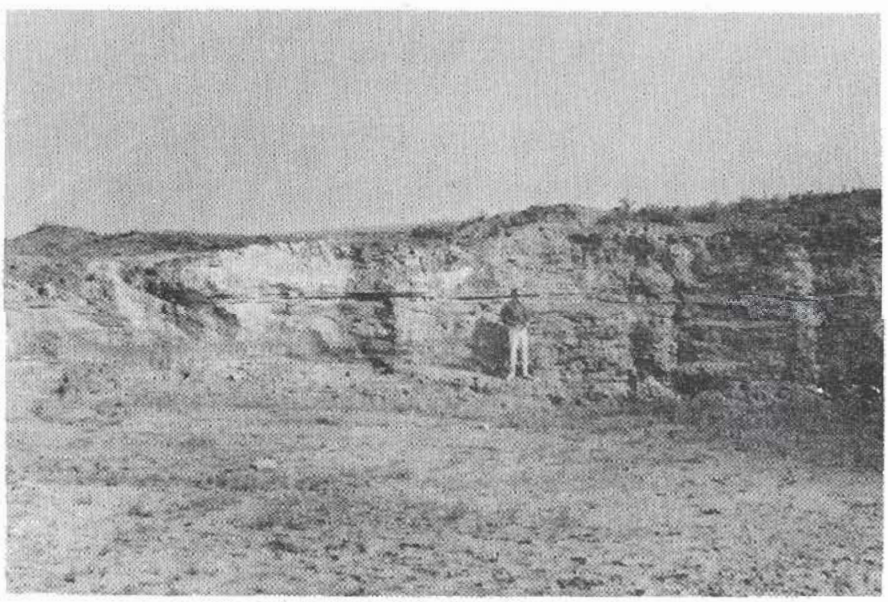


Figure 15. Volcanic ash pit located at site $\frac{VA+123}{Qs}$

Pleistocene-Recent Undifferentiated

The Pleistocene-Recent Undifferentiated map unit represents material that is predominantly Illinoisan and Nebraskan (?) age; however, in most cases, stream deposits and colluvial material of Recent age have either contaminated or buried these deposits. The material is composed of silt, fine sand and some gravel derived from the Ogallala Formation, and limestone gravel derived from the Fort Hays Limestone. This material could be used as light type surfacing material for rural roads; however, unless a high percent of limestone gravel is present, the fine sand and silt would be easily eroded by wind and water, and ruts would develop causing maintenance problems. Because of the high percent of sand and silt in some of the deposits, mineral filler may be produced from these sites. No quality tests have been completed on any samples of material taken from this unit in Ellis County.

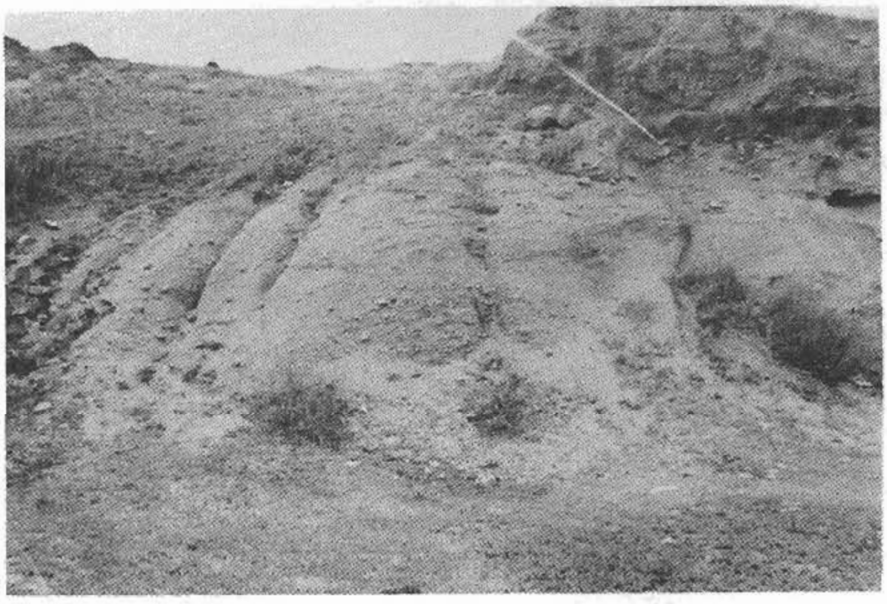


Figure 16. A ground view of a sand and gravel pit in Pleistocene-Recent Undifferentiated deposits located in Sec. 30, T13S, R16W.

Figure 16 is a ground view of a sand and gravel pit in the Pleistocene-Recent Undifferentiated deposits located in eastern Ellis County. Plates III, IV, and VI outline the geographic extent of this map unit.

Quaternary Alluvium

The alluvium map unit represents material that was laid down during Recent time in the flood plains of the Smoky Hill River, Saline River, Big Creek, and some of their larger tributaries. It also represents deposits from the Smoky Hill River and Big Creek during Wisconsinan time which have been subsequently covered by Recent deposits.

Smoky Hill River flood plain: Recent alluvium in the Smoky Hill River flood plain is composed of clay, silt, limestone gravel, and siliceous sand and gravel. The sand and gravel, derived from the Ogallala Formation to the west, is finer than the material deposited by the stream during earlier time. Even though sand and gravel could be produced from the Recent flood plain of the Smoky Hill River valley, the proximity of the underlying Wisconsinan deposits makes the production of better quality material possible. Fairly coarse sand and gravel is being produced from these deposits which have a maximum thickness of 65 feet in the Smoky Hill River valley in Ellis County. This material is composed predominantly of siliceous sand and gravel which will generally meet most specifications for bituminous and concrete aggregate. Inasmuch as all these deposits lie below the water table, production of the material has to be accomplished by pumping operations. Additional processing of the material may have to be accomplished to meet gradation specifications. No quality test results were available for material taken from this source.

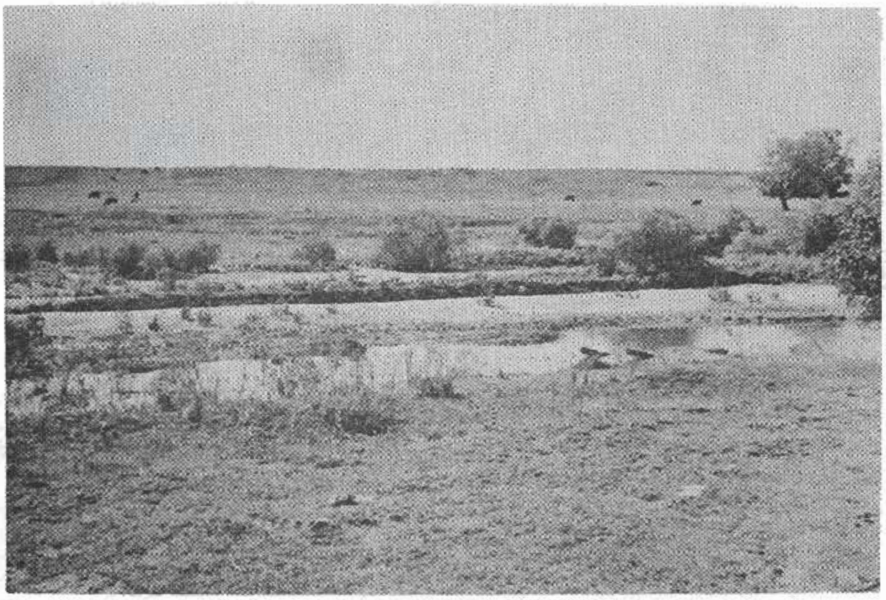


Figure 17. Prospective site $\frac{Sg+98}{Qal}$ in the Smoky Hill River flood plain.

Figure 17 is a ground view of the Smoky Hill River valley in the southwestern portion of the county showing prospective site $\frac{Sg+98}{Qal}$. Plates V and VI show the geographical extent of the alluvial map unit along the Smoky Hill River in Ellis County.

Saline River valley flood plain: The flood plain of the Saline River is much shallower than that of the Smoky Hill River and, consequently, the quantity of material that is available from this source is much more limited. The alluvial material found in the flood plain of the Saline River is finer and has a higher percentage of limestone gravel than the material from the Smoky Hill River valley.

Even though several of the larger tributaries of the Saline River carry sand derived from the Ogallala Formation, the quality of the material found in the Saline valley is questionable because of the presence of limestone gravel. Sand, fine sand, and some mineral filler (silt and fine sand) can be produced from the Saline River flood plain. No quality test results were available for material taken from this source. Plates I and II show the geographical extent of the Quaternary Alluvium map unit along the Saline River valley in Ellis County.

Big Creek flood plain: In the Wisconsinan Age, Big Creek carried a higher percentage of granular material than during Recent time. The lower and older Wisconsinan deposits are composed of silt, clay, fine sand, and some limestone gravel. The upper part of the flood plain, laid down during Recent time is composed primarily of silt and clay. A limited amount of sand and gravel can be produced from this source; however, most of the material is contaminated with silt and clay size particles. Some fine sand and silt may be produced for mineral filler purposes. No quality test results were available for the material derived from this source. Plates III, IV, and VI illustrate the geographical extent of the Quaternary Alluvium map unit along Big Creek and its tributaries in Ellis County.

Geo-Engineering

The purpose of this section of the investigation is to list and briefly describe the geologic units exposed in Ellis County that, through past experience, are known to consist of material possessing unsound engineering properties. A general discussion is presented pertaining to possible ground water problems that may be encountered during road construction and the quality of the water available for concrete mix purposes.

Material Usage Considerations

Graneros Shale: Only a small area in Ellis County is characterized by exposures of the Graneros Shale and it is doubtful that any primary road improvements will ever traverse this unit in Ellis County. Local improvements, however, may encounter this shale along the banks of the Smoky Hill and Saline River valleys in extreme eastern Ellis County.

The Graneros Shale, which is approximately 40 feet thick in Ellis County, is a dark blue, thin bedded, clay shale, with interbedded sandy shale and sandstone. A prominent bentonite bed, approximately one foot thick, lies near the top of the unit. The Graneros is composed of material containing large percentages of montmorillonite and is characterized by an extremely high plastic index (generally the plastic index will range from 40 to 55).

One of the most significant characteristics of the Graneros Shale is its great attraction for water and high swell properties. The results of the high swell tendency are easily detected on aerial photographs and in the field by observing the numerous slide areas and failures in roadbeds constructed on the formation. Figure 18 is a ground view of a typical slide which occurred in the Graneros Shale. On many occassions the re-alignment of proposed improvements would be justified to avoid traversing this unit. When a proposed highway crosses a hill side which contains the Graneros, berming down to unweathered or more stable shale is often recommended to insure highway stability. The shale removed by berming is generally wasted because of the undesirability of the material for embankment purposes.

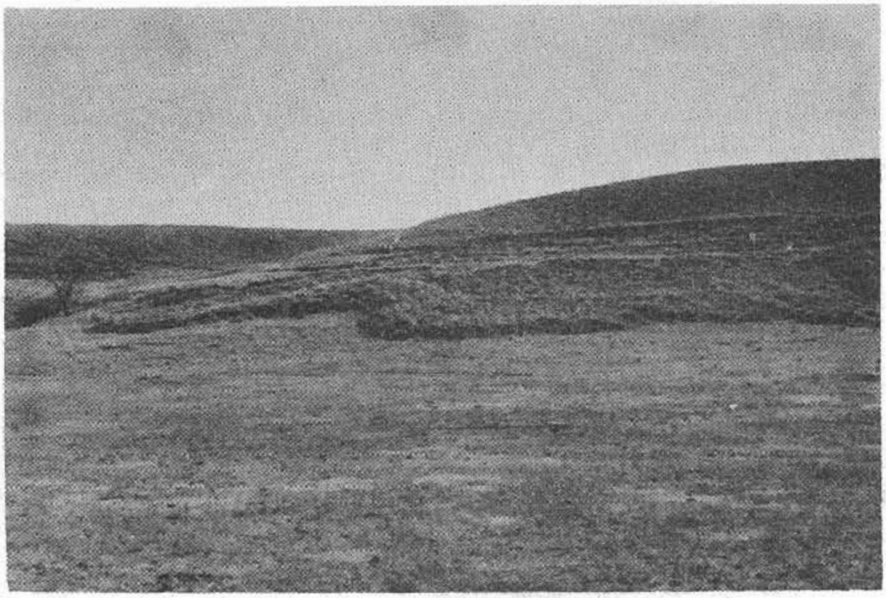


Figure 18. A typical slide in the Graneros Shale.

Blue Hill Shale Member: The Blue Hill Shale Member underlies all of Ellis County except the southeastern corner. It is exposed extensively in the northern part of the county in and near the Saline River valley and in the southern half of the county in the proximity of the flood plains of the Smoky Hill River, Big Creek, and their tributaries. In some areas in east-central Ellis County, the Blue Hill is overlain by approximately 10 to 15 feet of wind blown silt and, consequently, may be encountered by construction improvements in this area.

The Blue Hill is composed of dark gray shale which is highly plastic and exhibits high volume change characteristics. Test results indicate that in Ellis County, this unit is characterized by a plastic index that ranges from 30 to 55. Roadbeds constructed over this unit often fail and slides frequently occur in the backslopes of cuts where this member is present. Because of its high plastic index and instability, when economically feasible, material from the Blue Hill should not be used for construction purposes.

If it is necessary to use this shale, it should not be placed in the top 18 inches of the subgrade. It may be used in the lower portion of fill sections providing a limitation is placed on the embankment height to prevent failures due to overloading.

Pleistocene Silt: Wind blown silt of Pleistocene age blankets most of Ellis County except along the major drainage channels where it has been removed by erosion. Its thickness ranges from 0 to approximately 60 feet, and it will be encountered in most earthwork construction in the county.

The engineering characteristics of this material may vary from one area to another because of contamination by more recent deposits. Some of the more undesirable material found in this unit is characterized by plastic indices that range between 25 and 35 and would be termed clay or clay loam according to the Kansas soil classification system. According to American Assocation of State Highway Officials, much of this material would be classified as an A-6 soil and in more severe cases as an A-7. This silt has been generally satisfactory for embankment purposes due to the relatively low annual rainfall of the county (average 22.7 inches per year), and because the silt does contain some good quality material in addition.

Possible Ground Water Problems in Road Construction

Many of the geologic units exposed in Ellis County have properties which are conducive to ground water problems under adverse climatic conditions. Specific recommendations concerning these hydrology problems are beyond the scope of this report; however, some factors are briefly discussed herein to familiarize the reader with their existence. Detailed field investigation on proposed projects should be conducted to determine the extent of local ground water conditions.

The limestone zones and bentonite layers in the Greenhorn Formation are known to carry some water; however, this unit is seldom the source of major hydrology problems in road construction. Should any bentonite be encountered, subgrading may be necessary to provide proper protection to the road structure.

Normally, water movement is associated with Codell Sandstone Member, but it can be effectively intercepted by cutting the ditches into the sandstone or by constructing underdrains.

Ground water may be encountered along the Smoky Hill Chalk and Fort Hays Limestone contact and at different horizons within the Fort Hays. In many cases, however, these problems would be relatively insignificant during seasons of normal precipitation.

Occasionally, ground water is encountered along the base and in granular zones of the Ogallala Formation; however, because of the irregularity of these zones, and the limited geographical extent as well as the high elevation of the Ogallala in Ellis County, most of the ground water movement would be seasonal.

Ground water may also be encountered along the mantle-bedrock contact and along the base of the various terraces present in the county. The severity of the problems that may be associated with these conditions will be dependent upon local geological conditions and rainfall in the area.

Mineralization of Water Resources

The Smoky Hill and Saline Rivers and the associated flood plains and terraces provide the principal source of water in Ellis County. Water is also produced from the Big Creek flood plain and from various geological units in the subsurface. Chemical tests completed on samples of water from these sources indicate varying degrees of mineralization. Contamination, in many cases, can be attributed to the activities of man, and locally, these sources may be adulterated with water containing sulfates and chlorides from the Dakota and Greenhorn Formations.

Tests indicate that some of the water from the Greenhorn is highly mineralized; however, this unit yields only a limited amount of water. The most contaminated source of water in Ellis County is the Dakota Formation. Tests conducted on water from this unit indicate a fairly consistent and high degree of mineralization.

To insure a high quality of concrete, the water obtained in Ellis County for concrete mixes should be tested for mineralization as a precautionary measure.

GLOSSARY OF SIGNIFICANT TERMS

Aggradation: The natural filling up of the bed of a stream by deposition of sediment.

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.

Bentonite: A clay which is formed by the decomposition of volcanic ash and is largely composed of the clay minerals montmorillonite and beidellite.

Colluvial deposits: Heterogeneous aggregates of rock debris resulting from the transporting action of gravity.

Degradation: The general lowering of the surface of the land by erosive processes, especially by the removal of material through erosion and transportation by flowing water.

Fluvial cycle: Involves the sequence of erosion and deposition of a stream over a long period of time in a given area.

Fluvial deposit: Deposits laid down by a river or stream.

Geologic period: A division of geologic time. Permian, Cretaceous, and Tertiary 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 Pleistocene age.

Gradation factor: The value obtained by adding the percentages of material retained on the 1 1/2", 3/4", 3/8", No's. 4, 8, 16, 30, 50, and 100 sieves respectively and dividing the sum by 100. The figure obtained indicates the relative fineness or coarseness of an aggregate and indicates to some extent the distribution of sizes of the aggregate if the maximum size is known.

Grading A, B, C, and D: Specified in A.A.S.H.O. designation T 96 - 60 - p. 391 and Section Y 14 of the State Highway Commission of Kansas Standard Specifications, 1960 edition.

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".

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

Material source bed: A particular geologic unit, consolidated or unconsolidated, that provides material for construction purposes.

Montmorillonite: A clay mineral which has the outstanding feature of allowing water and other polar molecules to enter into the lattice and cause it to expand.

Open material site: A pit or quarry which has produced or is producing material suitable for construction purposes.

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

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

Sedimentary quartzite: A dense sandstone rock which has been thoroughly cemented by silica.

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

Specific gravity: Determined by tests 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.

Stratum: A single mass of sedimentary rock that is separable along well-defined bedding planes from rocks that are different above and below. In simplest terms it may be described as a single bed or layer of rock but may consist of many layers as long as they are of the same kind of material. Strata is the plural form of stratum.

Strength ratio: Determined by tests performed in accordance with A.A.S.H.O. designation T 71.

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

Terrace: A plain built up by the deposition of sediments by water.

Unconsolidated deposits: Deposits of clay, silt, sand or gravel. These deposits may be laid down by either wind or water action.

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. Berry, Delmar W., 1952, Geology and Ground-Water Resources of Lincoln County, Kansas: State Geological Survey of Kansas Bulletin No. 95.

2. Byrne, F. E., Coombs, V. B., and Bearman, C. H., 1949, Construction Materials in Ellis County, Kansas: United States Geological Survey Circular 30.

3. Carey, J. S., Frye, J. C., Plummer, N., and Swineford, A., 1952, Kansas Volcanic Ash Resources: State Geological Survey of Kansas Bulletin No. 96, Part I.

4. Frye, J. C., 1945, Valley Erosion Since Pliocene "Algal Limestone" Deposition in Central Kansas: State Geological Survey of Kansas Bulletin No. 60, Part III.

5. Frye, J. C., and Brazil, J. J., 1943, Ground-Water in the Oil Fields Areas of Ellis and Russell Counties, Kansas: State Geological Survey of Kansas Bulletin No. 50.

6. Frye, J. C., and Leonard, A. B., 1952, Pleistocene Geology of Kansas: State Geological Survey of Kansas Bulletin No. 99.

7. Frye, J. C. and Swineford, A., 1946, Silicified Rock in the Ogallala Formation: State Geological Survey of Kansas Bulletin No. 64, Part II.

8. Leonard, A. R. and Berry, D. W., 1961, Geology and Ground-Water Resources of Southern Ellis County and Parts of Trego and Rush Counties, Kansas: State Geological Survey of Kansas Bulletin No. 149.

9. Mack, L. E., 1962, Geology and Ground-Water Resources of Ottawa County, Kansas: State Geological Survey of Kansas Bulletin No. 154.

10. Plummer, N., and Romary, J. R., 1942, Stratigraphy of the Pre-Greenhorn Cretaceous Beds of Kansas: State Geological Survey of Kansas Bulletin 41.

11. Swineford, A., and Frye, J. C., 1946, Petrographic Comparison of Pliocene and Pleistocene Volcanic Ash from Western Kansas: State Geological Survey of Kansas Bulletin No. 64, Part I.