

**KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 54-2**

**A COMPILATION OF PUBLISHED CHEMICAL ANALYSES OF
SEDIMENTARY ROCKS OF THE UNITED STATES**

By

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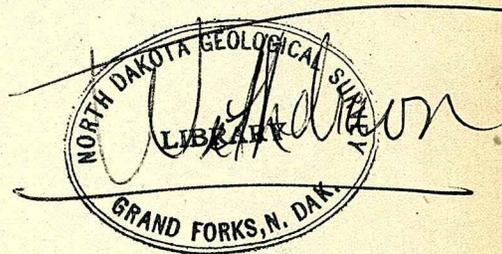
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KGS
OF
54-2

A Compilation of Published
Chemical Analyses
of Sedimentary Rocks
of the United States



[An experimental "mock-up" of analyses from the State of Kansas, prepared as a basis for suggestions and criticisms regarding the coverage of samples included, their classification and arrangement, the methods of presentation, and other procedures that may be followed in completing the entire compilation]

by
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Preface to the experimental "mock-up"

The compilation of published chemical analyses of sedimentary rocks was started as an official project of the U. S. Geological Survey in June of 1952. Much of the first two years has been spent in preliminary trial-and-error to discover satisfactory procedures for searching the literature, classifying the analyses, setting up the final tables, etc. Somewhat more than 3000 analyses from 16 States are now in various stages of handling by the personnel of the project and the progress of the work is accelerating constantly.

The major purpose of the compilation is to make the widely scattered data more readily accessible to many users of diverse interests. Precedents are rare for an undertaking of just this nature; and for this reason suggestions from the potential users at an early stage in the project would be especially helpful in selecting the best patterns for presentation of the data. To encourage such suggestions, it was decided to work up, into what might be approximately final copy for publication, a small but representative group of analyses and to distribute this experimental "mock-up" to a number of geologists and geochemists whose reactions and criticisms could be received early enough to guide the final stages of the work.

So large a proportion of the analyses have been published by the State geological surveys and comparable organizations, that it has seemed advantageous to start searching the literature by State units. The publications of the State of Kansas were among the first units completely searched and, as the analyses from this State were found to present nearly all the problems raised by analyses from other areas, they seemed a good sample to use for the experimental "mock-up". It is sincerely hoped that members of the Kansas Geological Survey will accept it as a tribute that the excellent reports of their organization should serve as a guinea pig for this purpose.

The published analyses of sedimentary rocks from Kansas, which are presented here, represent only about 5 percent of the entire job of compilation that is to be done. These 695 analyses are believed to be all the analyses of Kansas rocks that have been published by the State and Federal Surveys. If oversights or omissions are noted, we should be glad to know about them. This group of analyses does not include those that have been published in scientific and technical journals; it is estimated that an additional 10 percent of analyses may be added when these journals are searched.

It should clearly be noted that, in choosing for this experimental "mock-up" the analyses from a single region, one basic part of the over-all plan of presenting the material is considerably distorted. One of the most generally useful facts about an analysis is the lithologic character of the material it represents and for this reason lithologic character has been selected as the first criterion in classification and arrangement of the data. This means that in the final compilation, analyses from Kansas will not be grouped together consecutively as here but will be scattered under some 12 or 15 group headings thru the equivalent of about 3000 pages and several volumes of the complete compilation.

We who are working on the project are anxious to have all criticisms or suggestions that anyone who is interested cares to offer. We would like to know if the plan of presentation of the analyses is sufficiently logical, simple, and workable so that the compilation will be useful- and useful for a variety of purposes. If not, how might this plan be improved? Several particular problems seem difficult just now and any advice on them will be especially welcome:

(1) Is the system of references to original publications, (abbreviated but nevertheless complete on each page of the tables) satisfactory in its present form, or would it be more useful to give in these tables merely reference numbers to articles listed in a formal bibliography in the last volume of the entire compilation?

(2) Are the remarks under each analysis especially helpful in their present coverage of pertinent data or could these remarks be shortened without great loss? Experience has shown that gathering data for these incidental remarks is the most time-consuming step in the entire project.

(3) What should be policy regarding inclusion of analyses that have not yet been published formally but which are available as "open file" material, for copying by anyone who wants them, in the offices of the State and Federal Surveys?

(4) Should proximate and ultimate analyses of coal samples be included in this compilation?

(5) Should a separate stratigraphic index be provided of the geologic formations that are represented by analyses, comparable to the separate index of commercial uses?

(6) Averages and standard deviations are being calculated of all groups of analyses that have some measure of homogeneity (for example, all analyses reported to represent the same rock type, all samples of the same geologic age within each classification group, and all samples from the same geologic formation). Are these means and standard deviations of sufficiently general interest to be included in the compilation?

Finally, I wish to take this opportunity to mention the principal responsibilities of the three of us who are working on the project. Miss Welsh is primarily concerned with digging the original analyses and related data out of the published literature. Miss Hill makes the calculations from which the individual analyses are classified and she also has chief responsibility for the make-up of the tables. These two do the hard work of the project; as supervisor, I read proof on their copy and make the doubtful decisions to do something this particular way rather than that. All credit for work well done properly goes to Miss Welsh and Miss Hill. All blame for whatever is wrong with the project is entirely mine.

William W. Rubey

U. S. Geological Survey
Washington, D. C.
June 25, 1954

INTRODUCTION

The project of compiling published chemical analyses of sedimentary rocks of the United States was undertaken by the US Geological Survey in 1952, largely as an outgrowth of suggestions made several years earlier by a group of geochemists, geologists, geophysicists, and biologists called together by the Carnegie Institution of Washington for a conference on problems of the geochemistry of sedimentary rocks. This group pointed out that a knowledge of the composition of sedimentary rocks comparable to what has been known for several decades about the composition of igneous rocks would be extremely helpful in many fields of science. As a result of this and other conferences on the subject, the National Research Council in 1951 established a Committee on the Chemical Composition of Sediments, the purpose of which was to encourage individual investigations that will lead to a better balanced knowledge of the composition of sedimentary rocks. Since its establishment, this Committee has especially encouraged investigations of deep-sea sediments and of pre-Cambrian sedimentary rocks regarding which the available chemical information is clearly inadequate. An adequate knowledge of the geochemistry of sedimentary rocks must of course depend in part upon new chemical analyses of many samples; but to choose wisely the rock types of which new analyses are most needed the large amount of information now widely scattered thru a diverse literature needs to be assembled systematically, in itself a major undertaking.

The group of scientists who met under the auspices of the Carnegie Institution and the members of the NRC Committee were interested primarily in the more theoretical aspects of the geochemistry of sedimentary rocks. The Geological Survey shares fully in these theoretical interests because they bear directly on many important geological problems; but it is also, as a tax-supported institution, concerned with the utilization of sedimentary rocks for economic purposes-- as building stone, silica sand, ceramic and cement materials, and for many other practical uses. Because it shares in both the theoretical and applied interests in the chemistry of sedimentary rocks, the US Geological Survey could appropriately undertake the major task of compiling the published analyses, to the end that the widely scattered information may be made more readily available for the entire range of interests and possible uses.

Before it was decided to undertake compilation of these analyses, some effort was made to appraise the probable magnitude of the job. From several random samples of the literature, it appears that something like 10,000 to 15,000 chemical analyses of sedimentary rocks of the U. S. have been published and that perhaps 90 percent of these are in reports of the various State geological surveys and associated State universities and of the U. S. Geological Survey. It is estimated that another 10 percent or so of analyses are widely scattered thru technical journals of many scientific disciplines.

It should be noted at the outset that these 10,000 to 15,000 published analyses are almost certainly not fairly representative of the composition of all sedimentary rocks. The overwhelming majority of all rocks analyzed have

been selected because they are (or were thought to be) of special economic interest and, for that very reason, they are likely to be of unusual chemical composition. For example, the proportion of limestones that contain 95 percent or more of CaCO_3 are grossly over-represented in the published analyses when comparison is made with the range in purity of natural limestones. But this unrepresentative nature of the published analyses does not seriously detract from their potential usefulness-- quite the opposite, in fact, when one considers the variety of uses to which these analytic data may be put. The fact that carbonate rocks of unusual purity have been specially selected for analysis affords the potential manufacturer of lime, industrial fluxes, etc., with valuable information on where the best source materials for his particular purpose can be obtained most readily. It is true that the geologist or geochemist interested in estimating the average composition of the earth's materials is not likely to find gross averages of thousands of published analyses particularly useful for his purpose. However if he pays strict attention to the areal distribution and thickness of different rock types and of different geologic formations represented by the published analyses, he should be able to make better estimates of average compositions than most of those now available-- or at least to discover which rock types and formations are most in need of new analytic data.

Once it was decided to undertake compilation of the analyses the question arose of how to arrange 10,000 to 15,000 analyses so that users who have quite different interests in mind could find particular analyses or types of analyses without undue effort. Among the most generally useful facts about an analyzed sample are (1) its lithologic character, (2) the geographic locality from which it came, (3) the geologic formation from which it was collected, and (4) the commercial use or uses to which the material has been or might be put. But the relative importance of these and other facts about a sample varies considerably with the special interests of the particular user of the information. Although the actual or potential commercial use has been the chief consideration in selecting sedimentary rocks for chemical analysis, it is clear that the analyses simply cannot be classified and arranged primarily on this basis, because the information on commercial uses is extremely uneven from one report to another and even for a given deposit the use may change from time to time as a region develops and industrial processes are modified.

Considering the range of theoretical and practical interest in and of possible uses of the analyses, it was decided to arrange the samples by three successive criteria: first by their gross lithologic character, second by their locality, and third by their geologic formation or relative stratigraphic order, and then to provide a separate index of all commercial uses. This plan of organization groups all samples of one lithologic type together, then subdivides these similar samples by the State and county from which they were collected, and finally subdivides the county groups by relative stratigraphic position. This system of arrangement gives less emphasis to geologic formation and geologic age than would be desirable for certain uses of the data. But, after several tries with other plans of arrangement, it appears that any arrange-

ment must be a compromise that falls short of the ideal for some purposes. To offset this disadvantage of the particular system selected here, it is possible that a separate stratigraphic index of the geologic formations and geologic ages represented by the analyses should be provided, analogous to the separate index of commercial uses.

When the project was first started, it was hoped that all analyzed materials could be classified simply by the common lithologic terms (sandstone, shale, limestone, etc.) applied to them in the original reports from which the analyses were taken. Experience has shown, however, that such an ideally simple basis of classification is practicable only for the purer rock types. Nature draws no distinct boundaries between different rock types; and for mixed rocks the lithologic nomenclature has of necessity become exceedingly diverse. For example, argillaceous chalky rocks of nearly identical composition are variously reported as chalk, limestone, chalk-marl, marl, and shale. As a result, this system of classification would if followed make very closely similar rock types fall into categories that appear to be entirely different. For purposes of the present compilation, it seems necessary to adopt some objective system of classification that depends primarily upon the chemical analyses themselves.

Much has been written over the past fifty years about various systems of classification of the igneous rocks; but uniform agreement about the best system for all purposes has not yet been reached. In some ways, though, the classification of igneous rocks, according to their chemical composition, should be a simpler problem than that of the chemical classification of sedimentary rocks. This is because, at least in theory, the various types of igneous rocks may be characterized adequately in terms of a relatively small number of standard or normative minerals which crystallized during the cooling of an original magma. Many sedimentary rocks, on the other hand, are made up largely of fragmental materials-- grains of minerals that were formed in environments totally different from that in which the detrital sediment finally accumulated. Thus no rules of consanguinity, comparable to those for igneous rocks, govern the mineral assemblages in sedimentary rocks-- or at any rate no such rules have thus far been discovered. Furthermore, clay minerals are a major constituent of many sedimentary rocks, and the clay minerals are exceedingly complex in their mineralogy and chemical composition. This fact alone greatly handicaps efforts to establish a rational basis for the chemical classification of detrital sediments.

It is conceivable that a system may someday be devised for classifying all sedimentary rocks in terms of a few arbitrarily chosen and more or less fictitious minerals which can be computed from the chemical composition. It may be mentioned here in passing that the formulation of some such system may well be one of the scientific uses to which a comprehensive compilation of sedimentary analyses will be put. But the fact is that no such classification is yet available, and some other basis for the chemical classification of sedimentary rocks must be used for purposes of the compilation.

After trial efforts with several possible methods of classification, it appears that the system suggested by Mason ^{1/} combines the desirable elements of maximum simplicity with at least a modicum of scientific background as well as or better than any other yet devised. Briefly Mason's system treats all sedimentary rocks as if they were mixtures of the three components, SiO_2 , $(\text{Al,Fe})_2\text{O}_3 \cdot n\text{H}_2\text{O}$, and $(\text{Ca,Mg})\text{CO}_3$, and plots these mixtures on a triangular diagram. To a first very rough approximation, the three end-members of Mason's diagram might be thought of as the minerals, quartz, ferruginous bauxite, and calcite-dolomite. In actual fact, however, most sedimentary rocks cannot be stated even roughly as mixtures of these three minerals. Silica is a major constituent of all the commoner clay minerals, and thus the most abundant types of mudstones have chemical compositions that fall approximately mid-way between the two theoretical components, SiO_2 and $(\text{Al,Fe})_2\text{O}_3 \cdot n\text{H}_2\text{O}$. Similarly a clean, well-sorted sandstone that includes significant amounts of feldspar grains contains much Al_2O_3 and it thus appears in Mason's system as a mixture of SiO_2 and $(\text{Al,Fe})_2\text{O}_3 \cdot n\text{H}_2\text{O}$. If the sand grains include many particles of calcic plagioclase and of ferro-magnesian minerals, the rock contains significant amounts of Al_2O_3 , Fe_2O_3 , CaO , and MgO as well as SiO_2 and in this system it may appear as a mixture of all three components, much as if it were a calcareous mudstone. Obviously Mason's diagram cannot be taken as even a rough counterpart of the usual sand-mudstone-limestone diagram. Nevertheless if these qualifications are kept clearly in mind, the three somewhat hypothetical components of his diagram afford a useful basis for classifying the chemical analyses of most sedimentary rocks.

^{1/} Mason, Brian, 1952, Principles of geochemistry, p. 130-31, John Wiley and Sons

The three-component diagram becomes far more useful for classifying large numbers of analyses when it is subdivided into several areas that correspond to groups of analyses. Convenient subdivisions for this purpose may be defined rather arbitrarily as follows: (See also Fig 1)

- A. Very high silica group (SiO_2 from 90% to 100%)
- B. High silica group (SiO_2 from 75% to 90%)
- C. Aluminum silicates group [$\text{SiO}_2 < 75\%$; $\text{SiO}_2 > (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O}) > \text{Carbonates}$]
- D. Carbonate-silica group [$\text{SiO}_2 < 75\%$; $\text{SiO}_2 > \text{Carbonates} > (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O})$]
- E. High alumina-iron group [$(\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O}) > \text{SiO}_2$; $(\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O}) > \text{Carbonates}$]
- F. Impure carbonates group [$\text{Carbonates} < 75\%$; $\text{Carbonates} > \text{SiO}_2$; $\text{Carbonates} > (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O})$]
- G. High carbonates group (Carbonates from 75% to 90%)
- H. Very high carbonates group (Carbonates from 90% to 100%)

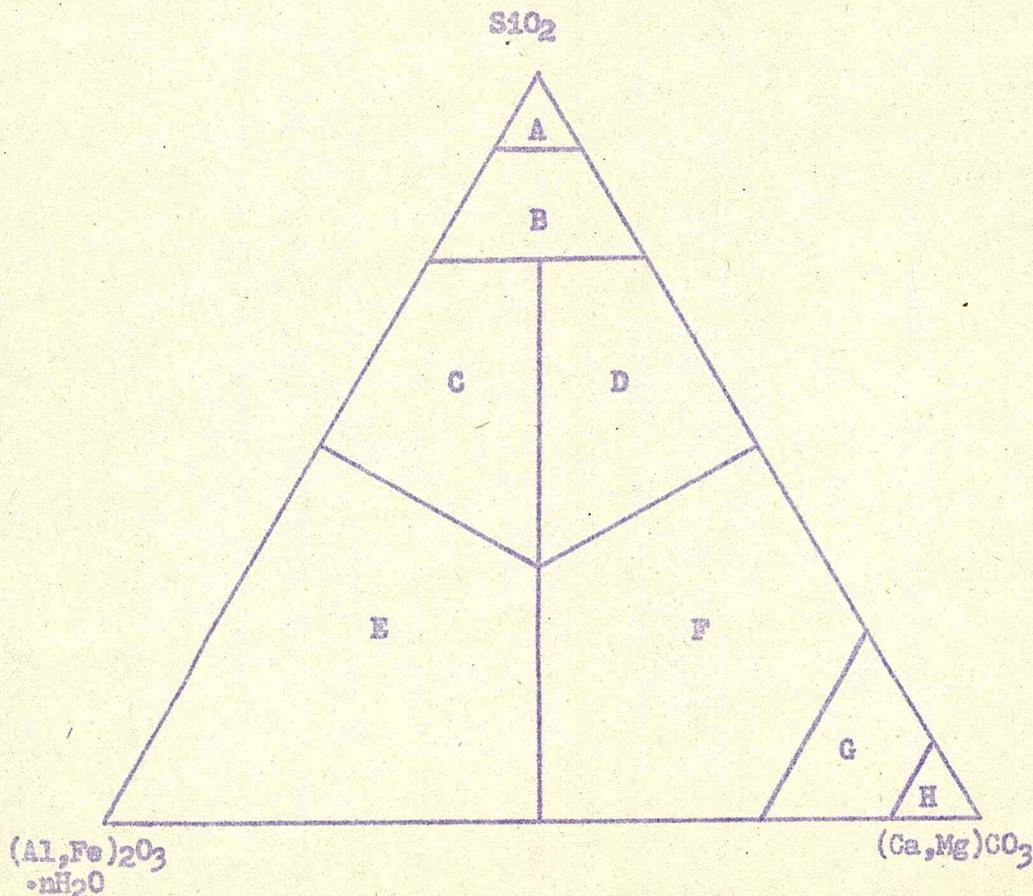


Fig. 1- Mason's diagram of the composition of sedimentary rocks subdivided into 8 areas corresponding to groups of chemical analyses.

In the tables of analyses that follow, each sample is given a classification notation which indicates the calculated percentages of the three components. For example, the numerals "12, 18, 68" following the designation "Class" are to read as "12% SiO_2 , 18% $(\text{P}_2\text{O}_5 \cdot n\text{H}_2\text{O})$, and 68% $(\text{Ca, Mg})\text{CO}_3$ ". This identifies the sample as a member of Group F.

The samples that are relatively high in carbonates (Groups F, G, and H) are given an additional notation to indicate the calculated ratio of calcite to dolomite in the carbonate fraction, as follows:

Notation	Calcite/dolomite mol ratio
calcite -----	0.9 to 1.0
mag calc -----	0.5 to 0.9
calc dol -----	0.1 to 0.5
dolomite -----	0.0 to 0.1

The analyses differ greatly in the constituents determined, especially H_2O and CO_2 ; and in actual practice it has been found helpful to formulate detailed working schedules for the calculation of the two components, $(\text{Al, Fe})_2\text{O}_3 \cdot n\text{H}_2\text{O}$ and $(\text{Ca, Mg})\text{CO}_3$. To save space, copies of these working schedules are not included in this report but they will gladly be sent to any readers of this experimental "neck-up" who express their wish to have them.

The great majority of analyses thus far examined yield calculated totals of 90% or more of the three major components of the Mason diagram. Stated another way, the analyses of all sedimentary rocks may be conceived to lie on or within a composition tetrahedron the three basal corners of which are these three components and the fourth or upper corner of which represents all other "impurities". In such a composition tetrahedron the analyses of most sedimentary rocks are found to lie well within 10% of the basal planes.

A small proportion of the analyses thus far examined contain larger amounts of other constituents, such as H_2O , K_2O , P_2O_5 , SO_3 , or Cl . Those that calculate out to contain a total of less than 90% but more than 50% of the three major components are designated by the letter of the group into which they would fall if the "impurities" were absent, and for these analyses the notation "90-" is added. For example, the "Class" designation, "A, 8, 24, 8", means that the sample contains a total of only 80% of the 3 major components and, because of the relative proportions of each, it falls into "Group C, 90-". That is to say, these "impure" samples are classified by projecting them onto the basal plane of the composition tetrahedron mentioned above. The analyses usually indicate the nature of the "impurities" in the "90-" samples, and wherever possible these "impurities" are mentioned in the Remarks under these analyses.

Samples that calculate to a total of less than 50% of the 3 major components are placed in a separate category entitled "Miscellaneous Sedimentary Rocks" and subdivided into groups of calcium sulfate rocks, salines, phosphates, etc., depending upon their major constituents.

Precise standards for the inclusion or rejection of analyses have not been formulated thus far; and the compilers would greatly appreciate suggestions at this time regarding what standards should be established. In general, partial analyses that give only a few constituents and have low summations have been excluded. The reader will note that no effort has been made to grade the analyses into categories of superior, good, fair, etc. The date of publication of the analyses affords a crude basis for appraising their reliability; and wherever available, the name of the analyst has been given as an index of the quality of the work. A critical selection of the truly superior analyses can probably best be made by others after this less critical and more inclusive compilation has been completed.

A Group (SiO₂ from 90% to 100%)

Kansas

A-C: LOWER CRETACEOUS, CHEYENNE ss. Analyst, R. Rummels.

A. Barber Co. Cen sec 18, T 31 S, R 15 W. Ross, K. E., 1950, Kans GS B 86, pt. 4, p. 96.

Sandstone, 24 ft channel sample near drill holes 7-10. Analysis of whole rock; locally contains aggregates which are readily removed by 20 mesh screen, p. 95, 96.

Possible use: Foundry sand, p. 102, 103.

B. Barber Co. Secs 17, 18, 19, T 31 S, R 15 W. Lab #50141. Nixon, E. K., et al., 1950, Kans GS B 86, pt. 3, p. 46, 68, 76.

Sandstone, composite of drill holes 7-10. Fraction passing 20 and retained on 100 mesh screens. For drill hole 10: mineralogy and percentage of heavy minerals, p. 62, 63; roundness of different size fractions, p. 58; sieve analysis, p. 54. Logs of drill holes 7-10, p. 50, 82, 83. Tonnage estimate, p. 77.

Suggested use: Foundry sand or glass sand, if treated, p. 79.

C. Barber, Comanche, and Kiowa Cos. Barber Co. Secs 17, 18, 19, T 31 S, R 15 W. Drill holes 7-10. Comanche Co. Secs 27, 34, T 31 S, R 16 W. Drill holes 11, 12. Kiowa Co. Secs 9, 10, 13, 17, 18, T 30 S, R 16 W. Drill holes 1-6. Lab #49207. Idem.

Sandstone, composite of 12 drill holes in 3 counties, p. 68. See samples #50140, Kiowa Co, and #50141, Barber Co. Tonnage estimate, p. 77. Logs of drill holes, p. 50, 80-84.

Suggested use: Foundry sand or glass sand, if treated, p. 79.

	A ^{e/}	B	C
SiO ₂	97.15	98.54	98.17
Al ₂ O ₃ ^{a/}		0.72	0.82
Fe ₂ O ₃ ^{b/}	0.20	0.17	0.23
R ₂ O ₃ ^{c/}	1.44		
MgO		0.07	0.06
CaO		0.03	0.03
Na ₂ O	} 0.67 ^{e/}	0.02	0.03
K ₂ O		0.09	0.11
TiO ₂ ^{d/}		0.09	0.10
P ₂ O ₅ ^{b/}		0.02	0.01
BaO ^{b/}			0.02
SO ₃ ^{b/}		0.01	0.02
S		tr	tr
Ignit Loss ^{e/}	0.54	0.34	0.39
Total	100.00	100.10	99.99
Class	97,2,0	99,1,0	98,1,0

a/Contains undetermined Mn
 b/Rounded off to two decimal places
 c/Includes alumina but not iron oxide
 d/Contains ZnO and V₂O₅ when present

e/105-1000°C
 f/Wt. percentage on air-dry basis
 g/By difference, chiefly alkalis

A Group

Kansas

A and B. Cheyenne Co. PENNSYLVANIAN, STRANGER fm, TONCANOXIE ss mem and LAWRENCE sh, IRELAND ss mem. ^{1/} Analyst, G. Steiger. USGS Lab #2227. Clarke, F. W., 1915, USGS B 591, p. 220; Burchard, E. F., 1906, USGS B 285, p. 462, 463.

Sieve tests and roundness data, USGS B 285, p. 462, 463.

Use: Samples considered too low in silica and too fine grained for glass sand, idem, p. 471.

A. S 1/2 SE 1/4 sec 19, T 34 S, R 13 E; town of Niotaze.
Sandstone, white.

B. S 1/2 SE 1/4 sec 19, T 34 S, R 13 E; town of Niotaze.
Sandstone, light yellowish brown.

^{1/} Letter from Kans GS, 7/16/53

	A	B
SiO ₂	96.90	96.45
Al ₂ O ₃	2.03	2.76
Fe ₂ O ₃ ^{a/}	0.67	0.37
Total	99.60	99.58
Class	97,3,0	96,4,0

^{a/} Total Fe

A Group

Kansas

A-F: Cherokee Co. MISSISSIPPIAN, T 34 S, R 25 E, town of Galena.

A. Probably WARSAW ls or KEOKUK ls. ^{1/} Bonanza shaft. Analyst, E. Schneider, collected by W. Jenney. USGS lab #1205. Clarke, F. W., 1897, USGS B 148, p. 253; Clarke, F. W., 1915, USGS B 591, p. 222.
Chert; altered.

B. Probably WARSAW ls, or KEOKUK ls. ^{1/} Bonanza shaft. Analyst, E. Schneider, collected by W. Jenney. USGS lab #1205. USGS B 148, p. 253; USGS B 591, p. 222.
Chert.

C. Probably WARSAW ls or KEOKUK ls. ^{1/} Bonanza shaft. Analyst, E. Schneider, collected by W. Jenney. USGS lab #1205. USGS B 148, p. 253, USGS B 591, p. 222.
Chert, blue; unaltered.

D. WARSAW ls or KEOKUK ls (?). Martin and Hughes mine. Analyst, J. Robertson. Lab #517. Haworth, E., et al, 1904, Kans GS V 8, p. 83.
Chert, light drab, porous. Occurs in fissures of primary chert.

E. WARSAW ls or KEOKUK ls (?). Analyst, J. Robertson, Lab #518. Idem.
Chert, dark brown, hard, somewhat granular and earthy with small crystals of galena and blende. Occurs as gangue material in fissures of primary chert.

F. Probably WARSAW ls or KEOKUK ls. ^{1/} Analyst, L. Eakins, collected by W. Jenney. USGS lab #1208. USGS B 148, p. 253; USGS B 591, p. 222.
Jasperite.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E	F
SiO ₂	99.13	98.60 ^{a/}	99.23	97.75	92.28	97.33
Al ₂ O ₃)	0.16	0.52	0.22	1.61	1.25	1.89
Fe ₂ O ₃)	0.01	tr	tr	tr		0.09
MgO	tr	0.10	0.02	0.45	tr	0.11
CsO					4.08	
ZnS						
Ignit Loss	0.20	0.40	0.50			0.77
Total	99.50	99.62	99.97	99.81	97.61 ^{b/}	100.19
Class	99,0,0	99,1,0	99,1,0	98,2,0	98,2,0	97,2,0

^{a/} Kans GS V 8, p. 79, SiO₂; 98.00

^{b/} 99.58 (sic text)

A Group

Kansas

A. Comanche Co. LOWER CRETACEOUS, CHEYENNE ss. Sec 27, T 31 S, R 16 W. Analyst, R. Runnels. Lab #50132. Nixon, E. K. et al., 1950, Kans GS B 86, pt. 3, p. 46, 76.

Sandstone. 30 ft channel sample, outcrop near drill hole 11; fraction passing 20 and retained on 100 mesh screen, p. 68. Tonnage estimate, p. 77.

Analysis of clay fraction finer than 1 micron; SiO₂, 49.33; Al₂O₃, 33.20; Fe₂O₃, 2.12; MgO, 1.36; CaO, 0.91; TiO₂, 0.57; Ignit Loss, 12.95; Total, 100.44. Lab #50173. Electron micrograph of sample, p. 56. 1.8% by weight of channel sample has grain size of less than 1 micron, p. 54, 55.

Suggested use: Glass sand, if treated, p. 79.

B. Comanche Co. LOWER CRETACEOUS, CHEYENNE ss. Sec 27, T 31 S, R 16 W. Analyst, R. Runnels. Lab #50133. Idem.

Sandstone. 30 ft channel sample, outcrop near drill hole 11; fraction from same sample as "A" but passing 100 mesh screen, p. 68. Tonnage estimate, p. 77.

Suggested use: Foundry sand or glass sand, if treated, p. 79.

C. Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SE 1/4 sec 29, T 15 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #EL-20-W5. Plummer, N., and Romary, J. F., 1947, Kans GS B 67, p. 132, 139.

Silt, kaolinitic, very fine-grained, smooth, nearly white with some yellow stain. Thickness 6.8 ft. Almost all material passes 200 mesh screen, p. 131. Ceramic tests, p. 141, 142.

Possible use: Structural clay product, refractory, pottery, p. 7.

	A	B	C
SiO ₂	98.72	97.75	91.36
Al ₂ O ₃	0.72 ^{a/}	1.23 ^{a/}	3.71
Fe ₂ O ₃	0.12 ^{b/}	0.16 ^{b/}	0.54
MgO	0.03	0.03	0.35
CaO	0.01	0.02	0.25
Na ₂ O	0.01	n.d.	(1.50
K ₂ O	0.03	n.d.	
TiO ₂	0.08 ^{c/}	0.19 ^{c/}	1.06
P ₂ O ₅	0.01 ^{b/}	0.01 ^{b/}	
BaO	0.01 ^{b/}		
SO ₃	0.03 ^{b/}	0.03 ^{b/}	
S	nil	nil	
Ignit Loss	0.34 ^{d/}	0.54 ^{d/}	1.40
Total	100.11 ^{e/}	99.98	99.97
Class	99,1,0	98,2,0	91,5,1

^{a/} Contains undetermined Mn

^{b/} Rounded off to two decimal places

^{c/} Contains ZrO₂ and V₂O₅ when present

^{d/} 105-1000°C

^{e/} 100.09 (sic text)

A Group

Kansas

A,C: Graham Co. PLIOCENE, OGALLALA fm. Analyst, U. S. Engineer Office, Kansas City, Mo. Frye, J. C. and Swineford, Ada, 1946, Kans GS B 64, pt 2, p. 63.

Quartzite. Standard physical tests, p. 63.

Possible use: Railroad ballast, riprap, road metal, p. 62.

A. Sec 31, T 7 S, R 22 W. 3 mi NE of Hill City

Even-textured medium to coarse-grained, gray to greenish gray, weathered surface a dull rusty red. Probable average thickness, 8 ft. Bulk density, 2.38. Sol in HCl, 4.90%. Tonnage estimate, p. 66.

B. Sec 34, T 8 S, R 22 W. 1/

Medium grained, gray-green; somewhat cavernous. Bulk density, 2.41. Sol in HCl, 3.62%. Tonnage estimate, p. 66.

C. Sec 13, T 8 S, R 23 W.

Texture from medium fine-grained to conglomeratic; green. Bulk density, 2.37. Sol in HCl, 5.62%. Tonnage estimate, p. 65.

1/Sec 24, Frye and Swineford, 1946, p. 66.

	A	B	C
SiO ₂	88.09	97.10	86.98
Al ₂ O ₃	3.50	1.26	3.71
Fe ₂ O ₃	1.35	0.06	1.89
MgO	1.08	0.10	1.13
CaO	0.69	0.00	1.08
Na ₂ O	1.01		1.20
K ₂ O	1.47		1.49
SO ₃		0.00	
Ignit Loss	2.21	1.52	2.08
Total	99.40	100.04	99.56
Class	88,6,2	97,3,0	87,7,1

A Group

Kansas

A-D; Greenwood Co. PENNSYLVANIAN, STRANGER fm, TONGANOXIE ss mem and LAWRENCE sh, IRELAND ss mem. 1/ SE 1/4 sec 13, T 28 S, R 12 E, near Fall River station. Analyst, C. Steiger. USGS lab #2293. Clarke, F. W., 1915, USGS B 591, p. 220.

Sandstone, 20 ft thick, parted near the middle by thin clay seam. Iron stain at top of upper bed and immediately above clay seam. Below clay seam 4 to 5 ft of clean, grayish-white, angular, rather friable ss. Burchard, E. F., 1907, USGS B 315, p. 380.

Possible use: Glass sand.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂	97.28	98.02	97.81	98.24
Al ₂ O ₃	0.96	0.81	0.73	0.57
Fe ₂ O ₃ ^{a/}	0.80	0.26	0.35	0.35
MgO	0.04	0.06	0.05	0.04
CaO	0.13	0.08	0.18	0.06
Ignit Loss	0.73	0.81	0.80	0.72
Total	99.94	100.04	99.92	99.98
Class	97,2,0	98,2,0	98,2,0	98,2,0

^{a/} Total Fe

A Group

Kansas

A. Kiowa Co. LOWER CRETACEOUS, CHEYENNE ss. Secs 9, 10, 15, 17, 18, T 30 S, R 16 W. Analyst, R. Runnels. Lab #50140. Nixon, E. K. et al., 1950, Kans GS B 86, pt. 3, p. 46, 68, 76.

Sandstone, composite of drill holes 1-6, fraction passing 20 and retained on 100 mesh screen. For drill hole 4: mineralogy and percentage of heavy minerals, p. 60, 61; roundness of different size fractions, p. 58, sieve analysis, p. 54. Logs of drill holes 1-6, p. 50, 82, 83. Tonnage estimate, p. 77.

Suggested use: Foundry sand or glass sand, if treated, p. 79.

B. Kiowa Co. LOWER CRETACEOUS, CHEYENNE ss. Secs 9, 10, 15, 17, 18, T 30 S, R 16 W. Analyst, R. Runnels. Lab #50139. Idem.

Sandstone, composite of drill holes 1-6, fraction passing 100 mesh screen. Suggested use: Foundry sand or glass sand, if treated, p. 79.

C. Montgomery Co. PENNSYLVANIAN, STRANGER fm, TONGANOXIE ss mem and LAWRENCE sh, IRELAND ss mem. 1/ Sec 13, T 34 S, R 13 E, town of Havana. 2/ Analyst, G. Steiger. USGS lab #2295. Clarke, F. W., 1915, USGS B 591, p. 219, 220.

Sandstone, pinkish brown. Sieve tests and angularity data, Burchard, E. F., 1906, USGS B 285, p. 462, 463, 470, 471.

Possible use: Glass sand.

D. Montgomery Co. PENNSYLVANIAN, STRANGER fm., TONGANOXIE ss mem. and LAWRENCE sh, IRELAND ss mem. 1/ Sec 36, T 34 S, R 13 E, 2 mi N of town of Caney. 2/ Analyst, G. Steiger. USGS lab #2222. USGS B 591, p. 220.

Sandstone, light yellowish brown. Sieve tests and angularity data, Burchard, E. F., 1906, USGS B 285, p. 462, 463, 470, 471. Stratigraphy of exposure, p. 470.

Possible use: Glass sand.

1/ Letter from Kans GS, 7/16/53
2/ USGS B 285, p. 462, 463, 470, 471

	A	B	C	D
SiO ₂	97.61	94.97	97.80	97.08
Al ₂ O ₃ <u>a/</u>	1.18	2.59		
Fe ₂ O ₃	0.29	0.55	0.84 <u>e/</u>	0.72 <u>e/</u>
MgO	0.06	0.18		
CaO	0.04	0.10		
Na ₂ O	n.d.	n.d.		
K ₂ O	n.d.	n.d.		
TiO ₂ <u>b/</u>	0.10	0.23		
P ₂ O ₅ <u>c/</u>	0.01	tr		
SO ₃ <u>c/</u>	0.03	0.02		
S <u>c/</u>	tr	0.02		
Ignit Loss <u>d/</u>	0.54	1.09		
Total	99.86	99.75	98.64	97.80
Class	98,2,0	95,4,0	98,1,0	97,1,0

a/ Contains undetermined Mn

b/ Contains ZrO₂ and V₂O₅ when present

c/ Rounded off to two decimal places

d/ 105-1000°C

e/ Total Fe

A Group

Kansas

A-E: PLEISTOCENE, OGALLALA fm. Analyst, U. S. Engineer Office, Kansas City, Mo. Frye, J. C., and Swineford, Ada, 1946, Kans GS B 64, pt. 2, p. 63.

Quartzite. Standard physical tests, p. 63.

Suggested use: Railroad ballast, riprap, road material, p. 62, 64.

A. Norton Co. Sec 15, T 5 S, R 21 W.

Green to gray green; medium to coarse-textured; cross-bedded; max thickness 12 ft. Bulk density, 2.39. Sol in HCl, 2.78%. Tonnage estimate, p. 67.

B. Phillips Co. Sec 7, T 5 S, R 17 W.

Quartzite crops out in discontinuous line along S side of North Solomon valley and tributary valleys from sec 7, T 5 S, R 17 W to sec 18, T 5 S, R 20 W. Bulk density, 2.39. Sol in HCl, 5.2%. Tonnage estimate, p. 68.

C. Phillips Co. Sec 4, T 1 S, R 19 W; 3 to 4 mi W of town of Woodruff.

Green to gray green; medium-grained to conglomeratic. Quartzite in lenticular masses in loose sand and gravel; lenses do not exceed 4 or 5 ft in thickness. Former quarry. Bulk density, 2.63. Tonnage estimate, p. 70.

D. Phillips Co. Sec 23, T 5 S, R 19 W.

Color-texture variations and tonnage estimate for southern area, p. 68, 69. Sol in HCl, 3.60%. Bulk density, 2.39.

E. Rocks Co. Sec 10, T 6 S, R 19 W.

Green to brownish green and fine-grained to conglomeratic. Quartzite in lentils; S of Ecm Creek valley from vicinity of Sugar Leaf Mound, sec 10, T 6 S, R 19 W, to sec 4, T 6 S, R 26 W. Bulk density, 2.39. Sol in HCl, 5.10%. Tonnage estimate, p. 71.

	A	B	C	D	E
SiO ₂	98.00	95.40	87.00	96.30	96.50
Al ₂ O ₃	0.52	1.33	4.01	1.28	0.78
Fe ₂ O ₃	0.06	0.29	1.59	0.24	0.32
MgO	0.06	0.11		0.10	0.06
CaO	0.04	0.06	1.10	0.08	0.44
Na ₂ O			) 3.30		
K ₂ O					
H ₂ O-			1.00		
SO ₃	0.00	0.00	n.d.	0.00	0.00
Ignit Loss	1.18	2.30	2.00	1.60	1.32
Total	99.86	99.49	100.00	99.60	99.42
Class	98,2,0	95,4,0	87,7,2	96,3,0	97,2,1

A Group

Kansas

A-E: Wilson Co. PENNSYLVANIAN, STRANGER fm, TONGANOXIE ss mem and LAWRENCE sh, IRELAND ss mem. ^{1/} Analyst, G. Steiger. USGS Lab #2222. Clarke, F. W., 1915, USGS B 591, p. 219, 220.

Sandstone.

Possible use: Glass sand.

A. Sec 20, T 29 S, R 14 E. Burchard, E. F., 1906, USGS B 285, p. 462, 463, 470, 471.

Grayish white. Sieve tests and angularity data, p. 462, 463.

B. Sec 20, 21, T 29 S, R 14 E. Idem, p. 462, 463, 470, 471.

Grayish white. Sieve tests and roundness data, p. 462, 463.

C. T 29 S, R 14 E; 5 mi SW of town of Fredonia. Idem, p. 462, 463, 470, 471.

Yellowish brown. Sieve tests and angularity data, p. 462, 463.

D. T 29 S, R 15 E; 1 1/2 mi SE of town of Fredonia. Idem, p. 462, 463, 470, 471.

Near base of formation. Cross-bedded, light-gray, micaceous, porous, soft and texturally coarser than other sss in vicinity. Section of drill hole, Burchard, E. F., 1907, USGS B 315, p. 379. Sieve tests and angularity data, USGS B 285, p. 462, 463, 470, 471.

E. T 30 S, R 16 E, town of Neodesha.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	97.59	98.00	97.94	97.50	98.71
Al ₂ O ₃				1.62	
Fe ₂ O ₃ ^{a/}	0.33	0.37	0.63	0.43	0.19
MgO				none	
CaO				0.10	
Total	97.92	98.37	98.57	99.65	98.90
Class	98,0,0	98,0,0	98,1,0	98,3,0	99,0,0

^{a/} Total Fe

B Group, SiO₂ from 75% to 90%

Kansas

A. Barton Co. UPPER CRETACEOUS, DAKOTA ss, JANSSEN clay mem. ^{1/} SW 1/4 SW 1/4 sec 21, T 18 S, R 13 W. Analyst, R. Runnels. Lab #BT-1-MR. Reed, A. C., 1950, Kans GS B 86, pt 2, p. 24, 27, 36.

Clay.

Use: Brick making, p. 24.

B. Chautauque Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 NW 1/4 SE 1/4 sec 9, T 34 S, R 12 E. Analyst, R. Runnels. Lab #CQV-1. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 15, 20.

Ash deposit underlies at least 10 acres, p. 40. Sample from bed 4.0 ft thick. Screen analysis, p. 24.

Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

C. Cherokee Co. MISSISSIPPIAN, KEOKUK ls or WARSAW ls (?). T 34 S, R 25 E, town of Galena, Weilup mine. Analyst, J. Robertson. Lab #379. Haworth, E., et al, 1904, Kans GS V 8, p. 83.

Chert, soft, clayey. Occurs in fissures of primary chert.

D. Cheyenne Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. SE 1/4 SE 1/4 sec 28, T 3 S, R 39 W. Analyst, R. Runnels. Frye, J. C. et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.

Silt. Depth below top of section 18 ft., p. 56. Plastic and dry properties, p. 88; fired properties, p. 98.

Possible use: Ceramic slag, p. 83.

^{1/} Letter from Kans GS, 7/16, 53

	A	B	C	D		
SiO ₂	76.52	67.75	85.19	69.99	Qualitative spectrographic analysis by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance.)	
Al ₂ O ₃	13.57	12.83	} 11.64	12.00		
Fe ₂ O ₃	1.75 ^{e/}	2.66		2.84		
MgO	0.21	0.52	0.07	1.62		
CaO	0.41	0.90	1.55	4.21		
Na ₂ O		} 7.82 ^{e/}		1.15 ^{e/}		
K ₂ O				2.86		
TiO ₂	1.37 ^{d/}	1.78		0.67		V 4
P ₂ O ₅		< 0.01		n.d.		Cr 3
V ₂ O ₅ ^{a/}	0.05					Mn 6
SO ₃	tr	0.10		0.09	Cu 4	
Ignit. Loss	4.73	5.64		4.57	Zn 4	
H ₂ O- ^{b/}				(0.19)	Zr 7	
Total	98.61	< 100.01	98.45	100.00		
Class	77,20,1	68,20,3	85,12,0	70,19,2		

^{a/} Analyzed spectrographically. Rounded to two decimal places.

^{b/} Below 105 to 140°C, not included in total

^{c/} Average of three or more determinations

^{d/} RO₂ + R₂O₃ reported as TiO₂ by gravimetric determination

^{e/} By difference

B Group

Kansas

A. Cheyenne Co. PLEISTOCENE, SANBORN fm, Peoria silt mem, Brady soil. SE 1/4 SE 1/4 sec 28, T 3 S, R 39 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.
Silt. Depth below top of section 5.5 ft., p. 56. Plastic and dry properties, p. 88; fired properties, p. 98.
Possible use: Ceramic slag, p. 83.

B. Clark Co. LOWER CRETACEOUS, KIOWA sh. NW 1/4 NW 1/4 sec 18, T 32 S, R 22 W. Analyst, R. Runnels. Lab #CL-6. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 26.
Lt. gray, unoxidized. 31.8 ft sampled out of a possible 50.0 ft available. Screen analysis, p. 30. Firing tests and physical properties of bloated aggregate in batch-type rotary kiln, p. 27. Bloating results in electric kiln, p. 37.
Possible use: Light weight aggregate, p. 68.

C. Clark Co. PLEISTOCENE, MEADE fm., PEARLETTE ash bed. SE 1/4 SE 1/4 sec 23, T 30 S, R 24 W. Analyst, R. Runnels. Lab #CLV-1A. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 15, 20, 40, 41.
Sample from lower 4.4 ft of bed 9 ft thick. Screen analysis, p. 24.
Possible uses: Abrasive, ceramic glaze, cement additive, light weight aggregate, p. 30-40.

D. Clark Co. PLEISTOCENE, MEADE fm., PEARLETTE ash bed. SE 1/4 SE 1/4 sec 23, T 30 S, R 24 W. Analyst, R. Runnels. Lab #CLV-1B. Idem.
Sample 1.6 ft below top of bed 9 ft thick. See CLV-1A. Screen analysis, p. 24.
Possible uses: Abrasive, ceramic glaze, cement additive, light weight aggregate, p. 30-40.

	A	B	C	D
SiO ₂	70.62	75.61	73.34	73.73
Al ₂ O ₃	12.13 ^{a/}	10.97	10.96	11.67
Fe ₂ O ₃	3.07	3.27	1.86	1.63
MgO	1.42	1.03	0.14	0.09
CaO	3.36	0.40	0.87	0.73
Na ₂ O	0.23 ^{b/}	0.27	3.33 ^{c/}	2.71 ^{c/}
K ₂ O	3.19	1.76	4.80	4.95
TiO ₂	0.99	0.93	0.68	0.49
P ₂ O ₅	0.10	0.17	tr	tr
SO ₃	0.06	0.37	tr	tr
Ignit Loss	4.93	4.53	4.02	4.00
H ₂ O-	(0.49) ^{d/}			
Total	100.10	99.31	100.00	100.00
Class	71,19,2	76,18,2	73,16,2	74,17,1

- ^{a/} Presumably not corrected for P₂O₅
- ^{b/} By difference
- ^{c/} By difference, ratio from spectro.
- ^{d/} Below 105 to 140°C, not included in total

B Group

Kansas

A-G: Clay Co. PLEISTOCENE, SANBORN $\frac{1}{4}$ NE $\frac{1}{4}$ sec 19, T 8 S, R 3 E.
 Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 85, 87, 93.
 Plastic and dry properties, p. 93. Fired properties, p. 112.
 Possible use: Brick and tile, p. 81.

A.	Loveland silt mem.	Depth below top of section	27.5 ft.
B.	" " "	" " "	22.5 "
C.	" " "	" " "	17.5 "
D.	" " "	" " "	13.5 "
E.	" " "	" " "	11.0 "
F.	Peoria	" " "	8.0 "
G.	" " "	" " "	4.0 "

	A	B	C	D	E	F	G
SiO ₂	77.32	77.64	78.62	77.95	76.69	75.86	74.75
Al ₂ O ₃	10.83 ^{c/}	10.38	10.24	10.18	10.80	10.79	10.96 ^{c/}
Fe ₂ O ₃	2.52	2.53	2.35	2.59	2.79	2.94	2.80
MgO	0.86	0.74	0.70	0.70	0.86	0.89	1.19
CaO	1.49	1.22	1.34	0.86	0.93	1.32	1.75
Na ₂ O ^{a/}	1.12	1.32	0.56	1.38	0.50	1.77	1.75
K ₂ O	2.87	3.23	3.23	3.02	3.68	3.18	3.27
TiO ₂	1.22	0.88	0.94	0.72	0.92	0.83	1.17
P ₂ O ₅	0.14	0.14	0.08	tr	tr	0.11	0.15
SO ₃	tr	0.15	0.20	tr	0.07	tr	tr
Ignit. Loss	1.77	1.83	1.74	2.60	2.76	2.31	2.36
H ₂ O ^{b/}	(0.29)	(0.25)	(0.08)	(0.18)	(0.21)	(0.23)	(0.39)
Total	100.14	100.06	100.00	100.00	100.00	100.00	100.15
Class	77,15,0	78,15,0	79,14,0	78,15,0	77,16,0	76,16,0	75,16,0

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

^{c/} Presumably not corrected for P₂O₅

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
 Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B	C	D	E	F	G
V	9	3	5	5	-	5	5
Cr	7	3	4	5	-	2	-
Mn	7	5	6	6	4	6	5
Cu	6	5	6	6	3	6	6
Zn	5	3	4	4	2	4	4
Zr	7	3	-	4	-	3	-

B Group

Kansas

A. Cloud Co. UPPER CRETACEOUS, DAKOTA ss. NW 1/4 NW 1/4 sec 12, T 6 S, R 3 W. Analyst, R. Runnels. Lab #C-51-C. Reed, A. C., 1950, Kans GS B 86, pt 2, p. 24, 27, 36.

Clay. Ceramic data, Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 210.

Use: Brick making, Kans GS B 86, pt 2, p. 24.

B. Cloud Co. UPPER CRETACEOUS, DAKOTA ss. NW 1/4 NW 1/4 sec 12, T 6 S, R 3 W. Analyst, R. Runnels. Lab #C-51-6. Idem., p. 24, 27, 36.

Clay. Ceramic data, Kans GS B 67, p. 210.

Use: Brick making, Kans GS B 86, pt 2, p. 24.

C. Cloud Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. E of cen sec 5, T 7 S, R 3 W. Analyst, R. Runnels. Lab #4. Frye, J. C., and Fent, O. S., 1947, Kans GS B 70, pt 3, p. 38, 39.

Sample from road cut. 10 ft below surface, above Greenhorn ls. Mechanical analyses of acid insoluble fraction of sample, p. 38. Solubility in HCl 13.6%.

D. Comanche Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SE 1/4 NE 1/4 sec 12, T 31 S, R 18 W. Analyst, R. Runnels. Lab #CMV-1A. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 15, 20.

Volcanic ash has been mined in this locality, p. 41. Sample from lower 5.5 ft of bed 13 ft thick. Screen analysis, p. 24.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

E. Crawford Co. PLEISTOCENE, terrace deposit. NW 1/4 SE 1/4 sec 18, T 30 S, R 25 E. Analyst, R. Runnels. Lab #CR-5. Plummer Norman, and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28, 29.

Loess. Oxidized, red and gray sample. 4.0 ft sample. Lightweight aggregate production in batch-type rotary kiln, p. 27, 45.

Possible use: Lightweight concrete aggregate, p. 72, 73, 74.

	A	B	C	D	E
SiO ₂	76.58	76.04	71.37	73.00	73.43
Al ₂ O ₃	13.12	14.76		12.59 ^{e/}	12.43
Fe ₂ O ₃	3.49 ^{b/}	1.53 ^{b/}		1.52	6.00
R ₂ O ₃			18.92		
MgO	0.39	0.34		0.14	0.62
CaO	0.45	0.42	1.27	0.59	0.38
Na ₂ O				2.82 ^{f/}	0.23
K ₂ O				5.59	1.12
TiO ₂	0.66 ^{e/}	0.89 ^{e/}			1.26
P ₂ O ₅	tr	tr		tr	0.05
V ₂ O ₅ ^{a/}	0.08	0.05			
SO ₃	tr	tr		nil	nil
Ignit Loss	4.85	5.08	3.00 ^{d/}	3.75	4.59
Total	99.62	99.11	94.56	100.00	100.11 ^{g/}
Class	77,21,1	76,21,1	71,22,0	73,18,0	73,23,0

^{a/} Analysed spectrographically. Rounded to two decimal places.

^{b/} Average of three or more determinations

^{c/} RO₂+R₂O₃ reported as TiO₂ by gravimetric determination

^{d/} Determined after drying to 140°C.

^{e/} Includes TiO₂

^{f/} By difference, ratio from spectro.

^{g/} 100.06 (sic text)

B Group

Kansas

A-K: Doniphan Co. PLEISTOCENE, SANFORD fm. NE 1/4 SE 1/4 sec 6, T 2 S, R 20 E.
 Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 85, 87, 94, 95.
 Plastic and dry properties, p. 94, 95. Fired properties, p. 115, 116, 117.
 Possible use: Ceramic slag, p. 83.

A.	Loveland silt mem.	Depth below top of section	71.3 ft.
B.	" " "	" " "	68.8 "
C.	" " "	" " "	66.3 "
D.	Peoria silt mem.	" " "	65 "
E.	" " "	" " "	60 "
F.	" " "	" " "	55 "
G.	" " "	" " "	50 "
H.	" " "	" " "	45 "
I.	Peoria silt mem, Brady soil.	Depth below top of section	40 ft.
J.	Bignell silt mem.	" " "	36 "
K.	" " "	" " "	27 "

	A	B	C	D	E	F	G	H
SiO ₂	75.63	76.80	76.58	71.21	71.62	73.33	76.79	77.38
Al ₂ O ₃ ^{a/}	11.95	12.05	12.05	10.11	11.61	12.00	10.85	11.82
Fe ₂ O ₃	2.77	2.75	3.03	2.61	2.92	3.02	2.87	2.72
MgO	1.27	0.96	1.08	2.62	2.08	1.06	1.15	1.26
CaO	2.17	0.98	1.17	3.70	3.55	2.67	1.10	0.95
Na ₂ O ^{b/}	0.59	1.39	0.82	1.62	1.54	1.48	2.39	0.77
K ₂ O	2.64	2.59	2.90	2.35	2.00	2.55	2.58	2.69
P ₂ O ₅	0.14	0.09	0.17	0.15	0.16	0.08	0.13	0.09
SO ₃	tr	tr	tr	tr	tr	tr	tr	tr
Ignit Loss	2.98	2.48	2.37	5.78	4.68	3.89	2.27	2.41
H ₂ O- ^{c/}	(0.39)	(0.30)	(0.26)	(0.13)	(0.56)	(0.47)	(0.36)	(0.40)
Total	100.14	100.09	100.17	100.15	100.16	100.08	100.13	100.09
Class	76,18,0	77,17,0	77,17,0	71,16,5	72,18,2	73,19,0	77,16,0	77,17,0

	I	J	K		B	E	F	G	H	I	J	
SiO ₂	76.78	76.99	69.11	Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance)								
Al ₂ O ₃ ^{a/}	10.47	11.14	10.80		V	4	5	7	6	5	6	3
Fe ₂ O ₃	3.32	2.86	3.15		Cr	4	5	5	7	-	5	4
MgO	0.97	1.01	2.51		Mn	7	7	7	6	7	7	6
CaO	1.02	0.98	4.22		Zr	6	8	6	6	6	6	5
Na ₂ O ^{b/}	1.44	1.39	1.61									
K ₂ O	2.41	2.21	2.52									
TiO ₂	1.30	0.80										
P ₂ O ₅	0.10	0.08	0.17									
SO ₃	tr	0.02	0.06									
Ignit Loss	2.29	2.60	6.02									
H ₂ O- ^{c/}	(0.40)	(0.60)	(0.45)									
Total	100.10	100.08	100.17									
Class	77,16,0	77,17,0	69,17,5									

^{a/} Presumably not corrected for P₂O₅

^{b/} By difference

^{c/} Below 105° to 140°, not included in total

B Group

Kansas

A. Ellis Co. PLEISTOCENE, MEADE fm, PEARLETTIE ash bed. SW 1/4 NW 1/4 sec 5, T 13 S, R 19 W. Analyst, R. Runnels. Lab #MSV-3. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 15, 20.

Ash fairly fresh. Thickness 10.5 ft. Overburden approx 8 ft, p. 43. Screen analysis, p. 24.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SW 1/4 sec 14, T 15 S, R 6 W. Analyst, R. Runnels. Swineford, Ada, 1947, Kans GS B 70, pt 4, p. 74, 75.

Sandstone, friable. Limonite occurs as scattered grains and coatings on etched quartz. In thin section grains are rhombohedral in shape. Sand grains poorly sorted, quartz grains etched, heavy minerals (tourmaline and zircon) not coated nor etched. Tonnage estimate, p. 97.

Use: Concrete aggregate, p. 93, 97.

C. Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. W 1/2 SE 1/4 sec 15, T 15 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #TC-2-1. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 136, 139, 141, 143, 210.

Highly siliceous fire clay, p. 131. Spot sample. Silty to very silty, light gray, some yellow stain, limonitic joint filling. Thickness 7.0 ft. Physical properties, p. 59. Ceramic tests, p. 141, 143.

Possible use: Refractory, p. 140, 144.

D. Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. W 1/2 SE 1/4 sec 15, T 15 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #TC-2-10. Idem, p. 120, 123, 130, 210.

Siliceous fire clay. Spot sample. Slightly silty, massive, gray, some yellow stain on joints, contains few lignite fragments. Thickness 6.3 ft. Physical properties, p. 59. Ceramic tests, p. 125, 129.

Possible use: Refractory, p. 130.

	A	B	C	D
SiO ₂	72.96	83.76	82.83	75.31
Al ₂ O ₃	12.62	4.06	9.89	17.04
Fe ₂ O ₃	1.55	8.69	1.14	0.97
MgO	0.13	0.94	tr	0.25
CaO	0.50	0.00	0.04	0.24
Na ₂ O	2.51		}1.77	}0.67
K ₂ O	5.51			
TiO ₂	0.21	0.48	1.20	0.17
P ₂ O ₅	tr			
SO ₃	0.31	0.00		
Ignit Loss	4.01	2.04	3.07	4.74
Total	100.31	99.97	99.94	99.39
Class	73,18,1	84,15,0	83,14,0	75,23,0

B Group

Kansas

A-D: Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss. Analysts, R. Thompson and R. Runnels. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67.

Physical properties, p. 59.

A. SW 1/4 SE 1/4 sec 19, T 14 S, R 7 W. Lab #E1-73-A. Idem, p. 133, 139, 211.
Highly siliceous fire clay, silty, dark gray, some yellow stain. Contains some selenite. Approx 7.2 to 9.7 ft of 32.2 ft bed is silt to fine-grained ss. Composite sample. Ceramic tests, p. 141, 142.

Possible use: Refractory, p. 140, 144.

B. SE 1/4 NE 1/4 sec 30, T 14 S, R 7 W. Lab #E1-78-3. Idem, p. 114, 123, 211.
Siliceous fire clay. Spot sample. Silty, lignitic, gray to dark gray with horizontal yellow bands, limonite on vertical joints and paper-thin inter-beddings of white silt. Lens of gray to buff fine-grained ss to silt in the lower part of the bed. Thickness 19 to 25 ft. Ceramic tests, p. 125, 127.

Possible use: Buff-firing brick if combined with adjacent material, p. 114.

C. Cen S 1/2 sec 20, T 15 S, R 7 W. Lab #E1-21-9. Idem, p. 111, 123, 130, 210.
Siliceous fire clay, silty, gray, slight stain, few thin short lenses of yellow clay, lignitized fossil leaves. Spot sample from bed 8.9 ft thick. Ceramic tests, p. 125, 126.

Possible use: Refractory, p. 130.

D. SW 1/4 sec 28, T 15 S, R 7 W. Lab #E1-20-EA. Idem, p. 133, 139, 144, 210.

Sample represents bed, 13.1 ft thick, layered as follows:

Clay, plastic, light gray at top and dark gray lignite at bottom, 2.9 ft.

Kaolin, white, banded with light gray, 0.5 ft.

Clay, slightly silty, lignitic, dark gray, with slight yellow stain, 2.9 ft.

Silt, kaolinitic, fine-grained, soft, nearly white, some yellow stain, 5 ft.

Clay, very silty, lignitic, gray, 1.8 ft.

Composite sample. Ceramic tests, p. 141, 142.

Possible use: Refractory, p. 140, 144.

	A	B	C	D
SiO ₂	76.40	75.18	71.64	80.62
Al ₂ O ₃	10.35	11.79	19.46	13.20 ^{a/}
Fe ₂ O ₃	1.40	1.26	0.36	0.71
MgO	0.55	0.35	0.88	0.47
CaO	0.88	0.11	1.06	0.58
Na ₂ O		}1.74	}1.93	
K ₂ O				
TiO ₂	0.91	1.89	1.15	
Ignit Loss	7.76	7.46	3.84	3.98
Total	98.25	99.78	100.32	99.56
Class	76,18,3	75,20,1	72,24,0	81,17,1

^{a/} Includes TiO₂

B Group

Kansas

A-D: PLEISTOCENE, MEADE fm, PEARLETTE ash bed. Analyst, R. Runnels. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 15, 20.

Screen analysis, p. 24.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

A. Ellsworth Co. Cen N line SW 1/4 sec 22, T 15 S, R 7 W. Lab #ELV-2A.
Sample from lower 3.0 ft of bed 9 ft thick.

B. Ellsworth Co. SE 1/4 NW 1/4 sec 28, T 16 S, R 7 W. Lab #ELV-24-A.
Sample from lower 7.5 ft of bed 13.5 ft thick, cropping out on creek bank, p. 43. Lower 9.5 ft composed of light-colored clean ash, but upper part, see ELV-24-B, contains some streaks of silt and clay.

C. Ellsworth Co. SE 1/4 NW 1/4 sec 28, T 16 S, R 7 W. Lab #ELV-24-B:
Sample from upper 6.0 ft of bed 13.5 ft thick, see ELV-24-A. Tonnage estimate, p. 43.

D. Gove Co. NE 1/4 SW 1/4 sec 21, T 13 S, R 26 W. Lab #GV-1A. Idem, p. 15, 20.
Ash fresh and free from impurities except scattered concretions and yellowish streaks in lower 4 to 6 ft, p. 44. Sample from lower part of bed 17 ft thick. Screen analysis, p. 24. Tonnage estimate, p. 43.
Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

	A	B	C	D
SiO ₂	72.61	72.87	72.53	73.43
Al ₂ O ₃	11.81	12.68	12.80	12.30
Fe ₂ O ₃	1.74	1.34	1.64	1.61
MgO	0.15	0.05	0.06	0.41
CaO	0.72	0.64	0.77	0.99
Na ₂ O	8.30 ^{a/}	2.64 ^{b/}	2.45 ^{b/}	2.45
K ₂ O		5.29	5.03	4.77
TiO ₂	0.36	0.24	0.30	0.22
P ₂ O ₅	nil	tr	tr	tr
SO ₃	sl tr	tr	tr	tr
Ignit Loss	4.31	4.25	4.42	3.90
Total	100.00	100.00	100.00	100.08
Class	73,17,2	73,18,1	73,18,2	73,17,1

^{a/} By difference

^{b/} By difference, ratio from spectro.

B Group

Kansas

A-D: FLEISTOCENE, MEADE fm, PEARLETTE ash bed. Carey, J. S., et al, 1952, Kans GS B 96, pt 1.

A. Gove Co. NE 1/4 SW 1/4 sec 21, T 13 S, R 26 W. Analyst, R. Runnels. Lab #GV-1B. Idem, p. 15, 20.

Sample from upper part of bed 17 ft thick. See GV-1A. Screen analysis, p. 24. Mechanical analysis, p. 22, 23.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. Graham Co. NE 1/4 SW 1/4 sec 11, T 8 S, R 25 W, town of Morland. Idem, p. 45. Landes, K. K., 1928, Kans GS B 14, p. 15, 22.

Volcanic ash, grayish white. Screen analysis, p. 22.

Possible use: Abrasive.

C. Grant Co. NW 1/4 sec 24, T 30 S, R 35 W, Western Spar Products Company mine. Kans GS B 96, pt 1, p. 45. Kans GS B 14, p. 14, 15, 22.

Volcanic ash, gray and free from lumps. Averages 9 ft thick. Overburden from 1 to 4 ft of loess and sand, occasional lime pebbles, p. 22, 23. Tonnage estimate and screen analysis, p. 23.

Possible use: Abrasive.

D. Grant Co. SE 1/4 NE 1/4 sec 1, T 30 S, R 36 W. Analyst, R. Runnels. Lab #GIV-1. Kans GS B 96, pt. 1, p. 15, 20.

Ash fresh, only contaminant is a small percentage of fine sand, p. 45.

Sample from 23.5 ft bed. Deposit worked in 1948. Screen analysis, p. 24. Mechanical analysis, p. 22, 23.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

	A	B	C	D
SiO ₂	73.13	74.30	72.30 ^{b/}	72.78 ^{d/}
Al ₂ O ₃	11.71	14.40	12.20	12.26 ^{d/}
Fe ₂ O ₃	1.93	2.00	1.40	1.52
MgO	0.12	1.00	0.58	0.07
CaO	0.65	0.20	tr	0.95
Na ₂ O	2.56 ^{a/}		6.52	3.10
K ₂ O	5.68		3.00	4.96
TiO ₂	0.29			
P ₂ O ₅	tr			nil
SO ₃	tr			<0.10
Ignit Loss	3.93	4.35		3.84
Total	100.00	96.25	96.00 ^{c/}	<99.58
Class	73,17,1	74,21,0	72,17,1	73,17,1

^{a/} By difference, ratio from spectro.

^{b/} SiO₂, 72.36, remainder of analysis the same. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 170, 171.

^{c/} 100.00 (sic text)

^{d/} Includes TiO₂

B Group

Kansas

A-F: Jewell Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. Analyst, R. Runnels. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 16, 20, 24.

Screen analysis, p. 24.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

A. NW 1/4 NE 1/4 sec 16, T 1 S, R 6 W. Lab #JV-6.

Sample from bed 17.0 ft thick exposed in open pit. Tonnage estimate, p. 48. Mechanical analysis, p. 22, 23.

B. SE 1/4 NE 1/4 sec 6, T 3 S, R 8 W. Lab #JV-7.

Sample from bed 2.5 ft thick, p. 49.

C. NW 1/4 SE 1/4 sec 32, T 1 S, R 9 W. Lab #JV-3A.

Sample from lower 5.5 ft of bed 9 ft thick. See JV-3B.

D. NW 1/4 SE 1/4 sec 32, T 1 S, R 9 W. Lab #JV-3B.

Sample from upper 3.5 ft of bed 9 ft thick. Tonnage estimate, p. 48.

E. SW 1/4 NE 1/4 sec 7, T 2 S, R 9 W. Lab #JV-11A.

Sample from lower 4.0 ft of exposed bed 8 ft thick.

F. N 1/2 NE 1/4 sec 29, T 5 S, R 9 W. Lab #JV-1.

Sample from bed 6.5 ft thick. Overburden 3 ft, p. 49.

	A	B	C	D	E	F
SiO ₂	73.32	72.24	73.11	72.84	73.26	73.36
Al ₂ O ₃	10.76	11.52	12.45	12.12	10.94	12.32
Fe ₂ O ₃	1.66	1.68	1.41	1.55	1.83	1.72
MgO	0.23	0.21	0.06	0.02	0.31	0.14
CaO	0.53	0.76	0.54	0.62	0.66	0.07
Na ₂ O	2.27	)8.25 <u>a/</u>	)2.93 <u>b/</u>	)8.59 <u>a/</u>	2.66	)7.93 <u>a/</u>
K ₂ O	5.30				5.18	
TiO ₂	1.36	1.01	0.14	0.18	1.22	0.54
P ₂ O ₅	tr	<0.01	tr	tr	tr	nil
SO ₃	n.d.	sl tr	nil	tr	n.d.	sl tr
Ignit Loss	3.93	4.33	3.91	4.08	3.95	3.92
Total	99.36	<100.01	100.00	100.00	100.01	100.00
Class	73,16,1	72,17,2	73,17,1	73,17,1	73,16,2	73,18,0

a/ By difference

b/ By difference, ratio from spectro.

B Group

Kansas

A-D: Johnson Co. PLEISTOCENE (?). Analyst, R. Runnels. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74.

Use: Production of ceramic slag, p. 74.

A. Lab #JN-AG-19A

B. Lab #JN-AG-19B

C. Lab #JN-AG-21A

D. Lab #JN-AG-21B

	A	B	C	D
SiO ₂	74.50	77.04	73.90	77.03
Al ₂ O ₃	11.24	11.36	12.38	8.85
Fe ₂ O ₃	3.38	2.62	3.26	3.32
MgO	1.60	1.25	0.99	1.57
CaO	0.64	0.46	0.63	0.69
TiO ₂	1.60	1.11	1.34	1.46
Ignit Loss	5.16	5.02	6.42	4.62
Total	98.12	98.86	98.92	97.54 ^{a/}
Class	75,18,3	77,17,3	74,20,3	77,15,3

^{a/} 97.57 (sic text)

B Group

Kansas

A. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. SE 1/4 sec 35, T 13 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #L-9-7. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 134, 139, 144, 212.

Silty, gray clay, few thin lenses of yellow fine-grained ss and silt; scattered fragments of lignite. Thickness 40 ft. Thickest bed of light-firing clay sampled in Dakota ss. Spot sample. Graphs of temp-vol, temp-absorption and temp-apparent porosity, p. 144-152. Physical properties, p. 59. Ceramic tests, p. 141, 142.

B. Lincoln Co. PLIOCENE and PLEISTOCENE. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 170, 171.

Volcanic ash. Generalized description of Kans ash deposits, distribution, and production statistics, p. 171, 172, 173. Tonnage estimate, p. 174.

Possible use: Abrasive.

C. Lincoln Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SW 1/4 SE 1/4 sec 27, T 13 S, R 10 W. Analyst, R. Runnels. Lab #LV-2. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 16, 20.

Sample from 6.5 ft bed exposed in pit faces; bed crops out along road cuts bordering sec 27 to the S and W and extends into adjacent secs 28 and 34, p. 50. Screen analysis, p. 25.

D. Lincoln Co. PLEISTOCENE, McPHERSON fm, terrace deposits. Sec 28, T 13 S, R 10 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 19, 22, 28.

Volcanic ash. Groups of elongate fluid inclusions present. Channel sample, 1 to 2 ft from base. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 18, 19, 28.

E. Lincoln Co. PLEISTOCENE, McPHERSON fm, terrace deposits. Sec 28, T 13 S, R 10 W. Analyst, F. Schloesser. Idem.

Volcanic ash. Groups of elongate fluid inclusions common. Trace quartz sand. Channel sample, 2 to 5 ft from base. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 18, 19, 28.

	A	B	C	D	E
SiO ₂	80.50	73.30	72.28	73.02	72.77
Al ₂ O ₃	10.79	14.46	12.60	13.20	13.87
Fe ₂ O ₃	1.72	1.54	1.71	1.77	1.82
MgO	0.68	0.21	0.22		
CaO	0.29	1.00	0.69	0.70	0.87
Na ₂ O	}1.00	--	2.90		
K ₂ O		5.64	5.45		
TiO ₂	0.86		0.27		
P ₂ O ₅			0.01		
SO ₃			tr		
Ignit Loss	4.18	4.60	3.83	3.27	3.15
Total	100.02	100.75	99.96	91.96	92.48
Class	81,16,2	73,20,1	72,18,1	73,18,0	73,19,0

B Group

Kansas

A. Logan Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SE 1/4 SW 1/4 sec 35, T 13 S, R 33 E. Analyst, R. Runnels. Lab #LOV-5A. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 16, 20, 51.

Ash is light gray with a few brown streaks, p. 51. Sample from 6.0 ft bed. Screen analysis, p. 24.

B. Logan Co. PLEISTOCENE, SANBORN fm, Peoria silt mem, Brady soil. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.

Silt. Depth below top of section, 8 ft. Plastic and dry properties, p. 88. Fired properties, p. 97.

Possible use: Ceramic slag, p. 83.

C. Logan Co. PLEISTOCENE, SANBORN fm, Bignell silt mem. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Idem.

Silt. Depth below top of section, 3 ft. Plastic and dry properties, p. 88. Fired properties, p. 97.

Possible use: Ceramic slag, p. 83.

D. McPherson Co. PLEISTOCENE or PLEISTOCENE. No locality given. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 170, 171.

Volcanic ash. Generalized description of Kansas ash deposits, distribution, and production statistics, p. 171, 172, 173. Tonnage estimate p. 174.

Possible use: Abrasive.

	A	B	C	D		B	C	
SiO ₂	72.73	69.88	68.66	72.50	Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance.)			
Al ₂ O ₃	11.55	14.03	12.27	14.15		V	6	4
Fe ₂ O ₃	1.65	4.24	2.59	1.65		Cr	4	-
MgO	0.12	1.67	1.54	0.30		Mn	9	7
CaO	0.92	1.42	4.57	0.70		Cu	4	-
Na ₂ O	8.35 ^{a/}	0.91 ^{a/}	4.11 ^{a/}	--		Zr	6	4
K ₂ O		2.88	n.d.	4.70		Ag	5	2
TiO ₂	0.38	0.90	0.95					
P ₂ O ₅	nil	tr	tr					
SO ₃	sl tr	0.05	0.05					
Ignit. loss	4.30	3.99	5.21	5.00				
H ₂ O- ^{b/}		(1.26)	(0.72)					
Total	100.00	99.97	99.95	99.00				
Class	73,17,2	70,22,0	69,19,3	72,24,0				

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

B Group

Kansas

A-D; McPherson Co.

A. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 SE 1/4 NW 1/4 sec 20, T 18 S, R 3 W. Analyst, R. Runnels. Lab #MPV-1. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 16, 20.

Ash, light colored, relatively clean, fairly fresh, exposed in an intermittently worked pit, p. 52. Sample from 8.5 ft bed. Overburden ranges from 1 to 10 ft. Screen analysis, p. 25. Mechanical analysis, p. 22, 23. Tonnage estimate, p. 53.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. ^{1/} NW 1/4 sec 20, T 18 S, R 3 W. ^{1/} Plummer, N., 1942, Kans GS Circ 13, p. 8.

Volcanic ash. Ceramic tests, p. 9. Generalized description of Kansas ash deposits, distribution and production statistics, Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 171, 172, 173. Tonnage estimate, p. 174.

Possible uses: Abrasive, ceramic glaze.

C. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SW 1/4 NW 1/4 sec 22, T 18 S, R 4 W. Analyst, R. Runnels. Lab #MPV-6A. Kans GS B 96, pt 1, p. 16, 20.

Lower 4.2 ft from bed 6.5 ft thick. See MPV-6B. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

D. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SW 1/4 NW 1/4 sec 22, T 18 S, R 4 W. Analyst, R. Runnels. Lab #MPV-6B. Idem.

Ash relatively clean, p. 52. Upper 2.3 ft of bed 6.5 ft thick. Exposed in small pit. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂	72.95	72.30	73.06	72.66
Al ₂ O ₃	12.30	13.62 ^{b/}	11.54	11.59
Fe ₂ O ₃	1.73	2.35	1.31	1.68
MgO	0.16	} 0.99	0.09	0.16
CaO	0.69		0.63	1.00
Na ₂ O	) 2.90 ^{a/}	4.00	} 8.28 ^{c/}	3.05
K ₂ O	) 5.04	2.00		4.80
TiO ₂	0.30		0.97	0.51
P ₂ O ₅	tr		0.02	tr
SO ₃	nil		sl tr	n.d.
Ignit Loss	3.93	4.68	4.12	4.26
Total	100.00	99.92	100.02	99.71
Class	73,18,1	72,20,1	73,16,1	73,17,2

^{a/} By difference, ratio from spectro.

^{b/} Al₂O₃, 16.62, Kans GS B 41, pt 3, p. 170

^{c/} By difference

B Group

Kansas

A-E: Meade Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed.

A. SW 1/4 sec 2, T 31 S, R 28 W. Analyst, R. Runnels. Lab #MEV-5A.
 Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 16, 21.
 Sample from lower 13 ft of bed 20 ft thick. See MEV-5B. Screen analysis, p. 25. Mechanical analysis, p. 22, 23.
 Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. SW 1/4 sec 2, T 31 S, R 28 W. Analyst, R. Runnels. Lab #MEV-5B. Idem.
 Sample from upper 7 ft of bed 20 ft thick. Exposed in pit. Mined by Cudahy Packing Co., p. 53. Screen analysis, p. 25.
 Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

C. Immediately above horizon of Cudahy fauna. Sec 2, T 31 S, R 28 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 18, 22, 27, 28.

Volcanic ash. Commercial pit of Cudahy Packing Co. Channel sample 8-10 ft from top. Groups of elongate vesicles present 7 ft from base. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 18, 19, 28.

D. Immediately above horizon of Cudahy fauna. Sec 2, T 31 S, R 28 W. Analyst, F. Schloesser. Idem.

Volcanic ash. Groups of elongate vesicles common. Spot sample, 3 ft below top. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 18, 19, 28.

E. Immediately above horizon of Cudahy fauna. Sec 2, T 31 S, R 28 W. Analyst, F. Schloesser. Idem, p. 18, 22.

Volcanic ash, altered, white. Few vesicles. Spot sample, 1.5 ft above base. Dominant refractive index, Ridgway color notation, and particle size distribution, p. 18, 27.

	A	B	C	D	E
SiO ₂	72.40	72.09	72.64	71.95	71.26
Al ₂ O ₃	11.45	11.48	12.06	12.65	13.13
Fe ₂ O ₃	1.70	2.07	1.67	1.43	1.50
MgO	0.31	0.65			
CaO	0.76	1.06	0.74	0.80	0.80
Na ₂ O) ^{a/}	2.42	2.34			
K ₂ O)	5.75	5.49			
TiO ₂	0.31	0.53			
P ₂ O ₅	nil	tr			
SO ₃	tr	tr			
Ignit Loss	4.90	4.29	4.24	4.13	4.18
Total	100.00	100.00	91.35	90.96	90.87
Class	72,17,2	72,17,2	73,17,1	72,18,1	71,18,1

^{a/} By difference, ratio from spectro

B Group

Kansas

A-E: Meade Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. Analyst, R. Runnels. Carey, J. S., et al, 1952, Kans GS B 96, pt 1.

Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

A. SE 1/4 SE 1/4 sec 33, T 31 S, R 28 W. Lab #MEV-2. Idem, p. 16, 20. 4.0 ft bed.

B. SW 1/4 sec 34, T 31 S, R 28 W. Lab #MEV-1A. Idem. Ash, clean and free from contaminants, p. 55. Sample from lower 5 ft of bed 9.5 ft thick.

C. SW 1/4 sec 34, T 31 S, R 28 W. Lab #MEV-1B. Idem. Ash, contains few silty streaks and scattered calcareous concretions, p. 55. Sample from upper 4.5 ft of bed 9 ft thick. See MEV-1A. Pit inactive.

D. NE 1/4 sec 9, T 32 S, R 28 W. Lab #MEV-4A. Idem, p. 16, 21. Sample from 8.0 ft bed 25 ft below MEV-4B. Contains dark specks and some yellow streaks, p. 55.

E. NE 1/4 sec 9, T 32 S, R 28 W. Lab #MEV-4B. Idem, p. 16, 20. Sample from upper 6.0 ft, separated by sandy silt from lower bed, MEV-4A. Pits inactive, p. 55.

	A	B	C	D	E
SiO ₂	69.82	71.47	71.63	70.26	72.01
Al ₂ O ₃	13.33	11.75	12.22	12.75	11.40
Fe ₂ O ₃	1.80	1.63	1.50	1.84	1.49
MgO	0.49	1.12	1.36	0.41	0.46
CaO	0.72	0.97	0.83	0.76	0.77
Na ₂ O	2.37	)2.88 ^{a/}	)2.11 ^{a/}	)2.37 ^{a/}	)2.68 ^{a/}
K ₂ O	5.95	)5.18	)5.34	)5.54	)5.98
TiO ₂	0.16	0.50	0.49	0.70	0.88
P ₂ O ₅	tr	tr	tr	tr	nil
SO ₃	0.31	nil	nil	tr	tr
Ignit Loss	5.17	4.50	4.52	5.37	4.33
Total	100.12	100.00	100.00	100.00	100.00
Class	70,19,2	71,17,2	72,17,2	70,19,2	72,16,2

^{a/} By difference, ratio from spectro

B Group

Kansas

A, B and C: Mitchell Co. PLEISTOCENE, SANBORN fm. Analyst, R. Runnels.
 Frye, J. C., and Fent, O. S., 1947, Kans GS B 70, pt 3 p. 38, 39.
 Mechanical analyses of acid insoluble fraction, p. 38.

- A. 4 ft above Loveland soil. NE 1/4 sec 29, T 8 S, R 6 W. Lab #3.
 Silt. Auger sample. Solubility in HCl, 21.2%.
- B. Loveland silt mem, Loveland soil. SE cor sec 20, T 9 S, R 6 W. Lab #2.
 Silt. Auger sample. 8 ft below surface. Solubility in HCl, 8.5%.
- C. 0.5 ft above Loveland soil, 4.5 ft below surface. SE cor sec 20, T 9 S,
 R 6 W. Lab #1.
 Silt. Auger sample. Solubility in HCl, 14.7%.

	A	B	C
SiO ₂	70.44	70.29	68.81
R ₂ O ₃	18.93	18.61	18.20
CaO	1.15	0.79	2.67
Ignit Loss ^{a/}	3.04	3.95	4.42
Total	93.56	93.64	94.10
Class	70,22,0	70,23,0	69,23,0

^{a/} Determined after drying to 140°C.

B Group

Kansas

A-D: Norton Co. PLIOCENE, OGALLALA fm.
Volcanic ash.

A. Renger ash bed, p. 58. Cen SE 1/4 sec 16, T 1 S, R 21 W. Analyst, R. Runnels. Lab #NNV-8. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash unaltered by weathering. Sample from 4.0 ft exposure. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. SW 1/4 NW 1/4 sec 16, T 2 S, R 21 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 16, 22.

Above Krynitzkia zone and below Biorbia zone. Channel sample 2.5 ft from pit. Shard outlines anisotropic. Small calcite inclusions in most particles, otherwise clear. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 16, 27, 28.

C. NW 1/4 SW 1/4 sec 23, T 2 S, R 22 W. Commercial pit of Wyandotte Chem Corp. Analyst, F. Schloesser. Idem.

Krynitzkia collected from the ash. Spot sample, 1 to 3 ft above base. Most shards clear. Trace quartz sand. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 16, 27, 28.

D. NW 1/4 SW 1/4 sec 23, T 2 S, R 22 W. Commercial pit of Wyandotte Chem Corp. Analyst, F. Schloesser. Idem.

Krynitzkia collected from the ash. Spot sample approx 4.5 ft above base. Most shards clear. Trace quartz sand. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 16, 27, 28.

	A	B	C	D
SiO ₂	76.68	73.80	72.00	71.73
Al ₂ O ₃	9.77	13.09	10.80	14.04
Fe ₂ O ₃	1.44	2.46	2.25	2.22
MgO	0.27			
CaO	1.45	1.11	0.63	0.65
Na ₂ O) ^{a/}	6.86			
K ₂ O)				
TiO ₂	0.51			
P ₂ O ₅	< 0.01			
SO ₃	tr			
Ignit Loss	3.02	3.04	4.41	4.44
Total	<100.01	93.50	90.09	93.08
Class	77,14,0	74,18,0	72,17,1	72,20,1

^{a/} By difference

B Group

Kansas

A-F: Norton Co. Pliocene, Ogallala fm. NW 1/4 SW 1/4 sec 23, T 2 S, R 22 W. Analyst, F. Schloesser. Swineford, Ada, and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 16, 22.

Volcanic ash. Krynitzkia collected from the ash. Most shards clear. Trace quartz sand. Commercial pit of Wyandotte Chem Corp.

A. Channel sample, bottom 6 ft. 1/

B. Spot sample, approx 7 ft above base. 1/

C. Spot sample, approx 12 ft above base. 1/

D. Channel sample, 6 to 12 ft from base. 1/

E. Idem, p. 16, 22, 27, 28.

Spot sample, approx 16 ft above base. Dominant refractive index, Ridgway color notation, particle size distribution and bulk density, p. 16, 27, 28.

F. Idem, p. 16, 22.

Refined product. 1/

1/ Dominant refractive index, Ridgway color notation and particle size distribution, p. 16, 17, 27, 28.

	A	B	C	D	E	F
SiO ₂	72.47	72.48	72.50	72.41	72.09	72.56
Al ₂ O ₃	13.61	11.64	10.42	12.09	11.68	11.99
Fe ₂ O ₃	2.16	2.20	2.34	2.38	2.42	2.39
CaO	0.68	0.07	0.67	0.59	0.62	0.78
Ignit Loss	5.16	4.65	5.00	5.97	5.05	5.65
Total	94.08	91.04	90.93	93.44	91.86	93.37
Class	72,20,1	72,18,0	73,17,1	72,20,1	72,19,1	73,19,1

B Group

Kansas

A-F: Norton Co. Pliocene, Ogallala fm.

A. NW 1/4 SW 1/4 sec 25, T 2 S, R 22 W. Analyst, R. Runnels. Lab #NNV-1A. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash. Sample from lower 7.5 ft of bed 17 ft thick. Mined by Wyandotte Chemicals Corp, Wyandotte, Mich. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. NW 1/4 SW 1/4 sec 25, T 2 S, R 22 W. Analyst, R. Runnels. Lab #NNV-1B. Idem. Sample from upper 4.0 ft of bed 17 ft thick. Above NNV-1A. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

C. Cen S line sec 1, T 3 S, R 22 W. Analyst, R. Runnels, Lab #NNV-6. Idem. Ash somewhat altered by weathering, p. 58. Sample from 9.5 ft exposure. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate p. 30-40.

D. NE 1/4 sec 2, T 4 S, R 24 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 17, 22, 27, 28.

Volcanic ash. Immediately above Biorbia zone. Channel sample, 2 to 8 inches from base. Most shards clear; a few altered. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 16, 27, 28.

E. NE 1/4 sec 2, T 4 S, R 24 W. Analyst, F. Schloesser. Idem, p. 17, 22.

Channel sample, 8 to 20 inches from base. Somewhat altered. Trace of quartz sand. Immediately above Biorbia zone. Dominant refractive index, Ridgway color notation, and particle size distribution, p. 16, 17, 27, 28.

	A	B	C	D	E
SiO ₂	73.44	71.98	71.14	74.31	72.10
Al ₂ O ₃	11.36	10.94	11.20	12.90	13.16
Fe ₂ O ₃	2.01	1.93	1.89	1.66	2.22
MgO	0.08	0.15	0.41		
CaO	0.61	2.14	1.81	1.41	0.84
Na ₂ O	2.33	)2.08 ^{a/})		
K ₂ O	5.23	)5.94	)7.81 ^{b/}		
TiO ₂	0.39	0.33	0.50		
P ₂ O ₅	tr	tr	0.03		
SO ₃	nil	nil	tr		
Ignit Loss	3.93	4.51	5.21	2.60	4.65
Total	99.38	100.00	100.00	92.88	92.97
Class	73,17,1	72,16,3	71,16,4	74,17,0	72,19,2

^{a/} By difference, ratio from spectro

^{b/} By difference

B Group

Kansas

A-F: Norton Co. PLEISTOCENE, OGALLALA fm. Analyst, F. Schloesser. Swineford, Ada, and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 17, 22.
Volcanic ash.

A. NE 1/4 sec 2, T 4 S, R 24 W.

Channel sample 20 inches to top of bed. Immediately above Biorbia zone.

Altered. Trace of quartz sand. $\frac{1}{2}$

B. NW 1/4 NE 1/4 sec 36, T 2 S, R 25 W.

Channel sample, 2 to 3 ft from bottom. Immediately below Biorbia zone.

Altered. Few Vesicles. Ca. 6% quartz sand. $\frac{1}{2}$

C. SW 1/4 SE 1/4 sec 2, T 3 S, R 25 W. Idem, p. 16, 22.

Spot sample, lowest inch. Several vesicles, some calcite. Many fossil insects, giving brown color. $\frac{1}{2}$

D. SW 1/4 SE 1/4 sec 2, T 3 S, R 25 W. Idem, p. 17, 22, 27, 28.

Channel sample, bottom 2 ft. Most shards clear. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 16, 27, 28.

E. SW 1/4 SE 1/4 sec 2, T 3 S, R 25 W. Idem.

Channel sample, 2 to 4 ft from base. Altered. Few vesicles. $\frac{1}{2}$

F. SW 1/4 SE 1/4 sec 2, T 3 S, R 25 W. Idem.

Channel sample, 4 to 6 ft from base, 150 yds N of road. Altered, few vesicles. Ca. 1% quartz sand. $\frac{1}{2}$

$\frac{1}{2}$ Dominant refractive index, Ridgway color notation, and particle size distribution, p. 16, 17, 27, 28.

	A	B	C	D	E	F
SiO ₂	73.87	75.50	70.97	71.37	71.53	70.58
Al ₂ O ₃	12.75	11.15	11.75	13.46	11.57	14.98
Fe ₂ O ₃	2.22	2.06	1.97	3.09	2.49	1.66
CaO	1.14	1.26	1.64	0.83	1.07	1.10
Ignit Loss	4.08	3.78	5.57	4.63	4.05	4.34
Total	94.06	93.75	91.90	93.38	90.71	92.66
Class	74,19,1	76,17,1	71,18,3	71,21,1	72,18,1	71,21,1

B Group

Kansas

A-E: Norton Co. PLEISTOCENE, SANBORN fm. SW 1/4 NW 1/4 sec 26 T 2 S, R 23 W.
Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 89, 90.
Silt. Plastic and dry properties, p. 89, 90. Fired properties, p. 102.

- A. Loveland silt mem.
Depth below top of section, 32.5 ft.
Possible use: Brick and tile, p. 81.
- B. Loveland silt mem.
Depth below top of section, 27.5 ft.
- C. Loveland silt mem.
Depth below top of section, 25.5 ft.
- D. Peoria silt mem.
Depth below top of section, 20.5 ft.
- E. Peoria silt mem.
Depth below top of section, 15.5 ft.
Possible use: Brick and tile, p. 81.

	A	B	C	D	E
SiO ₂	69.44	70.92	71.35	72.35	70.16
Al ₂ O ₃ ^{a/}	11.22	13.11	14.60	13.56	14.02
Fe ₂ O ₃	2.67	3.97	3.53	3.46	2.70
MgO	1.20	1.74	0.99	1.77	2.22
CaO	5.77	1.49	1.90	2.04	2.87
Na ₂ O ^{b/}	1.79	2.62	1.36	0.24	0.97
K ₂ O	2.47	2.80	2.50	2.78	2.19
P ₂ O ₅	0.09	0.08	0.08	0.14	0.15
SO ₃	tr	tr	tr	tr	tr
Ignit Loss	5.35	3.27	3.69	3.66	4.12
H ₂ O- ^{c/}	(0.35)	(0.79)	(0.94)	(0.83)	(0.67)
Total	100.00	100.00	100.00	100.00	99.40
Class	69,17,4	71,20,0	71,22,0	72,21,0	70,21,0

^{a/} TiO₂ included with Al₂O₃

^{b/} By difference

^{c/} Below 105° to 140°C, not included in total

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B	C	D	E
V	6	7	7	7	6
Cr	4	4	4	4	4
Mn	6	7	7	7	6
Zr	4	4	4	4	4

B Group

Kansas

A-D: Norton Co. PLEISTOCENE, SANBORN fm. SW 1/4 NW 1/4 sec 26, T 2 S, R 23 W.
 Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 89, 90.
 Silt. Plastic and dry properties, p. 89, 90. Fired properties, p. 102.
 Possible use: Brick and tile.

- A. Peoria silt mem, Brady soil.
Depth below top of section, 7.0 ft.
- B. Peoria silt mem, Brady soil.
Depth below top of section, 4.5 ft.
- C. Bignell silt mem.
Depth below top of section, 4.0 ft.
- D. Bignell silt mem.
Depth below top of section, 3.0 ft.

	A	B	C	D
SiO ₂	70.05	69.62	69.97	71.22
Al ₂ O ₃	12.99	11.91	11.60	12.78 ^{c/}
Fe ₂ O ₃	3.91	3.60	3.27	3.25
MgO	1.55	1.28	1.65	1.51
CaO	1.63	2.29	3.47	2.32
Na ₂ O ^{a/}	0.98	1.89	0.99	0.42
K ₂ O	3.31	3.22	2.99	3.29
TiO ₂	1.02	0.79	0.49	0.73
P ₂ O ₅	0.14	0.14	0.17	0.15
SO ₃	tr	tr	0.05	0.00
Ignit Loss	4.42	5.26	5.40	4.48
H ₂ O- ^{b/}	(0.68)	(0.70)	(0.49)	(0.42)
Total	100.00	100.00	100.05	100.15
Class	70,21,0	70,19,3	70,19,4	71,20,1

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

^{c/} Presumably not corrected for P₂O₅

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
 Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B	C	D
V	7	7	7	7
Cr	4	4	4	4
Mn	8	8	8	7
Zr	8	8	8	8

B Group

Kansas

A-B: Norton Co. PLEISTOCENE, SANBORN fm. Analyst, R. Runnels.

A. NW 1/4 sec 26, T 2 S, R 23 W. Lab #NN-6. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 73.

Oxidized, gray. Lightweight aggregate in batch-type rotary kiln, p. 28, 29. Screen analyses, p. 31. Bloating results, p. 46.

Possible use: Lightweight concrete aggregate.

B. Sec 26, T 2 S, R 23 W. Lab #NN-5. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 90, 91, 92.

Bed 19 ft thick. Firing and physical properties of ceramic slag made from sample, p. 82, 83. Compressive strength, Los Angeles abrasion loss, and rotary kiln production, p. 90, 91, 92.

Possible use: Ceramic slag.

	A	B
SiO ₂	70.56	68.80
Al ₂ O ₃	13.12	11.92
Fe ₂ O ₃	3.27	4.29
FeO		n.d.
MgO	1.56	1.95
CaO	2.85	3.30
Na ₂ O	1.18	n.d.
K ₂ O	2.68	n.d.
TiO ₂	0.73	1.45
P ₂ O ₅	0.09	tr
MnO		n.d.
SO ₃	tr	n.d.
Ignit Loss	4.36	4.58
Total	100.40	96.29
Class	71,20,1	69,20,1

B Group

Kansas

A. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss. W 1/2 sec 4, T 12 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #O-20-1. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 135, 213.

Highly siliceous fire clay, p. 131. Silty, gray to light gray, no stain; contains small bits of lignitized wood, in which some pyrite. Spot sample. Thickness, 8.5 ft. Ceramic tests, p. 141, 143. Physical properties, p. 59.

Possible use: Refractory, p. 140, 144.

B. Ottawa Co. PLEISTOCENE. NE 1/4 NW 1/4 sec 29, T 10 S, R 5 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 20, 22.

Volcanic ash. Immediately above large molluscan faunal zone. Altered. Elongate fluid inclusions rare. One ft channel from middle bed. Dominant refractive index, Ridgway color notation, and particle size distribution, p. 20, 28.

C. Phillips Co. PLEISTOCENE, OGALLALA fm. NE 1/4 NE 1/4 sec 19, T 2 S, R 18 W. Analyst, R. Runnels. Lab #PHV-1. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash fresh, small amount of sand. From 9.0 ft bed. Deposit extends more than 1/4 mile. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

D. Phillips Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NE 1/4 NE 1/4 sec 33, T 5 S, R 19 W. Analyst, R. Runnels. Lab #PHV-3A. Idem.

Sample from lower 7.3 ft of bed 15 ft thick, p. 60. See PHV-3B. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

E. Phillips Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NE 1/4 NE 1/4 sec 33, T 5 S, R 19 W. Analyst, R. Runnels. Lab #PHV-3B. Idem.

Sample from upper 6.0 ft of bed 15 ft thick. Mined commercially, p. 60. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

	A	B	C	D	E
SiO ₂	82.30	73.30	73.03	72.90	72.71
Al ₂ O ₃	9.15	14.46	11.79	12.05	12.28
Fe ₂ O ₃	1.23	1.54	1.66	1.61	1.65
MgO	0.09	0.21	0.09	0.09	0.08
CaO	0.75	1.00	0.64	0.54	0.58
Na ₂ O	)2.06	)5.64	)3.21 <u>b/</u>	)2.36 <u>b/</u>	)3.39 <u>b/</u>
K ₂ O					
TiO ₂	0.65		0.31	0.22	0.31
P ₂ O ₅			tr	tr	tr
SO ₃			tr	tr	tr
Ignit Loss	4.22	4.60 <u>a/</u>	4.50	3.84	3.94
Total	100.45	100.75	100.00	100.00	100.00
Class	82,14,2	73,20,1	73,17,1	73,17,1	73,17,1

a/ Includes moisture

b/ By difference, ratio from spectro.

B Group

Kansas

A-F: Analyst, R. Runnels. Carey, J. S. et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

A. Pratt Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. S 1/2 SW 1/4 sec 21, T 27 S, R 12 W. Lab #PRV-1A.

Sample from lower 7.5 ft of bed 14 ft thick. Tonnage estimate, p. 61.

B. Pratt Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 SE 1/4 sec 34, T 27 S, R 12 W. Lab #PRV-4.

Ash altered by weathering, gives it a slightly higher clay content than typical Pearlette deposit, p. 61. Sampled 4.0 ft bed in pit where overlain by 6 ft of mixed ash, sand and silt. Mechanical analysis, p. 22, 23.

C. Rawlins Co. PLEISTOCENE, OGALLALA fm. NW 1/4 NW 1/4 sec 33, T 3 S, R 34 W. Lab #RWV-3A.

Sample from lower 3 ft of bed 6 ft thick.

D. Rawlins Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NE 1/4 NW 1/4 sec 14, T 3 S, R 35 W. Lab #RWV-1.

Sample from 14.0 ft bed. Upper 6 ft exposed and lower 8 ft determined by augering, p. 62. Mechanical analysis, p. 22, 23.

E. Rawlins Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NE 1/4 NW 1/4 sec 14, T 3 S, R 35 W. Lab #RWV-1B.

Ash fresh and free from contaminants. Sample from exposed upper 6 ft of bed 14 ft thick. See RWV-1, p. 62.

F. Rawlins Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 SW 1/4 sec 22, T 3 S, R 35 W. Lab #RWV-4.

Ash fresh and free from contaminants. Sample from 14.0 ft exposure in pit intermittently active, p. 62.

	A	B	C	D	E	F
SiO ₂	72.51	72.89	72.12	72.77	73.88	73.51
Al ₂ O ₃	11.96	11.11	11.49	12.06	12.08 ^{b/}	12.10
Fe ₂ O ₃	1.70	2.05	2.26	1.68	1.64	1.64
MgO	0.18	0.21	0.77	0.16	0.14	0.11
CaO	0.72	0.89	1.10	0.75	0.63	0.63
Na ₂ O	)8.33 ^{a/}	)7.65 ^{a/}	)7.03 ^{a/}	2.71	)2.09 ^{c/}	)2.67 ^{c/}
K ₂ O				6.03			)5.98
TiO ₂	0.36	0.31	0.52	0.24		0.30
P ₂ O ₅	nil	nil	0.10	nil	tr	tr
SO ₃	nil	sl tr	sl tr	< 0.10	tr	nil
Ignit Loss	4.24	4.89	4.61	3.55	3.56	3.68
Total	100.00	100.00	100.00	<100.05	100.00	100.00
Class	73,17,2	73,17,2	72,17,2	73,17,0	74,17,0	74,17,1

^{a/} By difference

^{b/} Includes TiO₂

^{c/} By difference, ratio from spectro

B Group

Kansas

A. Reno Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SE 1/4 NE 1/4 sec 1, T 25 S, R 7 W. Analyst, R. Runnels. Lab #ROV-2. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash calcareous, somewhat altered by weathering, but relatively free from sand contamination, p. 63. Sample from 3.0 ft bed exposed in pit. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. Reno Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 SE 1/4 sec 14, T 25 S, R 8 W. Analyst, R. Runnels. Lab #ROV-1B. Idem.

Sample from upper 4.5 ft of bed 10 ft thick, exposed in pit, p. 63. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

C. Republic Co. UPPER CRETACEOUS, GRANEROS sh. NE 1/4 NW 1/4 sec 34, T 3 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #RP-7-3. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 179, 214.

Typical sample of Graneros sh, p. 182. Bed divided into ss, fine-grained, silt and clay in thin beds, gray, yellow and buff. Thickness 5 ft. Remaining 4.3 ft clay, shale, light gray with some yellow streaks; contains silt partings. Ceramic tests, p. 181.

Suggested use: Fire clay, if combined with adjacent bed.

	A	B	C
SiO ₂	72.83	73.14	72.80
Al ₂ O ₃	11.06	12.13	11.97
Fe ₂ O ₃	1.91	2.12	4.00
MgO	0.40	0.30	0.43
CaO	1.37	1.23	0.48
Na ₂ O	3.16	2.37	)4.05
K ₂ O	4.35	4.32	
TiO ₂	1.27	0.67	2.26
P ₂ O ₅	tr	nil	
SO ₃	n.d.	<0.10	
Ignit Loss	3.82	3.67	4.36
Total	100.17	<100.05	100.35
Class	73,16,1	73,18,0	73,20,1

B Group

Kansas

A-E: Republic Co. PLEISTOCENE, SANBORN fm. SW 1/4 SE 1/4 sec 35, T 2 S, R 3 W.
 Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 85, 87, 93.
 Plastic and dry properties, p. 93. Fired properties, p. 111, 112.

A.	Loveland silt mem.	Depth below top of section,	11	ft.
B.	"	"	8	"
C.	"	"	5.5	"
D.	Peoria	"	3.5	"
E.	"	"	0.5	"

	A	B	C	D	E
SiO ₂	71.01	73.30	71.45	71.01	68.36
Al ₂ O ₃	12.39 <u>c/</u>	12.01	11.59 <u>c/</u>	12.70 <u>c/</u>	12.22 <u>c/</u>
Fe ₂ O ₃	3.79	3.79	4.02	3.89	4.31
MgO	1.68	1.69	1.12	1.81	2.63
CaO	2.27	0.48	0.93	1.52	1.64
Na ₂ O <u>a/</u>	1.30	1.03	1.74	2.28	2.51
K ₂ O	2.29	2.51	3.13	2.31	1.89
TiO ₂	0.95	1.12	1.66	0.54	1.13
P ₂ O ₅	0.10	0.07	0.08	0.15	0.15
SO ₃	0.14	0.02	0.02	0.10	0.14
Ignit. Loss	4.18	3.55	4.34	3.84	5.17
H ₂ O- <u>b/</u>	(0.29)	(0.28)	(0.25)	(0.20)	(0.22)
Total	100.10	99.57	100.08	100.15	100.15
Class	71,20,0	73,19,0	71,20,1	71,20,0	68,21,2

a/ By difference

b/ Below 105° to 140°C, not included in total

c/ Presumably not corrected for P₂O₅

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
 Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B	C	D	E
V	6	5	6	5	6
Cr	4	4	4	4	4
Mn	6	6	7	6	7
Zr	6	5	7	6	7

B Group

Kansas

A-E: Rice Co. PLEISTOCENE, SANBORN fm. Analyst, R. Runnels.

A. Loveland silt mem. SW cor sec 24, T 19 S, R 6 W. Lab #5. Frye, J. C., and Fent O. S., 1947. Kans GS B 70, pt 3, p. 38, 39.

Silt, road cut. 4.5 ft below surface. Solubility in HCl, 12.1%. Mechanical analysis of acid insoluble fraction of sample, p. 38.

B. Loveland silt mem. NW 1/4 SW 1/4 sec 7, T 18 S, R 7 W. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 91.

Depth below top of section, 14.0 ft. Plastic and dry properties, p. 91. Fired properties, p. 105, 106.

Possible use: Brick and tile, p. 81.

C. Loveland silt mem. NW 1/4 SW 1/4 sec 7, T 18 S, R 7 W. Idem.

Depth below top of section, 10.5 ft. Plastic and dry properties, p. 91. Fired properties, p. 105, 106.

D. Loveland silt mem. NW 1/4 SW 1/4 sec 7, T 18 S, R 7 W. Idem.

Depth below top of section, 8.5 ft. Plastic and dry properties, p. 91. Fired properties, p. 105, 106.

E. Peoria silt mem. SW 1/4 sec 7, T 18 S, R 7 W. Lab #6. Kans GS B 70, pt 3, p. 38, 39.

Silt, road cut. 1 ft above Loveland soil. Solubility in HCl, 12.2%. Mechanical analysis of acid insoluble fraction of sample, p. 38.

Possible use: Brick and tile. Kans GS B 82, pt 3, p. 83.

	A	B	C	D	E
SiO ₂	70.03	78.95	73.66	74.69	72.77
Al ₂ O ₃		9.23	11.11	11.21	
Fe ₂ O ₃		2.45	2.68	3.65	
R ₂ O ₃	15.88				14.42
MgO		0.82	1.03	1.07	
CaO	2.56	1.03	2.33	1.31	1.82
Na ₂ O ^{a/}		4.49	3.51	4.11	
K ₂ O		n.d.	n.d.	n.d.	
TiO ₂		1.16	1.36	0.74	
P ₂ O ₅		0.05	0.05	tr	
SO ₃		0.05	0.05	0.05	
Ignit. Loss	4.16	1.77	4.22	3.12	4.27
H ₂ O- ^{b/}		(0.19)	(0.41)	(0.28)	
Total	92.63	100.00	100.00	99.95	93.28
Class	70,20,0	79,13,0	74,17,2	75,18,0	73,18,2

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	B	C	D
V	6	6	5
Cr	4	5	6
Mn	6	6	7
Cu	4	5	5
Zr	-	-	5

B Group

Kansas

A-C: PLEISTOCENE. Analyst, R. Runnels.

A. Rice Co. SANBORN fm. Peoria silt mem. NW 1/4 SW 1/4 sec 7, T 18 S, R 7 W. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 91.

Depth below top of section, 7.5 ft. Plastic and dry properties, p. 91. Fired properties, p. 105, 106.

B. Rice Co. SANBORN fm, Peoria silt mem. NW 1/4 SW 1/4 sec 7, T 18 S, R 7 W. Idem.

Depth below top of section, 5.5 ft. Plastic and dry properties, p. 91. Fired properties, p. 105, 106.

Possible use: Brick and tile, p. 81.

C. Russell Co. MEADE fm, PEARLETTE ash bed. NE 1/4 NW 1/4 sec 2, T 15 S, R 11 W. Lab #RV-2. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash fresh and relatively free of contaminants. Sample from exposed 7.0 ft bed. Overburden from 4 to 11 ft, p. 63. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

	A	B	C
SiO ₂	76.66	72.87	72.77
Al ₂ O ₃	12.04	11.84	12.14
Fe ₂ O ₃	3.36	3.20	1.57
MgO	1.01	1.11	0.09
CaO	0.91	0.84	0.59
Na ₂ O	1.36 <u>b/</u>	4.24 <u>b/</u>	2.79 <u>c/</u>
K ₂ O	n.d.	n.d.	5.76
TiO ₂	1.09	1.42	0.23
P ₂ O ₅	tr	tr	tr
SO ₃	0.05	0.00	tr
Ignit Loss	3.47	4.49	4.06
H ₂ O- <u>a/</u>	(0.28)	(0.40)	
Total	99.95	100.00	100.00
Class	77,19,0	79,19,1	73,17,1

a/ Below 105° to 140°C, not included in total

b/ By difference

c/ By difference, ratio from spectro

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B
V	5	7
Cr	2	5
Mn	4	6
Cu	5	5

B Group

Kansas

A. Saline Co. UPPER CRETACEOUS, DAKOTA ss. NW 1/4 SE 1/4 sec 18, T 15 S, R 5 W. Analysts, R. Thompson and R. Runnels. Lab #S-4-1. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 59, 160, 165, 215.

Clay, plastic, dark gray, alternating with thin laminae of white silt and fine sand. Thickness 6 ft. Spot sample from lowermost bed of Dakota ss.....p. 161. Dark buff to red-firing clay. Ceramic tests, p. 166, 167.

Possible use: Refractory, p. 168.

B. Seward Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. T 32 S, R 32 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 17, 22, 27, 28.

Volcanic ash. Groups of elongate vesicles common. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 17, 20, 27, 28.

C. Seward Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. SW 1/4 NE 1/4 sec 13, T 33 S, R 32 W. Analyst, R. Runnels. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Sample from 8.5 ft bed in old pit face; overlain by 5 ft of silt and brown sandy volcanic ash, p. 64. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

D. Sheridan Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. ^{1/} T 8 S, R 27 W, town of Tasco. Lendes, K. K., 1928, Kans GS B 14, p. 15, 45.

Volcanic ash.

Possible uses: Abrasive, p. 50, 51; cement, p. 51, 56.

^{1/} Kans GS B 96, pt 1, p. 65.

	A	B	C	D
SiO ₂	75.76	74.34	73.16	73.75
Al ₂ O ₃	13.72 ^{a/}	12.40	12.33	13.20
Fe ₂ O ₃	2.88	2.07	1.67	2.20
MgO	0.38	0.65	0.14	0.18
CaO	0.45	0.64	0.69	1.30
Na ₂ O		}5.59	}2.84 ^{b/}	
K ₂ O				}4.97
TiO ₂			0.36	
P ₂ O ₅			tr	
SO ₃			nil	
Ignit Loss	5.23	4.24	3.84	4.60
Total	98.42	99.93	100.00	95.23
Class	76,21,2	74,18,1	73,18,1	74,19,2

^{a/} Includes TiO₂

^{b/} By difference, ratio from spectro

B Group

Kansas

A. Sheridan Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NE 1/4 SW 1/4 sec 11, T 8 S, R 28 W. Analyst, R. Runnels. Lab #SNV-2. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Ash, fresh and contains approx 2% sand and silt. Sample from 6.0 ft bed, exposed about 200 yds SE of pit and across main creek about 400 yds to E, p. 65. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. Sheridan Co. PLEISTOCENE, SANBORN fm. NW 1/4 sec 34, T 8 S, R 28 W. Analyst, F. Schloesser. Swineford, Ada and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 20, 22, 28.

Volcanic ash. Groups of elongate vesicles very abundant. Cross-bedded lens 3 ft from bottom of exposure. Dominant refractive index, Ridgway color notation, particle size distribution, and bulk density, p. 17, 20, 27, 28.

C. Washington Co. UPPER CRETACEOUS, DAKOTA ss. NE 1/4 NW 1/4 sec 13, T 15 S, R 1 E. Analysts, R. Thompson and R. Runnels. Lab #W-57-2. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 137, 139, 144, 216.

Highly siliceous fire clay, p. 131. Silty, gray with some yellow in upper 1.9 ft; contains lignite particles and selenite crystals; thickness 4.7 ft. Spot sample. Ceramic tests p. 141, 143. Physical properties, p. 59.

Possible use: Refractory, p. 140, 144.

D. Washington Co. UPPER CRETACEOUS, DAKOTA ss. SE 1/4 SW 1/4 sec 1, T 3 S, R 2 E. Analysts, R. Thompson and R. Runnels. Lab #W-1-4. Idem, p. 122, 123.

Siliceous fire clay, p. 109. Slightly silty, light gray, small amount of yellow stain; contains lignite particles; fracture conchoidal. Thickness 7.7 to 10.7 ft. Spot sample. Physical properties, p. 59. Ceramic tests, p. 125, 129.

Possible use: Refractory, p. 130.

	A	B	C	D
SiO ₂	72.73	72.83	80.03	79.95
Al ₂ O ₃	11.82	14.38	12.44	13.33
Fe ₂ O ₃	1.69	1.84	0.73	0.78
MgO	0.03		0.38	0.51
CaO	0.76	0.56	0.34	0.75
Na ₂ O	)2.51 ^{a/}		)2.02	
K ₂ O	)6.18			
TiO ₂	0.21		0.36	
P ₂ O ₅	tr			
SO ₃	tr			
Ignit Loss	4.07	5.53	3.79	4.18
Total	100.00	95.14	100.09	99.50
Class	73,17,1	73,21,1	80,16,1	80,18,1

^{a/} By difference, ratio from spectro

Group B 90-

[SiO₂ from 75% to 90%; SiO₂ + (R₂O₃·nH₂O) + Carbonates < 90%]

Kansas

A-D: PLEISTOCENE, MEADE fm, FEARLETTE ash bed. Analyst, R. Runnels. Carey, J. S., et al, 1952, Kans GS B 96, pt 1.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

A. Comanche Co. SE 1/4 NE 1/4 sec 12, T 31 S, R 18 W. Lab #CMV-1B. Idem, p. 15, 20.

Analysis shows 10% alkalis.

Ash fairly fresh. Sample from upper 10 ft of bed 13 ft thick. Sample includes 2.5 ft of CMV-1A, see p. 13. Tonnage estimate, p. 41.

B. Lincoln Co. SE 1/4 SW 1/4 sec 27, T 13 S, R 10 W. Lab #LV-1. Idem, p. 16, 20.

Analysis suggests 10% alkalis.

Ash fairly fresh and free from contaminants, p. 50. Sample from 6.0 ft bed. Screen analysis, p. 25.

C. Logan Co. SW 1/4 NW 1/4 sec 12, T 13 S, R 35 W. Lab #LOV-3. Idem.

Analysis shows 9% alkalis.

Ash fresh and free from contaminants, p. 50. Sample from 14.0 ft bed. Working face in pit approx 200 yds wide, overburden 10 ft thick. Mined by State Highway Dept. Screen analysis, p. 25.

D. Ness Co. SE 1/4 NW 1/4 sec 30, T 18 S, R 23 W. Lab #NSV-1. Idem, p. 16, 21.

Analysis suggests 10% alkalis.

Sample from 6.0 ft bed. Chem analysis also in Swineford, A., and Frye, J. C., 1946, Kans GS B 64, pt 1, p. 18, 22. Locality S 1/2 NW 1/4 sec 30. This analysis omits TiO₂, Na₂O and K₂O, analyst, F. Schloesser. Size distribution, p. 27. Bulk density, p. 28. Screen analysis, p. 25.

	A	B	C	D
SiO ₂	71.68	72.51	72.31	71.16
Al ₂ O ₃	12.00	11.55	12.14	11.70
Fe ₂ O ₃	1.37	1.21	1.75	1.47
MgO	0.87	0.07	0.14	0.38
CaO	0.43	0.68	0.84	1.46
Na ₂ O	3.16	2.77 ^{b/}	2.84	9.84 ^{c/}
K ₂ O	6.76	6.86	6.37	
TiO ₂	0.49	0.54	0.26	0.16
P ₂ O ₅	tr	tr	nil	n.d.
SO ₃	nil	nil	0.10	n.d.
Ignit Loss	4.02	3.81	3.29	3.86
Total	100.78 ^{a/}	100.00	100.04	100.03 ^{d/}
Class	72,17,1	73,16,1	72,17,0	71,16,1

^{a/} Total 100.77 (sic text)

^{b/} By difference, ratio from spectro

^{c/} By difference

^{d/} Total 100.00 (sic text)

Group B, 90-

Kansas

A. Reno Co. PLEISTOCENE, MEADE fm, PEARLETTE ash bed. NW 1/4 SE 1/4 sec 14, T 25 S, R 8 W. Analyst, R. Runnels. Lab #ROV-1. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21, 63.

Analysis shows 1.0% TiO₂ and suggests 7.7% alkalis.

Ash relatively fresh and free from contaminants, p. 63. Sample from 10 ft bed exposed in pit face. Screen analysis, p. 25.

Possible uses: Abrasive, ceramic glaze, cement additive, lightweight aggregate, p. 30-40.

B. Rice Co. PLEISTOCENE, SANBORN fm, Loveland (?) silt mem. NW 1/4 NW 1/4 sec 22, T 20 S, R 7 W. Analyst, R. Runnels. Lab #7. Frye, J. C., and Fent, O. S., 1947, Kans GS B 70, pt 3, p. 38, 39.

Partial analysis.

Road cut. 3 ft below surface. Solubility in HCl, 13.2%.

	A	B
SiO ₂	74.12	68.58
Al ₂ O ₃	11.20	
Fe ₂ O ₃	1.87	
R ₂ O ₃		16.65
MgO	0.31	
CaO	1.08	2.19
Na ₂ O	)2.77 <u>a/</u>	
K ₂ O	)4.96	
TiO ₂	0.97	
P ₂ O ₅	nil	
SO ₃	tr	
Ignit Loss	2.72	3.86
Total	100.00	91.28 <u>b/</u>
Class	74,16,0	69,21,0

a/ By difference, ratio from spectro

b/ Total, 91.29 (sic text)

C Group [$\text{SiO}_2 < 75\%$; $\text{SiO}_2 > (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O}) > \text{Carbonates}$]

Kansas

A-B: Allen Co. No stratigraphic position given. Haworth, Erasmus, 1903, Kans
GS Ann B for 1902, p. 56.

Possible use: Cement material.

A. T 24 S, R 18 E, town of Iola.

B. T 24 S, R 18 E, near town of Iola.
Shale.

	A	B
SiO_2	55.00 <u>a/</u>	57.20
Al_2O_3)	24.37 <u>a/</u>	26.80
Fe_2O_3)	3.30	3.10
MgO	0.77	5.40
CaO	2.11 <u>a/</u>	3.90
Na_2O)	7.71 <u>a/</u>	7.00
K_2O)		
$\text{H}_2\text{O}-$)		
$\text{H}_2\text{O}+$)		
Total	95.26	103.40
Class	55,32,8	57,34,0

a/ Rounded off to two decimal places

C Group

Kansas

A. Atchison Co. PLEISTOCENE, SANBORN fm. Cen N line sec 12, T 7 S, R 18 E. ^{1/} Analyst, R. Runnels. Lab #A-6. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28. Also, Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 82, 83.

Loess, oxidized, gray, 32 ft channel sample. Lightweight aggregate production in batch-type rotary kiln, Kans GS B 91, p. 29. Screen analysis, idem, p. 31. Bloating results, idem, p. 45. Firing and physical properties of ceramic slag, Kans GS B 76, pt 4, p. 82, 83.

Possible uses: Lightweight aggregate, Kans GS B 91, p. 73, 95. Ceramic slag for railroad ballast, Kans GS B 76, pt 4, p. 96.

B. Barton Co. UPPER CRETACEOUS, DAKOTA ss, Janssen clay mem. ^{2/} SW 1/4 SW 1/4 sec 21, T 18 S, R 13 W. Analyst, R. Runnels. Lab #BT-3-3. Reed, A. C., 1950, Kans GS B 86, pt 2, p. 24, 27, 36.

Clay.

Use: Brick making, p. 24.

C. Bourbon Co. PENNSYLVANIAN, CHEROKEE sh, shale above Mulky coal. NE 1/4 NW 1/4 sec 27, T 26 S, R 25 E. Analyst, R. Runnels. Lab #48-298. Runnels, R., 1949, Kans GS B 82, pt 2, p. 42, 43, 44, 45.

Composite sample of bed 2 ft thick. Size distribution of shales ground in pan mill, p. 43.

Possible use: Agricultural fertilizer, p. 39, 47.

^{1/} NE 1/4 sec 12, T 17 S, R 19 E, Kans GS B 76, pt 4, p. 82.

^{2/} Letter from Kans GS, 7/16/53

	A	B	C
SiO ₂	70.97 ^{a/}	72.56	53.41
Al ₂ O ₃	15.98	17.44	11.65
Fe ₂ O ₃	3.32	1.21 ^{b/}	5.44
MgO	0.42	0.31	1.83
CaO	2.28	0.40	4.33
TiO ₂	1.39	0.84 ^{c/}	1.96 ^{e/}
P ₂ O ₅	n.d.	tr	2.30 ^{f/}
V ₂ O ₅		0.04 ^{d/}	
SO ₃	n.d.	tr	0.12
Ignit Loss	4.60	5.68	16.10
Total	98.96	98.48	97.14
Class	71,24,0	73,24,1	53,28,12

Qualitative spectrographic analysis by A. C. Reed. Key to symbols, p. 45. (Higher numbers indicate greater abundance)

	C	C ^{g/}
B	-	6
Na	6	-
K	8	-
V	9	9
Cr	9	9
Mn	8	10
Cu	6	9
Zn	6	4
Zr	8	-
Mo	-	5
Ag	4	5
Pb	-	7

^{a/} SiO₂, 70.98, Kans GS B 76, pt 4, p. 74

^{b/} Average of 3 or more determinations

^{c/} RO₂ + R₂O₃ reported as TiO₂ by gravimetric determination

^{d/} Determined spectrographically using graphite electrodes. Rounded off to two decimal places.

^{e/} Gravimetric method used

^{f/} Sol. in citric acid, 1.54%, p. 43

^{g/} High purity graphite electrodes

C Group

Kansas

A-C: Brown Co. PENNSYLVANIAN, WABAUNSEE group. Analyst, R. Runnels. Plummer, Forman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 26.

Screen analysis, p. 30, 31. Production of lightweight aggregate in batch-type rotary kiln, p. 26, 27. Bloating results in electric kiln, p. 32.

Possible use: Lightweight aggregate, p. 62.

- A. WILLARD sh (lower). SW 1/4 SW 1/4 sec 4, T 4 S, R 18 E. Lab #BR-5.
Shale, oxidized, red and black. 12.0 ft sampled out of 30.0 ft available.
- B. Caneyville-Pony Creek sh. SE 1/4 SE 1/4 sec 31, T 1 S, R 17 E. Lab #BR-3-1.
Shale, unoxidized, red and gray. 8.5 ft sampled out of 8.5 ft available.
- C. Caneyville-Pony Creek sh. SE 1/4 SE 1/4 sec 31, T 1 S, R 17 E. Lab #BR-3-2.
Shale, unoxidized, pink and gray. 4.5 ft sampled out of 4.5 ft available.

	A	B	C
SiO ₂	54.72	55.33	56.22
Al ₂ O ₃	15.99	20.69	20.61
Fe ₂ O ₃	5.73	7.58	8.26
MgO	2.56	2.55	2.67
CaO	6.70	0.86	0.55
Na ₂ O	0.87	0.49	0.56
K ₂ O	3.06	3.03	3.45
TiO ₂	1.01	1.22	0.59
P ₂ O ₅	0.21	0.23	0.18
SO ₃	tr	0.53	0.17
Ignit Loss	9.27	6.75	6.20
Total	100.12	99.26	99.46
Class	55,27,8	55,35,0	56,35,0

C Group

Kansas

A and B: Cheyenne Co. PLEISTOCENE, SANBORN fm. SE 1/4 SE 1/4 sec 28, T 3 S, R 39 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.

Silt. Plastic and dry properties, p. 88. Fired properties, p. 98.
Possible use: Ceramic slag, p. 83.

- A. Peoria silt mem.
Depth below top of section 10 ft, p. 56.
- B. Bignell silt mem.
Depth below top of section, 2.5 ft, p. 56.

	A	B
SiO ₂	67.62	68.25
Al ₂ O ₃ <u>a/</u>	11.03	10.91
Fe ₂ O ₃	2.86	2.49
MgO	1.55	1.27
CaO	5.57	6.41
Na ₂ O <u>b/</u>	0.71	0.48
K ₂ O	3.47	2.97
TiO ₂	1.22	1.01
P ₂ O ₅	0.24	0.26
SO ₃	0.06	0.06
Ignit Loss	5.91	6.15
H ₂ O- <u>c/</u>	(0.42)	(0.46)
Total	100.24	100.26
Class	68,17,5	68,17,6

a/ Presumably not corrected for P₂O₅

b/ By difference

c/ Below 105° to 140°C, not included in total

Qualitative spectrographic analyses by A. C. Reed. Carbon electrodes.
Key to symbols, p. 87. (Higher numbers indicate greater abundance)

	A	B
V	6	6
Cr	4	4
Mn	9	8
Cu	6	5
Zn	6	6
Zr	7	7

C Group

Kansas

A. Cloud Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. S 1/2 sec 18, T 8 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #C-28-3. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 155, 165.

Clay, silty to plastic, with lavender, red, brown mottling. Total thickness 15.7 ft, sectioned as follows:

Clay, plastic, lavender and gray with red mottling and small amount of yellow, top 5.4 ft.

Clay, slightly silty, light gray with red mottling, 1.9 ft.

Clay, plastic, gray with lavender, red, brown mottling, 7.2 ft.

Clay, silty, lignitic, dark gray, bottom 1.2 ft.

Ceramic tests, p. 166.

B. Cloud Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. NW 1/4 sec 31, T 8 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #C-29-3. Idem, p. 110, 123.

Clay, rather silty, gray with slight yellow stain; contains lignite fragments and fossil leaves. Thickness 5.5 ft. Ceramic tests, p. 125, 126. Physical properties, p. 60.

Possible use: Refractory, p. 124, 130.

	A	B
SiO ₂	65.20	72.01
Al ₂ O ₃	18.79	19.50 ^{a/}
Fe ₂ O ₃	5.66	1.15
MgO	0.46	0.24
CaO	0.48	0.18
Na ₂ O)		
K ₂ O)	2.25	2.32
Ignit Loss	6.49	5.01
Total	99.33	100.41
Class	65,31,1	72,26,0

^{a/} Includes TiO₂

C Group

Kansas

A-C: Cloud Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay men.

A. SE 1/4 sec 13, T 8 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #C-27-5. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 67, 79.

Ball clay, p. 64, 65. Gray and light gray, slight yellow stain on joints in lower portion; pronounced conchoidal fracture; contains fossil leaves, some lignite, and slight amount of gypsum. Thickness 7.5 ft. Ceramic tests, p. 82. Physical properties, p. 60.

B. SW 1/4 sec 32, T 8 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #C-27-13a. Idem.

Ball clay, gray, plastic, slight yellow stain. Massive, pronounced conchoidal fracture on fresh exposure. Tends to weather platy. Thickness 10.8 ft. Ceramic tests, p. 83. Physical properties, p. 60. From same bed as #C-27-5.

C. Cen S 1/2 sec 32, T 8 S, R 2 W. Analyst, R. Thompson. Lab #C-27. Plummer, Norman and Romary, J. F., 1942, Kans GS B 41, pt 9, p. 335. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 101, 102.

High alumina clay. Partly thin-bedded, contains fossil leaves. Overlain by light gray and red mottled clay that grades upward into highly hematitic clay; underlain by gray, silty, lignitic clay, Kans GS B 41, pt 9, p. 335. Ceramic tests, idem, p. 335. Mineral composition and tonnage estimate, Kans GS B 41, pt 3, p. 101, 102.

Possible use: Source of alumina, idem, p. 74.

	A	B	C
SiO ₂	59.60	57.94	59.94
Al ₂ O ₃	26.71 <u>a/</u>	27.35	29.38
Fe ₂ O ₃	1.44	1.79	1.20
MgO	0.64	0.47	
CaO	0.22	0.62	1.10
Na ₂ O)			
K ₂ O)	3.88	0.87	
TiO ₂		0.13	
Ignit Loss	7.80	9.71	8.60 <u>c/</u>
Total	100.29	98.88 <u>b/</u>	100.22 <u>d/</u>
Class	60,35,2	58,38,2	60,38,2

a/ Includes TiO₂

b/ 98.75 (sic text)

c/ Ignit Loss, 8.40, Kans GS B 41, pt 9, p. 335

d/ 100.32 (sic text)

C Group

Kansas

A-D: Cloud Co. UPPER CRETACEOUS, DAKOTA ss.

A. Janssen clay mem. SE 1/4 sec 11, T 8 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #C-12-B. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 89, 101.

Fire clay, slightly silty to fairly plastic, gray to light gray, slight yellow stain; contains lignite particles. Jointing vertical, and fracture conchoidal. Thickness 17.2 ft. Ceramic tests, p. 102, 103, 107. Physical properties, p. 60.

Possible use: Face brick, structural tile, p. 108.

B. Janssen clay mem. NW 1/4 sec 12, T 6 S, R 3 W. Analyst, R. Runnels. Lab #C-51-7. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 80, 81. Clay from bed 5.2 ft thick. Channel sample. Firing and physical properties of ceramic slag, p. 81, 82.

Possible use: Ceramic slag, p. 82.

C. Janssen clay mem. NE 1/4 NW 1/4 and NW 1/4 NE 1/4 sec 15, T 8 S, R 3 W. Analysts, R. Thompson and R. Runnels. Lab #C-43-4. Kans GS B 67, p. 110, 123.

Siliceous fire clay, slightly silty, gray to dark gray, some yellow stain; thickness 3.0 ft. Plastic, light gray, some limonite-filled root cavities; thickness, 2.6 ft. Ceramic tests, p. 125, 126. Physical properties, p. 60.

Possible use: Refractory, p. 124, 130.

D. NE 1/4 NW 1/4 sec 32, T 8 S, R 2 W. Analyst, R. Runnels. Lab #C-27. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 26.

Clay, unoxidized, light gray. 12.0 ft sampled out of a possible 12.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 26, 27. Screen analysis, p. 31.

Possible use: Lightweight aggregate, p. 69.

	A	B	C	D
SiO ₂	68.56	68.61	72.18	59.60
Al ₂ O ₃	17.39	16.16	19.58 ^{b/}	25.44
Fe ₂ O ₃	1.68	4.62	1.70	1.58
MgO	0.40	1.03	0.51	0.64
CaO	0.30	0.72	0.27	0.22
Na ₂ O	)1.56	n.d.	)2.11	0.73
K ₂ O		n.d.		1.78
TiO ₂		2.66		1.32
P ₂ O ₅		none		n.d.
SO ₃		0.04		n.d.
Ignit Loss	10.91	6.34	5.29	7.80
Total	100.80	100.18 ^{a/}	101.64	99.11
Class	69,29,1	69,26,2	72,27,0	60,34,2

^{a/} 99.98 (sic text)

^{b/} Includes TiO₂

C Group

Kansas

A-D: Crawford Co. PENNSYLVANIAN, CHEROKEE sh. Analyst, R. Runnels.

A. Shale under Pilot coal. Sec 18, T 30 S, R 25 E. Lab #CR-6. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Shale, gray, mostly oxidized. 20.0 ft sampled out of a possible 20.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Bloating results, p. 32.

Possible use: Lightweight aggregate, p. 95.

B. Shale above Croweburg coal. SW 1/4 SW 1/4 sec 34, T 38 ^{1/2} S, R 25 E. Lab #48-296. Runnels, R., 1949, Kans GS B 82, pt 2, p. 42, 43, 44, 45.

Shale. Composite sample from bed 4 ft thick.

Possible use: Agricultural fertilizer, p. 39, 47.

C. NE 1/4 SE 1/4 sec 16, T 16 ^{1/2} S, R 25 E. Lab #CR-9. Kans GS B 91, p. 20, 24.

Shale, dark gray, mostly oxidized. 10.0 ft sampled out of a possible 20.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

D. NW 1/4 SE 1/4 sec 18, T 30 S, R 25 E. Lab #CR-7. Idem.

Shale, dark gray, mostly unoxidized. 10.0 ft sampled out of 10.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 30. Bloating results, p. 32.

Possible use: Lightweight aggregate, p. 95.

^{1/2} Sic text but this township not in Crawford Co.

	A	B	C	D	Qualitative spectrographic analysis by A. C. Reed. Key to symbols, p. 45. (Higher numbers indicate greater abundance)		
SiO ₂	67.56	45.58	60.92	67.46			
Al ₂ O ₃	19.90	14.10	18.48	17.10			
Fe ₂ O ₃	2.16	4.30	6.82	4.63	B	-	B ^{c/} 6
MgO	0.52	0.99	1.76	1.23	B	-	6
CaO	0.31	5.46	0.49	0.27	V	7	7
Na ₂ O	0.18	n.d.	1.20	1.03	Cr	7	9
K ₂ O	1.91	n.d.	3.47	2.38	Mn	5	6
TiO ₂	1.15	0.29 ^{b/}	1.68	1.01	Cu	6	8
P ₂ O ₅	0.05	4.24	0.22	0.17	Zn	4	4
SO ₃	nil	tr	nil	nil	Zr	4	-
Ignit Loss	6.02	21.77	5.39	4.72	Mo	-	6
					Ag	3	4
					Pb	-	5
Total	99.76 ^{a/}	96.73	100.43	100.00			
Class	68,28,1	46,35,12	61,31,0	67,26,0			

^{a/} 99.71 (sic text)

^{b/} Gravimetric method used

^{c/} High purity graphite electrodes

C Group

Kansas

A. Crawford Co. PLEISTOCENE, terrace deposit. NE 1/4 SE 1/4 sec 16, T 16 1/2 S, R 25 E. Analyst, R. Runnels. Lab #CR-8. Plummer, Norman and Hledik, W. B., 1951, Kans GS B 91, p. 21, 28.

Loess, dark gray, oxidized. 9.0 ft sampled out of a possible 9.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 31. Bloating results, p. 45.

Possible use: Lightweight aggregate, p. 95.

B. Doniphan Co. PENNSYLVANIAN, DOUGLAS group, LAWRENCE sh. Cen W 1/2 SW 1/4 sec 33, T 3 S, R 22 E. Analyst, R. Runnels. Lab #DN-4. Idem, p. 20, 26.

Shale, gray, partially oxidized. 25.0 ft sampled out of 25.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 26. Screen analysis, p. 31. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

1/ Sic text but this township not in Crawford Co.

	A	B
SiO ₂	64.79	60.38
Al ₂ O ₃	16.17	18.60
Fe ₂ O ₃	7.37	6.94
MgO	0.99	2.05
CaO	0.38	0.84
Na ₂ O	0.83	0.85
K ₂ O	2.24	2.63
TiO ₂	1.65	1.31
P ₂ O ₅	0.05	0.19
SO ₃	nil	tr
Ignit Loss	5.69	5.99
Total	100.16 ^{a/}	99.78
Class	65,29,0	60,32,0

^{a/} 100.11 (sic text)

C Group

Kansas

A-D: Doniphan Co. PLEISTOCENE, SANBORN fm, Bignell silt mem. NE 1/4 SE 1/4 sec 6, T 2 S, R 20 E. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 85, 94.

Silt. Plastic and dry properties, p. 94.

Possible uses: Ceramic aggregate, railroad ballast, p. 77.

A. Depth below top of section 31 ft. Fired properties, p. 116.

B. " " " " 19 " " " p. 115.

C. " " " " 13 " " " p. 115.

D. " " " " 7 " " " p. 115.

	A	B	C	D
SiO ₂	68.02	68.83	65.39	66.58
Al ₂ O ₃	10.82	11.09 ^{c/}	10.15 ^{c/}	11.06 ^{c/}
Fe ₂ O ₃	2.76	3.04	3.25	3.20
MgO	3.22	2.41	2.97	2.50
Ca)	4.87	4.16	6.15	5.60
Na ₂ O ^{a/}	3.31	1.68	1.53	0.28
K ₂ O	n.d.	2.63	2.26	2.84
P ₂ O ₅	tr	0.15	0.15	0.15
SO ₃	tr	0.06	0.04	0.20
Ignit Loss	7.00	6.10	8.26	7.74
H ₂ O- ^{b/}	(0.57)	(0.45)	(0.08)	(0.25)
Total	100.00	100.15	100.15	100.15
Class	68,17,8	69,18,5	65,17,10	67,18,9

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

^{c/} Presumably not corrected for P₂O₅

Qualitative spectrographic analysis by A. C. Reed. Carbon electrodes.
Key to symbols, p. 87. (Higher numbers indicate greater abundance)

V	8
Cr	8
Mn	9
Cu	1
Zr	9
Ag	2

C Group

Kansas

A. Douglas Co. PENNSYLVANIAN, DOUGLAS group, STRANGER fm, VINLAND sh mem. Cen S 1/2 SW 1/4 sec 15, T 14 S, R 20 E. Analyst, R. Runnels. Lab #DG-15. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 26.

Shale, oxidized, gray. 20.0 ft sampled out of 30.0 ft available. Screen analysis, p. 31. Lightweight aggregate production in batch-type rotary kiln, p. 26. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

B. Douglas Co. PENNSYLVANIAN, DOUGLAS group, STRANGER fm. SW 1/4 sec 11, T 14 S, R 20 E. Analyst, R. Runnels. Lab #DG-12-A. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 78, 79.

Shale, channel sample from bed 12 ft thick. Firing and physical properties of ceramic slag, p. 78.

Possible uses: Railroad ballast, concrete aggregate, p. 95. Not suitable for rotary kiln.

C. Douglas Co. PENNSYLVANIAN, DOUGLAS group, LAWRENCE sh. SW 1/4 NW 1/4 sec 27, T 14 S, R 20 E. Analyst, R. Runnels. Lab #DG-14. Kans GS B 91, p. 20, 26.

Shale, oxidized, gray. 20.0 ft sampled out of 25.0 ft available. Screen analysis, p. 30. Lightweight aggregate production in batch-type rotary kiln, p. 26. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

D. Elk Co. PENNSYLVANIAN, DOUGLAS group, STRANGER fm, ROBBINS sh mem. W 1/2 SW 1/4 sec 22, T 31 S, R 13 E. Analyst, R. Runnels. Lab #EK-1. Idem.

Shale, unoxidized, dark gray. 22.0 ft sampled out of 22.0 ft available. Screen analysis, p. 30. Lightweight aggregate production in batch-type rotary kiln, p. 26. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

E. Elk Co. PENNSYLVANIAN, WABAUNSEE group, SEVERY sh. SW 1/4 NW 1/4 sec 2, T 30 S, R 10 E. Analyst, R. Runnels. Lab #EK-5. Idem.

Shale, unoxidized, gray. 22.0 ft sampled out of 40.0 ft available. Screen analysis, p. 30. Lightweight aggregate production in batch-type rotary kiln, p. 26. Bloating results, p. 33.

Possible use: Lightweight aggregate, p. 95.

	A	B	C	D	E
SiO ₂	58.96	54.46	58.38	54.20	62.50
Al ₂ O ₃	18.44	25.05	19.96	19.87	16.95
Fe ₂ O ₃	6.15	6.78	6.95	6.37	6.61
MgO	1.64	0.39	1.75	2.04	2.24
CaO	3.02	0.25	1.24	3.30	0.68
Na ₂ O	0.69	} 4.51 a/	0.74	0.49	1.75
K ₂ O	2.83		3.17	3.12	2.88
TiO ₂	1.27	0.98	1.15	0.98	1.08
P ₂ O ₅	0.20	n.d.	0.23	0.18	0.19
SO ₃	tr	0.04	tr	0.14	0.01
Ignit Loss	7.13	7.31	6.10	8.32	4.56

Total	100.33	99.77 b/	99.67	99.01 c/	99.45 d/
Class	59,31,2	54,39,0	58,33,0	54,33,4	63,28,0

a/ By difference b/ 100.00 (sic text) c/ 99.19 (sic text) d/ 99.63 (sic text)

C Group

Kansas

A. Ellis Co. UPPER CRETACEOUS, CARLILE sh, BLUE HILL mem. NE 1/4 SE 1/4 sec 21, T 13 S, R 19 W. Analyst, R. Runnels. Lab #ES-1. Plummer, Norman and Hladik, W. B., 1951. Kans GS B 91, p. 21, 28.

Shale, unoxidized, pink and gray. 13.0 ft sampled out of 30.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 30. Bloating results, p. 39.

Possible use: Lightweight aggregate, p. 95.

B. Ellsworth Co. LOWER CRETACEOUS, KIOWA sh. NE 1/4 NE 1/4 sec 34, T 17 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #El-100-3. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 171, 174.

Clay-shale, plastic, gray with yellow stain. Thickness 10 ft. Bottom half contains clay-ironstone concretions. Ceramic tests, p. 175.

Possible use: Lightweight aggregate, p. 182.

C. Ellsworth Co. LOWER CRETACEOUS, KIOWA sh. Cen S 1/2 sec 1, T 16 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #El-22-6. Idem, p. 170, 174.

Clay-shale, plastic, gray to dark gray with some brown and yellow stain; contains selenite crystals, clay-ironstone bands, and cone-in-cone gypsiferous limestone; shale has acid taste. Thickness 21.1 ft. Ceramic tests, p. 175.

Possible use: Lightweight aggregate, p. 182.

D. Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. Sec 21, T 15 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #El-32-A. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 80.

Clay, channel sample, 95 ft thick. Firing and physical properties of ceramic slag, p. 81.

Possible uses: Good material for ceramic slag. Railroad ballast, concrete aggregate, p. 96.

	A	B	C	D
SiO ₂	60.43	59.38	57.25	67.00
Al ₂ O ₃	18.68	25.50	22.98	21.11
Fe ₂ O ₃	5.36	1.49	3.30	3.20
MgO	1.35	1.15	2.35	0.85
CaO	0.81	0.73	0.48	0.38
Na ₂ O	0.46	} 3.95	} 3.87	} 1.15
K ₂ O	3.14			
TiO ₂	1.06	1.64	1.15	0.20
P ₂ O ₅	0.14			tr
MnO				tr
SO ₃	1.03			n.d.
Ignit Loss	8.19	6.58	8.21	5.86
Total	100.65	100.42 ^{a/}	99.59	99.75
Class	60,30,4	59,34,0	57,33,3	67,30,0

^{a/} 100.45 (sic text)

C Group

Kansas

A-E: Ellsworth Co. UPPER CRETACEOUS.

A. DAKOTA ss, Terra Cotta clay mem. NW 1/4 sec 29, T 15 S, R 6 W. Analyst, R. Thompson and R. Runnels. Lab #E1-12-4. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 68, 79.

Ball clay, thickness 6.6 ft. Upper 3 ft gray, plastic with fossil leaves; middle 1 ft light gray, slightly silty; lower 2.6 ft dark gray, fairly plastic; considerable lignite, some fossil leaves. Ceramic tests, p. 83, 87. Physical properties, p. 60.

Possible use: Refractory, p. 81.

B. DAKOTA ss, Terra Cotta clay mem. $\frac{1}{2}$ NW 1/4 sec 29, T 15 S, R 6 W. Analyst, R. Thompson. Lab #E1-12-4. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 101, 102.

High-alumina clay. Mineral composition and tonnage estimate, p. 101, 102.

Possible use: Production of alumina, p. 99.

C. DAKOTA ss, Terra Cotta clay mem. NW 1/4 sec 25, T 15 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #E1-14-01. Kans GS B 67, p. 91, 101.

Plastic fire clay, fine-grained, gray to dark gray, thin-bedded; minute amounts of light-colored silt on bedding planes; some lignitic particles, small amount of pyrite. 6.9+ ft thick. Physical properties, p. 60. Ceramic tests, p. 102, 103.

Possible uses: Face brick, structural tile, refractory, p. 108.

D. DAKOTA ss, Terra Cotta clay mem. $\frac{1}{2}$ NW 1/4 sec 19, T 16 S, R 7 W. Analyst, R. Thompson. Lab #E1-52-3. Kans GS B 41, pt 3, p. 101, 102.

High-alumina clay, nearly white, plastic, very smooth. Thickness of bed, 2.8 ft. Kans GS B 67, p. 69. Mineral composition and tonnage estimate, Kans GS B 41, pt 3, p. 101, 102.

Possible use: Production of alumina, idem, p. 99.

E. DAKOTA ss, Terra Cotta Clay mem. NW 1/4 sec 19, T 16 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #E1-52-3. Kans GS B 67, p. 69, 79, 1947.

Ball clay, nearly white, plastic, very smooth. Composite sample from series of six pits. Thickness 2.8 ft. Ceramic tests, p. 83. Physical properties, p. 60.

Possible use: Refractory, p. 81.

$\frac{1}{2}$ Kans GS B 67, p. 68, 69, 1947.

	A	B	C	D	E
SiO ₂	61.40	60.26	67.14	56.40	55.76
Al ₂ O ₃	26.74 ^{a/}	28.69	22.15	31.00	33.06
Fe ₂ O ₃	1.67	0.49	1.28	1.08	0.97
MgO	0.27		0.27		0.50
CaO	0.36	0.21	0.55	0.18	0.31
Na ₂ O	} 0.64		} 1.68		} 0.42
K ₂ O					
TiO ₂			0.56		0.34
Ignit Loss	9.41	9.81	6.80	11.15	8.87
Total	100.49	99.46	100.43 ^{b/}	99.81	100.23
Class	61,37,1	60,39,0	67,30,2	56,43,0	56,43,1

^{a/} Includes TiO₂

^{b/} 100.51 (sic text)

C Group

Kansas

A-E: Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss. Analysts, R. Thompson and R. Runnels. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67.

Plastic fire clay. Physical properties, p. 60.

Possible uses: Face brick, structural tile, refractory, p. 108.

A. Terra Cotta clay mem. NW 1/4 NW 1/4 sec 15, T 16 S, R 9 W. Lab #EL-38-04. Idem, p. 93, 101.

Thin-bedded, plastic, light gray, slight amount of yellow stain and isolated spots of yellow sand on bedding planes in upper two-thirds. Thickness 6.4 ft. Ceramic tests, p. 102, 103.

B. Terra Cotta clay mem. NW 1/4 NW 1/4 sec 15, T 16 S, R 9 W. Lab #EL-38-05. Idem.

Thin-bedded, plastic, gray, some yellow and pinkish stain; minor amounts of sand. Thickness 5 ft. Ceramic tests, p. 102, 103.

C. Janssen clay mem. Cen W 1/2 sec 23, T 14 S, R 7 W. Lab #EL-29-4. Idem, p. 92, 101.

Silty to plastic, gray to nearly black. Top 5 ft plastic, remainder silty. Total thickness, 12.8 ft. Ceramic tests, p. 102, 103, 107.

D. Janssen clay mem. NW 1/4 sec 33, T 14 S, R 7 W. Lab #EL-91-1. Idem, p. 94, 101.

Slightly silty, dark gray, some yellow stain; some selenite crystals, lignitized wood, and fossil leaves. Thickness 16+ ft. Fracture conchoidal; massive when freshly excavated but weathers platy due to paper-thin streaks of fine silt. Ceramic tests, p. 102, 104.

E. Janssen clay mem. NW 1/4 sec 33, T 14 S, R 7 W. Lab #EL-91-2. Idem.

Slightly silty, gray, slight yellow stain; contains particles of lignitized wood and fossil leaves. Kaolin 4 ft from top and at bottom. Thickness 8.1 ft. Ceramic tests, p. 102, 104.

	A	B	C	D	E
SiO ₂	68.70	67.59	68.98	62.58	62.99
Al ₂ O ₃	21.05	21.13	19.35	22.02	22.30
Fe ₂ O ₃	1.23	1.15	1.61	2.18	1.74
MgO	0.37	0.32	tr	0.44	0.71
CaO	0.29	0.66	0.16	0.61	0.73
Na ₂ O)					
K ₂ O)	1.80	1.88	1.25	1.38	1.70
TiO ₂		0.55	1.30	0.29	1.49
Ignit Loss	5.72	5.81	6.70	10.88	8.23
Total	99.16	99.09	99.35	100.38	99.89
Class	69,28,0	68,28,1	69,28,0	63,34,2	63,31,3

C Group

Kansas

A-D: Ellsworth Co. UPPER CRETACEOUS, DAKOTA ss, Janssen clay mem. Analysts, R. Thompson and R. Runnels. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67. Siliceous fire clay. Physical properties, p. 60. Possible uses: Refractory, p. 130. Source of alumina, Kinney, E. D., 1952, Kans GS B 96, pt 7, p. 327.

A. Sec 2, T 15 S, R 7 W. Lab #E1-85-3. Kans GS B 67, p. 115, 123. Silty, conchoidal fracture; gray, some yellow stain, small selenite crystals on joints; lignite fragments. Thickness 5.9 ft. Ceramic tests, p. 125, 127.

B. Sec 2, T 15 S, R 7 W. Lab #E1-85-4. Idem. Top 1.6 ft silty, lignitic gray clay, some yellow stain. Middle 1.5 ft fairly plastic gray clay, some yellow stain. Bottom 4.5 ft fairly silty, pronounced conchoidal fracture, gray, slight yellow stain; contains lignite and some selenite crystals. Ceramic tests, p. 125, 128.

C. SE 1/4 SW 1/4 sec 19, T 15 S, R 9 W. Lab #E1-60-6. Idem, p. 112, 123. Kans GS B 96, pt 7, p. 305, 306. Very silty, light gray, yellow stain, pronounced conchoidal fracture. Thickness 4.1 ft. Trace of kaolin at top. Ceramic tests, Kans GS B 67, p. 125, 126. Beneficiation tests, Kans GS B 96, pt 7, p. 308. Results of lime-sinter process, idem, p. 312, 314, 317, 318.

D. SE 1/4 SW 1/4 sec 19, T 15 S, R 9 W. Lab #E1-60-13. Idem, p. 113, 123. Silty, gray, slight yellow stain; pronounced conchoidal fracture. Thickness 4.3 ft. Ceramic tests, p. 125, 127.

	A	B	C	D
SiO ₂	70.34	72.46	71.80	72.38
Al ₂ O ₃	16.63	16.58	19.12	18.55
Fe ₂ O ₃	0.46	1.31	0.88	0.75
MgO	1.11	0.73	0.16	0.14
CaO	0.42	0.49	0.18	0.21
Na ₂ O)				
K ₂ O)	2.57	2.52	0.82	0.78
TiO ₂	1.15	0.45	1.30	1.33
Ignit Loss	7.62	6.12	6.05 ^{a/}	6.33
Total	100.30	100.66	100.31	100.47
Class	70,23,3	72,23,2	72,26,1	72,25,1

^{a/} 140° - 1000°C

C Group

Kansas

A-C: Ellsworth Co. UPPER CRETACEOUS.

A. DAKOTA ss. NE 1/4 sec 25, T 15 S, R 7 W. Analysts, R. Thompson and R. Runnels. Lab #E1-14-04. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 62, 64.

Kaolin, very light gray to white, some yellow joint stains; fracture conchoidal. Thickness 1.5 ft. Ceramic tests, p. 65.

Possible use: To increase quality of under-lying and over-lying fire clays, p. 64.

B. DAKOTA ss. W 1/2 NW 1/4 sec 30, T 15 S, R 6 W. Analyst, R. Runnels. Lab #E1-69-2. Kinney, E. D., 1952, Kans GS B 96, pt 7, p. 305, 306.

Clay, kaolinitic type. Beneficiation tests, p. 308. Results of lime-sinter process, p. 312, 314, 317, 318.

Possible use: Production of alumina, p. 327.

C. GRANEROS sh. NW 1/4 NW 1/4 sec 25, T 15 S, R 10 W. Analysts, R. Thompson and R. Runnels. Lab #E1-43-19. Kans GS B 67, p. 176, 180.

Clay shale, very plastic, yellowish gray, concretionary limonite at top and bottom. Thickness 2 ft. Ceramic tests, p. 181.

Possible uses: Lightweight aggregate, insulating and structural tiles and blocks, p. 182.

	A	B	C
SiO ₂	55.35	66.08	55.63
Al ₂ O ₃	31.90	23.70 ^{a/}	25.84
Fe ₂ O ₃	0.94	0.46	3.77
MgO	0.12		1.27
CaO	0.45	2.03	0.85
Na ₂ O			} 2.76
K ₂ O			
TiO ₂	0.60		1.01
Ignit Loss	10.97	6.62 ^{b/}	8.36
Total	100.33	98.89	99.49
Class	55,43,1	66,30,1	56,37,2

^{a/} Includes TiO₂

^{b/} 140° - 1000°C

C Group

Kansas

A. Ford Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. NW 1/4 SW 1/4 sec 30, T 25 S, R 23 W. Analysts, R. Thompson and R. Runnels. Lab #F-1-13. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 96, 101.

Plastic clay, p. 87. Upper 1.6 ft nearly white, almost no stain; lower 0.9 ft dark gray. Thickness 2.5 ft. Physical properties, p. 60. Ceramic tests, p. 102, 104. Possible uses: Face brick, structural tile, refractory, p. 108.

B. Ford Co. UPPER CRETACEOUS, DAKOTA ss, terra Cotta clay mem. NW 1/4 SW 1/4 sec 30, T 25 S, R 23 W. Analysts, R. Thompson and R. Runnels. Lab #F-1-14. Idem.

Plastic fire clay, p. 87. Nearly white, smooth, fine-grained but hard; few limonite-filled root cavities. Thickness 2.8 ft. Physical properties, p. 60. Ceramic tests, p. 102, 104.

Possible uses: Face brick, structural tile, refractory, p. 108.

C. Ford Co. UPPER CRETACEOUS, DAKOTA ss, Janssen clay mem. SW 1/4 SW 1/4 sec 19, T 25 S, R 23 W. Analysts, R. Thompson and R. Runnels. Lab #F-3-2. Idem, p. 116, 123.

Siliceous fire clay, p. 109. Smooth, hard, very light gray to white; some limonite filling in root cavities. Thickness 5.4 ft. Physical properties, p. 60. Ceramic tests, p. 125, 128.

Possible use: Refractory, p. 130.

D. Franklin Co. PENNSYLVANIAN, STANTON ls, EUDORA sh mem. SW 1/4 SW 1/4 sec 6, T 17 S, R 19 E. Analyst, R. Runnels. Lab #48-311. Runnels, R., 1949, Kans GS B 82, pt 2, p. 42, 43, 44, 45.

Composite sample of phosphate-bearing shale from Ross Quarry.

Possible use: Agricultural fertilizer, p. 39, 47.

	A	B	C	D	Qualitative spectrographic analysis by A. C. Reed. Key to symbols, p. 45. (Higher numbers indicate greater abundance)	
SiO ₂	57.48	62.16	70.06	53.61		D
Al ₂ O ₃	27.03	22.71	17.80	16.86		
Fe ₂ O ₃	1.70	1.64	1.31	4.66		
MgO	1.02	1.80	1.55	2.41		
CaO	0.79	0.64	0.96	3.32		
Na ₂ O	}2.71	}2.20	}1.48	n.d.	B	5
K ₂ O				3.46	Na	6
TiO ₂	0.30	1.10	1.00	1.12 ^{c/}	V	6
P ₂ O ₅				0.86 ^{d/}	Cr	6
SO ₃				1.95	Mn	5
N				0.10	Cu	7
Ignit Loss	7.61	7.09	5.29	11.41	Zn	2
					Ag	2
Total	98.64 ^{a/}	99.34	99.45 ^{b/}	99.76		
Class	57,36,1	62,30,2	70,24,1	54,28,11		

a/ 99.41 (sic text)

b/ 99.46 (sic text)

c/ Gravimetric method used

d/ 0.81, p. 43

C Group

Kansas

A. Franklin Co. PENNSYLVANIAN, Pedee group, WESTON sh. Cen SW 1/4 sec 29, T 15 S, R 21 E. Analyst, R. Runnels. Lab #FR-6-AB. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Shale, mostly unoxidized, red and gray. 48.5 ft sampled out of 60.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24, and screen analysis, p. 30, of composite of #FR-6-AB and #FR-6-C.

Possible use: Lightweight aggregate, p. 68.

B. Franklin Co. PENNSYLVANIAN, Pedee group, WESTON sh. Cen SW 1/4 sec 29, T 15 S, R 21 E. Analyst, R. Runnels. Lab #FR-6-C. Idem.

Shale, mostly unoxidized, red and gray. 48.5 ft sampled out of 60.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24, and screen analysis, p. 30, of composite of #FR-6-AB and #FR-6-C.

Possible use: Lightweight aggregate, p. 68.

C. Hodgeman Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SE 1/4 SW 1/4 sec 24, T 22 S, R 22 W. Analysts, R. Thompson and R. Runnels. Lab #H-1-6. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 97, 101.

Plastic fire clay, p. 87. Fairly plastic, gray to black. Thickness 5.4 ft. Lower 2.5 ft contains some lignite. Physical properties, p. 60. Ceramic tests, p. 102, 105.

Possible uses: Face brick, structural tile, refractory, p. 108.

	A	B	C
SiO ₂	51.56	54.28	63.07
Al ₂ O ₃	22.50	21.90	23.91
Fe ₂ O ₃	8.21	8.28	1.61
MgO	2.27	1.96	0.30
CaO	1.09	0.65	0.39
Na ₂ O	0.59	0.67	)1.62
K ₂ O	3.54	3.69	
TiO ₂	1.27	1.01	2.46
P ₂ O ₅	0.22	0.13	
SO ₃	0.23	tr	
Ignit Loss	7.77	6.79	7.75
Total	99.25 <u>a/</u>	99.36 <u>b/</u>	101.11
Class	52,38,0	54,37,0	63,33,1

a/ 99.47 (sic text)

b/ 99.49 (sic text)

C Group

Kansas

A. Hodgeman Co. UPPER CRETACEOUS, GRANEROS sh and DAKOTA ss, Janssen clay mem. Cen SW 1/4 sec 8, T 23 S, R 22 W. Analysts, R. Thompson and R. Runnels. Lab #H-3-4. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 177, 180.

Graneros:- Clay-shale, very fine-grained, plastic, dark gray; some pyrite. Total thickness 3.8 ft.

Dakota:- Silt, friable, clayey, gray. Thickness 1.7 ft.

Ceramic tests, p. 181.

Possible uses: Lightweight aggregate, insulating and structural tiles and blocks, p. 182.

B. Johnson Co. PENNSYLVANIAN, KANSAS CITY group, Fontana-Wea sh. N line NE 1/4 NE 1/4 sec 21, T 13 S, R 25 E. Analyst, R. Runnels. Lab #JN-7. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Shale, mostly unoxidized, red and black. 37.0 ft sampled out of 37.0 ft available. Production of lightweight aggregate in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Floating results, p. 34.

Possible use: Lightweight aggregate, p. 68.

C. Johnson Co. PLEISTOCENE, SANBORN fm. SE 1/4 sec 34, T 11 S, R 23 E. Analyst, R. Runnels. Lab #JN-1A. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 82, 83.

Clay, 30 ft thick. Channel sample from prospecting hole. Firing and physical properties of ceramic slag, p. 83.

Possible uses: Railroad ballast, concrete aggregate, p. 96.

	A	B	C
SiO ₂	59.47	55.14	68.64
Al ₂ O ₃	19.90	21.05	16.28
Fe ₂ O ₃	4.30	7.59	4.15
MgO	1.97	2.12	1.58
CaO	0.99	1.32	2.17
Na ₂ O	)1.03	1.08	n.d.
K ₂ O		3.56	n.d.
TiO ₂	1.08	1.47	1.21
P ₂ O ₅		0.22	n.d.
MnO			0.98
SO ₃		0.22	n.d.
Ignit Loss	10.62	6.90	5.66
Total	99.36	100.67 ^{a/}	100.67 ^{b/}
Class	59,32,6	55,36,0	69,26,1

^{a/} 100.60 (sic text)

^{b/} 100.72 (sic text)

C Group

Kansas

A-C: Labette Co. PENNSYLVANIAN. Analyst, R. Runnels. Runnels, R. T., 1949, Kans GS B 82, pt 2.

Possible use: Agricultural fertilizer, p. 39, 47.

A. Little $\frac{1}{4}$ Anna sh mem. NE $\frac{1}{4}$ sec 16, T 33 S, R 21 E. Lab #48-220. Idem, p. 42, 44, 45.

Shale. Composite sample from bed 2 ft thick.

B. PLEASANTON group. SE $\frac{1}{4}$ sec 17, T 32 S, R 19 E. Lab #48-219. Idem, p. 42, 44.

Shale. Spot sample 15 ft from top of 29 ft bed.

C. PLEASANTON group. SE $\frac{1}{4}$ sec 17, T 32 S, R 19 E. Lab #48-224. Idem, p. 42, 43, 44, 45.

Shale, composite sample 6 ft thick, taken 18 ft from top of bed 29 ft thick.

$\frac{1}{4}$ Presumably same as PANNEE ls, Anna sh mem, Moore, R. C., 1949, Kans GS B 83, p. 56.

	A	B	C
SiO ₂	47.79	55.97	52.96
Al ₂ O ₃	14.44	15.72	12.43
Fe ₂ O ₃	3.37	4.30	4.19
MgO	1.64	1.74	1.55
CaO	3.03	6.19	4.29
K ₂ O	n.d.	n.d.	2.07
TiO ₂ <u>a/</u>	1.00	1.18	0.85
P ₂ O ₅	1.29	0.09	3.20
SO ₃	0.39	0.96	0.55
N	n.d.	n.d.	0.20
Ignit Loss	21.42 <u>b/</u>	10.74	18.00
Total	94.37	96.89	100.09
Class	48,35,9	56,25,12	53,30,11

a/ Gravimetric method used

b/ 1400 - 1000°C

Qualitative spectrographic analyses by A. C. Reed.

Key to symbols, p. 45. (Higher numbers indicate greater abundance)

	A	A <u>c/</u>	B <u>c/</u>	C
B	-	6	6	6
Na	5	-	-	-
K	8	-	-	-
V	8	6	6	7
Cr	9	8	8	9
Mn	5	6	10	8
Cu	6	7	7	8
Zn	5	3	5	5
Zr	5	2	5	4
Mo	-	2	2	5
Ag	4	4	2	5
Pb	-	5	4	4

c/ High purity graphite electrodes

C Group

Kansas

A. Lane Co. Pliocene, OGALLALA fm. SW 1/4 NW 1/4 sec 23, T 16 S, R 27 W. Analyst, R. Runnels. Lab #LE-1. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 50.

Shale, thickness 8 ft. Floating results, p. 45.
Possible use: Lightweight aggregate, p. 95.

B. Leavenworth Co. PENNSYLVANIAN, LANSING group, VILAS sh. NW 1/4 NE 1/4 sec 19, T 9 S, R 23 E. Analyst, R. Runnels. Lab #LV-5. Idem, p. 20, 24.

Shale, unoxidized, dark gray. 20.0 ft sampled out of 24.0 ft available.
Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Floating results, p. 34.
Possible use: Lightweight aggregate, p. 95.

C. Leavenworth Co. PENNSYLVANIAN, Pedee group, WESTON sh. Cen E line sec 35, T 9 S, R 22 E. Analyst, R. Runnels. Lab #LV-4. Idem.

Shale, mostly unoxidized, gray. 30.0 ft sampled out of 30.0 ft available.
Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Floating results, p. 34.
Possible use: Lightweight aggregate, p. 95.

D. Leavenworth Co. No stratigraphic position and no locality given. Analyst, R. Runnels. Lab #LW-1. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74.

Use: Production of ceramic slag, p. 74.

	A	B	C	D
SiO ₂	60.26	55.25	61.54	68.31
Al ₂ O ₃	18.35	17.92	18.52	13.91
Fe ₂ O ₃	5.45	5.48	6.54	5.26
MgO	3.40	2.08	1.75	0.98
CaO	1.07	4.55	0.41	0.44
Na ₂ O	0.63	0.92	0.79	n.d.
K ₂ O	2.98	3.01	2.97	n.d.
TiO ₂	1.42	0.99	1.36	0.93
P ₂ O ₅	0.17	0.11	0.18	n.d.
SO ₃	tr	0.19	tr	n.d.
Ignit Loss	6.27	8.97	5.89	4.18
Total	100.00	99.47 ^{a/}	99.95	94.01
Class	60,30,1	55,29,7	62,31,0	68,24,0

^{a/} 99.77 (sic text)

C Group

Kansas

A-E: Lincoln Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. Analysts, R. Thompson and R. Rummals. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67. Physical properties, p. 60.

A. SE 1/4 sec 1, T 11 S, R 6 W. Lab #L-6-6. Idem, p. 116, 123. Siliceous fire clay, p. 109. Thickness 8.2 ft. 0.7 ft silty, rest plastic, light gray to dark gray, some yellow stains on joints; lignite fragments in bottom 2 ft. Ceramic tests, p. 125, 128. Possible use: Refractory, p. 130.

B. SE 1/4 sec 1, T 11 S, R 6 W. Lab #L-6-11. Idem, p. 98, 101. Plastic fire clay. Thickness 8.0 ft. Upper 3.5 ft plastic, light gray, slight yellow stain; lower 4.5 ft very tough plastic, dark gray, no stain. Abundant lignitized fossil leaves. Ceramic tests, p. 102, 105. Possible uses: Face brick, structural tile, refractory, p. 108.

C. SE 1/4 sec 1, T 11 S, R 6 W. Lab #L-6-13. Idem, p. 116, 123. Siliceous fire clay. Thickness 3 ft. Plastic, gray clay, no stain; small lenses of lignite. Ceramic tests, p. 125, 128. Possible use: Refractory, p. 130.

D. NW 1/4 NW 1/4 sec 10, T 13 S, R 7 W. Lab #L-10-01. Idem, p. 118, 123. Siliceous fire clay. Thickness 12.4 ft. Silty, gray to light gray; lignite and some pyrite in bottom 1.0 ft. Ceramic tests, p. 125, 128. Possible use: Refractory, p. 130.

E. NE 1/4 sec 19, T 12 S, R 10 W. Lab #L-38-5. Idem, p. 70, 79. Ball clay. Thickness 7.2 ft. Plastic, light gray, very little yellow stain; slight amount of sulfur yellow on joints; lignite particles and lignitized fossil leaves. Ceramic tests, p. 83. Possible uses: Manufacturing refractories, structural units, p. 70.

	A	B	C	D	E
SiO ₂	70.00	68.97	71.03	71.60	62.96
Al ₂ O ₃	16.77	19.96	19.22	18.15	25.25
Fe ₂ O ₃	1.58	0.59	0.69	1.35	0.96
MgO	1.26	1.04	0.49	1.00	0.48
CaO	0.64	0.72	0.55	0.50	0.44
Na ₂ O	}2.15		}0.18	}1.10	}1.71
K ₂ O					
TiO ₂	1.71	0.48	0.72	1.00	0.57
Ignit Loss	6.03	5.54	6.71	5.30	6.79
Total	100.14	97.30	99.59	100.00	99.16
Class	70,23,3	69,26,1	71,26,2	72,24,1	63,33,1

C Group

Kansas

A-E: Lincoln Co. UPPER CRETACEOUS, DAKOTA ss.

A. Janssen clay mem. SW 1/4 NW 1/4 sec 18, T 13 S, R 10 W. Analysts, R. Thompson and R. Runnels. Lab #L-39-1. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 101, 118.

Clay. Upper 1.5 ft silty, lignitic, pinkish gray, yellow bands. Lower 2.1 ft, plastic, very light gray, streaks of lignitic silt. Physical properties, p. 60.

Possible use: Refractory, p. 130.

B. Janssen clay mem. SW 1/4 NW 1/4 sec 18, T 13 S, R 10 W. Analysts, R. Thompson and R. Runnels. Lab #L-39-2. Idem.

Clay, plastic, gray, very little stain, 5.3 ft. Plastic, dark gray to nearly black; some lignite, 2.5 ft. Physical properties, p. 60. Ceramic tests, p. 102, 105.

Possible use: Refractory, p. 130.

C. Janssen clay mem. SW 1/4 NW 1/4 sec 18, T 13 S, R 10 W. Analysts, R. Thompson and R. Runnels. Lab #L-39-3. Idem.

Clay, silty to very silty, gray, slight yellow stain. Thickness 4.5 ft. Physical properties, p. 60. Ceramic tests, p. 102, 105.

Possible use: Refractory, p. 130.

D. Janssen clay mem. SW 1/4 NW 1/4 sec 18, T 13 S, R 10 W. Analysts, R. Thompson and R. Runnels. Lab #L-39-A. Idem.

Clay. Thickness 15.9 ft. Silty to plastic, light gray to dark gray, some lignite. Ceramic tests, p. 102, 106. Physical properties, p. 60.

Possible use: Refractory, p. 130.

E. SW 1/4 NW 1/4 sec 36, T 11 S, R 7 W. Analyst, R. Runnels. Lab #L-4-C. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Clay, 14.2 ft sampled out of a possible 20.0 ft available. Unoxidized, dark gray. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 31. Bloating results, p. 39.

Possible use: Lightweight aggregate.

	A	B	C	D	E
SiO ₂	68.40	65.91	67.04	66.75	59.64
Al ₂ O ₃	20.60	22.91	22.43	22.26	17.98
Fe ₂ O ₃	1.11	0.73	0.65	0.79	8.14
MgO	0.90	0.85	1.06	0.92	2.09
CaO	0.75	0.93	0.83	0.87	0.94
Na ₂ O	}1.50	}0.20	}0.76	}0.66	0.29
K ₂ O					1.93
TiO ₂	0.70	0.35	0.33	0.45	2.36
P ₂ O ₅					0.04
SO ₃					0.21
Ignit Loss	6.00	8.16	6.86	7.30	6.69
Total	99.96	100.04	99.96 a/	100.00	100.31 b/
Class	68,27,1	66,30,3	67,29,2	67,29,3	60,33,0

a/ 99.13 (sic text)

b/ 100.30 (sic text)

C Group

Kansas

A. Linn Co. PENNSYLVANIAN, PLEASANTON group. NE 1/4 SW 1/4 sec 18, T 22 S, R 24 E. Analyst, R. Runnels. Lab #LN-1-1 & 2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Shale, outcrop partially oxidized, red and gray. 42.5 ft sampled out of 42.5 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 25. Screen analysis, p. 30. Floating results, p. 34.

Possible use: Lightweight aggregate, p. 95.

B. Logan Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.

Silt. Depth below top of section, 12 ft. Plastic and dry properties, p. 88. Fired properties, p. 97.

Possible use: Ceramic slag.

C. Logan Co. PLEISTOCENE, SANBORN fm. Bignell silt mem. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Idem.

Silt. Depth below top of section, 6 ft. Plastic and dry properties, p. 88. Fired properties, p. 97.

Possible use: Ceramic slag, p. 83.

D. Lyon Co. PENNSYLVANIAN, WABAUNSEE group, Langdon sh. SE 1/4 sec 35, T 17 S, R 12 E. Analyst, R. Runnels. Lab #LY-22. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 78, 79.

Shale. Channel sample, 5 ft thick. Firing and physical properties of ceramic slag, p. 78, 79.

Suggested use: Ceramic slag.

	A	B	C	D	Qualitative spectrographic analysis by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance)	
SiO ₂	61.91	65.37	67.78	58.81		
Al ₂ O ₃	17.70	12.00	12.55	) 29.39		
Fe ₂ O ₃	5.43	3.41	3.47			
MgO	1.62	1.89	1.64	2.11		
CaO	0.50	5.88	4.35	0.94		
Na ₂ O	n.d.	1.14 <u>b/</u>	1.41 <u>b/</u>	n.d.		B
K ₂ O	n.d.	2.78	2.78	n.d.	V	4
TiO ₂	1.74	0.83	0.58		Mn	7
P ₂ O ₅	0.34	tr	tr	tr	Zr	6
SO ₃		0.05	0.05	n.d.	Ag	2
Ignit Loss	5.15	6.60	5.34	5.17		
H ₂ O- <u>a/</u>		(0.73)	(0.90)			
Total	94.39	99.95	99.95	96.42		
Class	62,28,0	65,19,6	68,20,3	59,35,0		

a/ Below 105° to 140°C, not included in total.

b/ By difference

C Group

Kansas

A. Lyon Co. PENNSYLVANIAN, WABAUNSEE group, Langdon sh. NE 1/4 SW 1/4 sec 35, T 17 S, R 12 E. Analyst, R. Runnels. Lab #LY-4. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 26, 27.

Shale, unoxidized, red and gray. 11.0 ft sampled out of 11.0 ft available. Production of lightweight aggregate in batch-type rotary kiln, p. 27. Screen analysis, p. 30. Bloating results, p. 35.

Possible use: Lightweight aggregate, p. 95.

B. Meade Co. PLIOCENE and PLEISTOCENE. No locality given. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 170, 171.

Volcanic ash. Generalized description of Kansas ash deposits, distribution, and production statistics, p. 171, 172, 173. Tonnage estimate, p. 174.

Use: Abrasive, p. 173, 174.

C. Mitchell Co. UPPER CRETACEOUS, CARLILE sh, BLUE HILL mem. NW 1/4 NW 1/4 sec 26, T 8 S, R 10 W. Analyst, R. Runnels. Lab #MT-1. Kans GS B 91, p. 21, 28.

Shale, 79.5 ft sampled out of 90.0 ft available. Unoxidized, pink and gray. Lightweight aggregate production in batch-type rotary kiln, p. 28. Bloating results, p. 43. Screen analysis, p. 30.

Possible use: Lightweight aggregate, p. 95.

D. Montgomery Co. PENNSYLVANIAN, PLEASANTON group, COFFEYVILLE fm. W 1/2 sec 2, T 35 S, R 16 E. Analyst, R. Runnels. Lab #MG-3. Idem, p. 20, 24.

Shale, unoxidized. Red and gray. 25.0 ft sampled out of 60.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 24. Screen analysis, p. 30. Bloating results, p. 35.

Possible use: Lightweight aggregate, p. 95.

	A	B	C	D
SiO ₂	55.74	72.40	66.06	57.09
Al ₂ O ₃	21.00	10.65	16.94	20.31
Fe ₂ O ₃	7.49	2.65	4.01	7.47
MgO	2.57	0.13	1.56	1.86
CaO	0.70	1.68	0.51	0.69
Na ₂ O	1.54		0.48	0.87
K ₂ O	3.77	4.82	3.04	2.44
TiO ₂	1.02		0.81	1.55
P ₂ O ₅	0.17		0.05	n.d.
SO ₃			0.04	0.10
S	nil			
Ignit Loss	5.97	9.60	6.40	6.83
Total	99.97 <u>a/</u>	101.93 <u>b/</u>	99.90 <u>c/</u>	99.21 <u>d/</u>
Class	56,34,0	72,21,3	66,26,2	57,35,0

a/ 100.14 (sic text)
b/ 96.93 (sic text)
c/ 99.81 (sic text)
d/ 99.31 (sic text)

C Group

Kansas

A. Montgomery Co. PENNSYLVANIAN, KANSAS CITY group, Bonner Springs sh. NE 1/4 SW 1/4 sec 7, T 31 S, R 16 E. Analyst, R. Runnels. Lab #MC-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Shale, unoxidized. Dark gray. 29.0 ft sampled out of 45.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 25. Screen analysis, p. 30. Floating results, p. 35.

Possible use: Lightweight aggregate, p. 95.

B. Montgomery Co. PENNSYLVANIAN, Pedee group, WESTON sh. N line SE 1/4 SW 1/4 sec 1, T 35 S, R 13 E. Analyst, R. Runnels. Lab #MC-1-1. Idem.

Shale, unoxidized. Dark gray. 27.0 ft sampled out of 70.0 ft available. Screen analysis, p. 31. Lightweight aggregate production in batch-type rotary kiln, p. 24. Floating results, p. 35.

Possible use: Lightweight aggregate, p. 95.

C. Montgomery Co. PENNSYLVANIAN, Pedee group, WESTON sh. N line SE 1/4 SW 1/4 sec 1, T 35 S, R 13 E. Analyst, R. Runnels. Lab #MC-1-2. Idem.

Shale, unoxidized. Dark gray. 29.0 ft sampled out of 45.0 ft available. Screen analysis, p. 30. Lightweight aggregate production in batch-type rotary kiln, p. 24. Floating results, p. 35.

Possible use: Lightweight aggregate, p. 95.

D. Montgomery Co. No stratigraphic position given. Town of Coffeyville. Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 56.

Shale.

Possible use: Cement material.

	A	B	C	D
SiO ₂	54.73	68.23	62.69	64.62
Al ₂ O ₃	17.90	14.72	17.61	} 21.82
Fe ₂ O ₃	8.05	5.89	6.62	
MgO	2.56	1.33	1.49	0.43
CaO	3.55	0.46	0.61	2.50
Na ₂ O	1.42	0.55	0.67	} 4.15
K ₂ O	3.07	2.52	2.95	
TiO ₂	0.87	1.54	1.20	
P ₂ O ₅	0.28	0.15	0.14	
H ₂ O-				} 5.01
H ₂ O+				
SO ₃	tr	nil	nil	
Ignit Loss	8.33	4.81	5.62	
Total	100.76	100.20	99.60	98.53
Class	55,32,4	68,25,0	63,30,0	65,27,3

C Group

Kansas

A. Norton Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. SW 1/4 NW 1/4 sec 26, T 2 S, R 23 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 89, 90.

Silt. Depth below top of section, 10.5 ft. Plastic and dry properties, p. 89, 90. Fired properties, p. 102.

Possible use: Brick and tile.

B. Osage Co. No stratigraphic position given. T 14 S, R 15 E, town of Carbondale. Saunders, W. H., 1896, reprint, Kans Acad Sci Trans, v 3, p. 99.

Fire clay. Beneath coal bed.

C. Osborne Co. UPPER CRETACEOUS, CARLILE sh, BLUE HILL mem. Cen SW 1/4 sec 12, T 7 S, R 15 W. Analyst, R. Runnels. Lab #OS-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Shale, unoxidized, red and gray. 59 ft sampled out of 100 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 30. Bloeting results, p. 44.

Possible use: Lightweight aggregate, p. 95.

D. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SW 1/4 SE 1/4 sec 5, T 9 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #O-6-3. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 70, 79.

Ball clay, plastic, light gray, very little stain; conchoidal fracture. Thickness 5.3 ft. Ceramic tests, p. 83. Physical properties, p. 60.

Possible use: Refractory, p. 81.

E. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. NW 1/4 NE 1/4 sec 8, T 9 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #O-38-4. Idem, p. 71, 79.

Ball clay, plastic, light gray, almost no stain; slickensides on small joints; some lignite particles. Thickness 6.2 ft. Ceramic tests, p. 81, 82, 83, 87. Physical properties, p. 60.

Possible use: Refractory, p. 81.

	A	B	C	D	E	Qualitative spectro- graphic analysis by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (High- er numbers indicate greater abundance)
SiO ₂	68.39	48.60	60.61	60.41	61.62	
Al ₂ O ₃	12.38	21.85	19.03	26.93 ^{e/}	26.46 ^{e/}	
Fe ₂ O ₃	3.56		4.50	1.41	1.12	
FeO		16.70				
MgO	1.79	0.35 ^{e/}	2.07	0.76	0.50	
CaO	3.32	2.80 ^{e/}	0.41	0.31	0.35	
Na ₂ O	1.75 ^{a/}		0.33	}2.25	}2.90	
K ₂ O	2.57		3.29			
TiO ₂	0.54		0.84			V 6
P ₂ O ₅	0.16		0.05			Cr 4
H ₂ O-	(0.67) ^{b/}	3.00 ^{d/}				Mn 7
SO ₃	0.05	4.70	0.04			Zr 7
Organic		2.00				
Ignit Loss	5.54		8.53	7.65	7.28	
Total	100.05	100.00	99.70	99.72	100.23 ^{f/}	
Class	68,20,3	49,44,0	61,29,5	60,35,1	62,34,1	

^{a/} By difference

^{b/} Below 105° to 140°C, not included in total

^{c/} Calculated from reported sulfate

^{d/} At 100°C

^{e/} Includes TiO₂

^{f/} 100.20 (sic text)

C Group

Kansas

A. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. $\frac{1}{2}$ NW 1/4 NW 1/4 sec 8, T 9 S, R 2 W. Analysts, R. Thompson and R. Runnels. Lab #0-38-4. Kinney, E. D., 1952, Kans GS B 96, pt 7, p. 305, 306.

Clay, kaolinitic type. Beneficiation tests, p. 308. Results of lime-sinter process, p. 312, 315.

Suggested use: Production of alumina, p. 303.

B. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss. NE 1/4 NW 1/4 sec 14, T 9 S, R 5 W. Analysts, R. Thompson and R. Runnels. Lab #0-4-C. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 119, 125.

Clay, composite sample. Total thickness 17 ft. Slightly silty to fairly plastic, gray, some yellow stain. Top 12 ft contains some lignite; bottom 5 ft shows small flinty concretions. Ceramic tests, p. 125, 129. Physical properties, p. 60.

Possible use: Refractory, p. 130.

C. Ottawa Co. UPPER CRETACEOUS, DAKOTA ss. NE 1/4 NW 1/4 sec 14, T 9 S, R 5 W. Analysts, R. Thompson and R. Runnels. Lab #0-4-16. Idem, p. 119, 123.

Clay, slightly silty, gray, some yellow stain; contains lignitized wood fragments; fracture conchoidal. Thickness 5.4 ft. Ceramic tests, p. 125, 129. Physical properties, p. 60.

Possible use: Refractory, p. 130.

D. Ottawa Co. No stratigraphic position given. No locality given. Analyst, R. Thompson. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 101, 102.

High-alumina clay. Mineral composition and tonnage estimate, p. 101, 102.

Possible use: Production of alumina, p. 99.

$\frac{1}{2}$ See Kans GS B 67, p. 71, 1947.

	A	B	C	D
SiO ₂	64.78	71.98	72.24	62.09
Al ₂ O ₃	22.24	17.15	17.51	27.45
Fe ₂ O ₃	1.58	1.55	1.56	0.58
MgO	0.66	0.58	0.73	
CaO	0.27	0.68	0.96	0.94
TiO ₂	1.32	0.98	0.53	
P ₂ O ₅	nil			
SO ₃	0.05			
Ignit Loss	7.49 ^{a/}	5.44	5.50	8.90
Total	98.39	98.36	99.03 ^{b/}	99.96
Class	65,30,2	72,23,2	72,24,2	62,36,2

^{a/} Between 140° and 1000°C

^{b/} 98.03 (sic text)

C Group

Kansas

A-D: Phillips Co. UPPER CRETACEOUS, presumably between PIERRE sh and NIOBRARA fm, p. 355. Analyst, R. Thompson.

Effect of immersion and swelling properties in H₂O, p. 364. Gelatin test, p. 365. Bleaching tests by contact method, p. 366. Density, grit on 250 mesh, acidity, color at 900°C, p. 373.

A. Sec 10, T 1 S, R 18 W. 1/3 mi W of Kans Highway 1. Kinney, E. D., 1942, Kans GS B 41, pt 10, p. 356, 358.

Alkali earth sub-bentonite, p. 363, green-gray. Lower part of deposit, thickness sampled, 1 1/2 ft. Molding sand tests on mixture, p. 372.

B. Sec 10, T 1 S, R 18 W. 1/3 mi W of Kans Highway 1. Idem, p. 356, 358, 375.

Alkali bentonite, p. 363, blue-gray. Middle part of deposit, thickness sampled, 1 ft. Tests in which bentonite added to high grade Georgia kaolin, both raw and calcined, p. 369.

Possible uses: Refractory ware, paper on soap filler, cosmetics, p. 375.

C. Sec 10, T 1 S, R 18 W. 1/3 mi W of Kans Highway 1. Idem, p. 355, 358.

Alkali earth sub-bentonite, p. 363, blue-gray. Upper part of deposit, thickness sampled 1 1/2 ft. Overburden 15 ft.

D. SE 1/4 sec 35, T 1 S. From roadside drainage ditch, 1 1/2 mi S of Long Island. Idem, p. 356, 358.

Alkali-earth bentonite, p. 363, light gray. Lower part of deposit; thickness sampled, 1 ft. Molding sand tests on mixtures, p. 372. Oil refined in bentonite after contact process of bleaching, p. 368.

	A	B	C	D
SiO ₂	57.25	51.60	51.92	66.44
Al ₂ O ₃	15.34	20.46	20.52	17.26
Fe ₂ O ₃	2.76	1.86	2.10	2.30
MgO	0.10	0.04	0.02	0.60
CaO	4.67	2.25	2.17	2.34
Na ₂ O)				
K ₂ O)	0.52	0.19	0.62	0.35
TiO ₂	0.03	0.02	0.02	0.01
H ₂ O- <u>a/</u>	8.4	13.6	12.2	6.1
SO ₃	0.99	1.10	0.84	1.00
Ignit Loss- <u>b/</u>	6.30	9.35	10.47	3.91
Total	96.36	100.47	100.88	100.31
Class	57,29,6	52,43,4	52,44,4	66,27,5

a/ 105°C

b/ Loss on ignition minus hygroscopic H₂O

C Group

Kansas

A-D: Phillips Co. UPPER CRETACEOUS, presumably between PIERRE sh and NIOBRARA fm, p. 355. Analyst, R. Thompson.

Effect of immersion and swelling properties in H₂O, p. 364. Gelatin test, p. 365. Bleaching tests by contact method, p. 366. Density, grit on 250 mesh, acidity, color at 900°C, p. 373.

A. SE 1/4 sec 35, T 1 S, R 20 W. From roadside drainage ditch, 1 1/2 mi S of Long Island. Kinney, E. D., 1942, Kans GS B 41, pt 10, p. 356.

Clay, green-gray. Middle part of deposit, thickness sampled, 2 ft.

B. SE 1/4 sec 35, T 1 S, R 20 W. From roadside drainage ditch, 1 1/2 mi S of Long Island. Idem, p. 356, 358, 375.

Alkali earth sub-bentonite, p. 363, green-gray. Upper part of deposit; thickness sampled, 1 ft. Overburden, 5 ft. Oil refined in bentonite after contact process of bleaching, p. 368.

Possible uses: Clarifying dry cleaner fluids, de-inking newsprint, p. 375.

C. SE 1/4 sec 35, T 1 S, R 20 W. 1/3 mi W of highway. Idem, p. 356, 358, 375. Sub-bentonite, p. 363, very light yellow-gray. Bottom of deposit; thickness sampled, 0.66 ft.

Possible use: Soap, p. 375.

D. SE 1/4 sec 35, T 1 S, R 20 W. 1/3 mi W of highway. Idem.

Alkali bentonite, p. 363, light greenish gray. Upper part of deposit; thickness sampled 3 1/2 ft. Tests in which bentonite added to high grade Georgia kaolin, both raw and calcined, p. 369. Molding sand tests on mixture, p. 372.

Possible use: Bonding agent, p. 375.

	A	B	C	D
SiO ₂	59.34	61.35	52.36	53.39
Al ₂ O ₃	16.45	17.47	18.82	18.15
Fe ₂ O ₃	4.16	2.90	3.16	4.05
MgO	0.05	0.09	0.45	0.13
CaO	2.59	1.87	1.98	5.15
Na ₂ O		}1.54		}1.80
K ₂ O				
TiO ₂	0.03	0.02	0.02	0.03
H ₂ O- <u>a/</u>	6.0	6.0	12.9	9.0
SO ₃	1.87	0.93	0.90	0.34
Ignit Loss _{b/}	8.65	8.18	9.58	7.02
Total	99.14	100.35	100.17	99.06
Class	59,33,5	61,33,4	52,42,4	53,34,9

a/ 105°C

b/ Loss on ignition minus hygroscopic H₂O

C Group

Kansas

A. Phillips Co. UPPER CRETACEOUS, PIERRE sh. SW 1/4 NE 1/4 sec 10, T 1 S, R 18 W. Analyst, R. Runnels. Lab #PH-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Shale, unoxidized, light gray. 20 ft sampled out of 20 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 30. Bloating results, p. 45.

Possible use: Lightweight aggregate, p. 95.

B. Phillips and Wallace Counties. UPPER CRETACEOUS and PLEISTOCENE; in Phillips Co, bentonite at boundary between NIOBRARA fm and PIERRE sh; in Wallace Co, bentonite in OGALLALA fm. Analyst, E. Kinney. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 123.

Clay. Average chemical composition of ten bentonites.

Possible uses: Drilling mud, bleaching oil, bonding material for foundry sand, p. 122.

C. Pottawatomie Co. PENNSYLVANIAN, WABAUNSEE group, Harveyville sh. SW 1/4 NE 1/4 sec 13, T 10 S, R 9 E. Analyst, R. Runnels. Lab #PT-1. Kans GS B 91, p. 20, 26.

Shale, partly oxidized, black. 15.0 ft sampled out of 20.0 ft available. Production of lightweight aggregate in batch-type rotary kiln, p. 26. Screen analysis, p. 31. Bloating results, p. 36.

Possible use: Lightweight aggregate, p. 95.

D. Rawlins Co. PLEISTOCENE, OGALLALA fm. NW 1/4 NW 1/4 sec 33, T 3 S, R 34 W. Analyst, R. Runnels. Lab #RWV-3. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.

Volcanic ash. Thickness, 6.0 ft. Extends 0.3 mi to E and N, p. 62. Screen analysis of upper and lower beds, p. 25.

Possible uses: Abrasive, ceramics, enamels, lightweight aggregate, concrete, p. 30-40.

	A	B	C	D
SiO ₂	61.52	54.72	57.32	67.48
Al ₂ O ₃	21.47	18.58	15.89	10.73
Fe ₂ O ₃	2.56	2.77	6.04	1.91
MgO	0.06	0.38	2.28	0.30
CaO	3.46	3.50	5.12	5.10
Na ₂ O	0.50	)0.82	1.04	)1.71 <u>d/</u>
K ₂ O	1.11		2.99	)4.56
TiO ₂	0.03	0.01	1.20	0.54
P ₂ O ₅	n.d.		0.20	<0.10
SO ₃	n.d.	1.00	tr	tr
Ignit Loss	8.71	17.10 <u>b/</u>	8.03	7.67
H ₂ O- <u>a/</u>		(0.89)		
Total	99.42	98.88 <u>c/</u>	100.11	<100.10
Class	62,30,6	55,35,7	57,27,5	67,16,10

a/ Lost at 105°C, not included in total

b/ At 900°C

c/ 98.96 (sic text)

d/ By difference, ratio from spectro

C Group

Kansas

A. Reno Co. PLEISTOCENE, SANBORN fm, post-Loveland silt mem. NW 1/4 SW 1/4 sec 17, T 22 S, R 4 W. Analyst, R. Runnels. Lab #9. Frye, J. C., and Fent, O. S., 1947, Kans GS B 70, pt 3, p. 38, 39.

Silt, NR cut, 4 ft below surface. Solubility in HCl, 16.2 %. Mechanical analysis of acid insoluble fraction of sample, p. 38.

B. Republic Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. Cen W 1/2 sec 11, T 4 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #RP-8-2. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 159, 165.

Clay, total thickness 21.9 ft, sectioned as follows:

Silty, buff and gray, top 2.4 ft.

Slightly silty, yellow, gray and brownish red to red mottled, middle 6.8 ft.

Slightly silty, light gray with pinkish red, yellow and some lavender mottling, bottom 12.7 ft.

Ceramic tests, p. 166, 167.

Possible use: Refractory, p. 168.

C. Republic Co. UPPER CRETACEOUS, GRANEROS sh. NE 1/4 NW 1/4 sec 34, T 3 S, R 1 W. Analysts, R. Thompson and R. Runnels. Lab #RP-7-3. Idem, p. 179, 180.

Clay-shale, gray to dark gray, some silty partings, yellow limonitic streaks. Thickness 9.3 ft. Ceramic tests, p. 181.

Suggested use: A usable red-firing clay. (If combined with some of the silty beds immediately below might produce a good dark buff-firing clay.)

D. Rice Co. LOWER CRETACEOUS, KIOWA sh. NW 1/4 SE 1/4 sec 3, T 18 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #RE-2-1. Idem, p. 171, 174.

Shale, total thickness 8.8 ft. Upper 6.8 ft; clay to clay-shale, plastic, gray, some yellow stain, contains three thin bands of concretionary limonite and some gypsum crystals. Lower 2 ft; clay-shale, plastic, dark gray; contains large crystals of selenite and some pyrite. Ceramic tests, p. 175.

	A	B	C	D
SiO ₂	68.61	62.00	59.83	59.66
Al ₂ O ₃		20.19	21.02	19.44
Fe ₂ O ₃		5.46	6.07	3.18
R ₂ O ₃	19.72			
MgO		0.55	0.38	3.02
CaO	0.96	0.41	1.82	1.35
Na ₂ O		}2.41	}1.57	}4.25
K ₂ O				
TiO ₂		2.86	1.16	1.97
Ignit Loss	3.64 <u>a/</u>	6.50	7.83	7.58
Total	92.93	100.38 <u>b/</u>	99.68 <u>c/</u>	100.45 <u>d/</u>
Class	69,23,0	62,32,2	60,34,2	60,28,4

a/ After drying to 140°C

b/ 100.47 (sic text)

c/ 100.12 (sic text)

d/ 100.43 (sic text)

C Group

Kansas

A. Russell Co. UPPER CRETACEOUS, DAKOTA ss Janssen clay mem. NE 1/4 NW 1/4 sec 25, T 12 S, R 11 W. Analysts, R. Thompson and R. Runnels. Lab #R-6-5. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 158, 165.

Clay, plastic, gray to dark gray, small amount of fine red mottling; small selenite crystals. Thickness 11.2 ft. Upper 7 ft also contains some yellow mottling. Ceramic tests, p. 166, 167.

Possible use: Refractory, p. 168.

B. Russell Co. UPPER CRETACEOUS, DAKOTA ss, Janssen clay mem. NE 1/4 NW 1/4 sec 25, T 12 S, R 11 W. Analysts, R. Thompson and R. Runnels. Lab #R-6-9. Idem, p. 72, 79.

Clay, plastic, dark gray to black, some sulfur yellow stain. Thickness 7.8 ft. Ceramic tests, p. 83. Physical properties, p. 60.

Possible use: Refractory, p. 81.

C. Russell Co. UPPER CRETACEOUS, DAKOTA ss, Janssen clay mem. NE 1/4 NW 1/4 sec 25, T 12 S, R 11 W. Analysts, R. Thompson and R. Runnels. Lab #R-6-11. Idem.

Clay, plastic, gray to dark gray; lignite particles. Thickness 3.9 ft. Ceramic tests, p. 83. Physical properties, p. 60.

Possible use: Refractory, p. 81.

D. Russell Co. UPPER CRETACEOUS, GRANEROS sh. NW 1/4 NW 1/4 sec 35, T 12 S, R 14 W. Analyst, R. Runnels. Lab #R-15. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Shale, unoxidized red and gray. 14.0 ft sampled out of a possible 14.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 30. Bloating results, p. 39.

Possible use: Lightweight aggregate, p. 95.

	A	B	C	D
SiO ₂	58.65	61.81	61.94	55.30
Al ₂ O ₃	21.22	26.45 ^{a/}	25.48 ^{a/}	16.02
Fe ₂ O ₃	4.27	1.28	2.86	8.51
MgO	0.53	0.64	0.26	0.79
CaO	0.98	0.37	0.53	2.06
Na ₂ O)	2.40	1.98	2.03	2.18
K ₂ O)				
TiO ₂	3.91			0.59
P ₂ O ₅				0.24
SO ₃				4.70
Ignit Loss	7.55	8.97	7.68	10.70
Total	99.51	101.50 ^{b/}	100.78 ^{c/}	100.89
Class	59,32,3	62,36,2	62,35,1	55,33,5

^{a/} Includes TiO₂

^{b/} 101.40 (sic text)

^{c/} 100.68 (sic text)

C Group

Kansas

A. Saline Co. LOWER CRETACEOUS, KIOWA sh. NE 1/4 NE 1/4 sec 8, T 15 S, R 4 W. Analyst, R. Runnels. Lab #S-18. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 26.

Shale, unoxidized, pink and gray. 27.0 ft sampled out of a possible 27.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 39. Screen analysis, p. 30. Bloating results, p. 26.

Possible use: Lightweight aggregate, p. 95.

B. Saline Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. NW 1/4 SE 1/4 sec 18, T 15 S, R 5 W. Analysts, R. Thompson and R. Runnels. Lab #S-4-4. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 160, 165.

Clay, plastic. Total thickness 28.5 ft, sectioned as follows:

Gray and yellow, top 4 ft.

Yellow and red, 2 ft.

Gray with red mottling and slickensides on oblique joints, 7 ft.

Yellow, red mottling, 1.8 ft.

Gray, red mottling, 3.6 ft.

Red and yellow, 3.8 ft.

Silty, red and yellow, 1.0 ft.

Yellow, red and gray, bottom 5.3 ft.

Ceramic tests, p. 166, 167.

Possible use: Refractory, p. 168.

C. Scott Co. PLEISTOCENE, SANBORN fm. Sec 19, T 18 S, R 32 W. Analyst, R. Runnels. Lab #SC-1-A. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 82, 83.

Clay, sugar sample. Thickness 9 ft. Firing and physical properties of ceramic slag.

Possible uses: Excellent material for ceramic slag. Railroad ballast, concrete aggregate, p. 95.

D. Shawnee Co. PENNSYLVANIAN, SHAWNEE group, CALHOUN sh. Cen N 1/2 SW 1/4 sec 15, T 11 S, R 16 E. Analyst, R. Runnels. Lab #SH-2. Kans GS B 91, p. 20, 26.

Shale, unoxidized red and gray. 15.0 ft sampled out of 15.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 26. Screen analysis, p. 30. Bloating results, p. 36.

Possible use: Lightweight aggregate, p. 95.

	A	B	C	D
SiO ₂	60.56	67.83	61.98	57.45
Al ₂ O ₃	18.96	17.05 ^{b/}	12.02	20.75
Fe ₂ O ₃	5.86	3.23	3.44	6.48
MgO	1.84	0.80	2.18	2.07
CaO	1.37	0.71	9.05	0.82
Na ₂ O	0.11		n.d.	1.08
K ₂ O	2.32		n.d.	3.54
TiO ₂	1.09		0.63	1.37
P ₂ O ₅	0.12		n.d.	0.23
SO ₃	1.19		n.d.	tr
Ignit Loss	6.53	6.84	7.93	6.67

Total	99.95 ^{a/}	96.48	97.23 ^{c/}	100.46
Class	61, 31, 1	68, 26, 3	62, 19, 9	57, 34, 0

^{a/} 100.07 (sic text)

^{b/} Includes TiO₂

^{c/} 98.23 (sic text)

C Group

Kansas

A-E: Wallace Co. PLEISTOCENE, OYALLALA fm. Analyst, R. Thompson. Kinney, E. D., 1942, Kans GS B 41, pt 10.

Effect of immersion in water, p. 364. Swelling properties in water, p. 364. Results of gelatin test, p. 365.

A. SW 1/4 sec 19, T 12 S, R 41 W. Idem, p. 356, 358.

Alkali bentonite, p. 363. Pale olive-green; overburden, 0 to 20 ft. Thickness sampled 10 ft. Bleaching tests by intermittent-contact method, p. 367; percolation method, p. 368; contact method, p. 366. Density, grit on 250 mesh, acidity, color at 900°C, p. 373. Tests in which bentonite was added to high grade Georgia kaolin, both raw and calcined, p. 369. Molding sand tests on mixtures, p. 372. Oil refined in bentonite after contact process of bleaching, p. 368.

Suggested uses: Bleaching agent for oil, oil field drilling mud, de-inking, clarifying dry cleaner fluids, newsprint, p. 365.

B. NW 1/4 sec 29, T 12 S, R 41 W. Idem, p. 357, 358.

Bentonite, light brown. Thickness sampled, 5 ft., no overburden. Bleaching tests by contact method, p. 366.

C. SE 1/4 sec 2, T 12 S, R 42 W. 200 yds SW of draw 1/4 mi S from Roy C. Johnson ranch. Idem, p. 357, 358, 375.

Sub-bentonite, p. 363, pale gray-green. Thickness sampled, 5 ft., overburden, 20 ft. Bleaching tests by contact method, p. 366. Density, grit on 250 mesh, acidity, color at 900°C, p. 373. Molding sand tests on mixtures, p. 372. Oil refined in bentonite after contact process of bleaching, p. 368.

Suggested uses: Cement mixture, refractory ware, bond for foundry sand, p. 375.

D. SE 1/4 sec 2, T 12 S, R 42 W. 150 yds W of draw 1/4 mi S of Roy C. Johnson ranch. Idem, p. 357, 358.

Clay, sandy, pale gray-green. Thickness sampled, 5 ft.

E. NE 1/4 sec 12, T 12 S, R 42 W. From draw 1/2 mi W and 3/4 mi S of Woodhouse ranch. Idem.

Clay-shale, brownish gray. Thickness sampled, 4 ft., overburden 40 ft. Bleaching tests by contact method, p. 366. Density, grit on 250 mesh, acidity, color at 900°C, p. 373.

	A	B	C	D	E
SiO ₂	52.28	51.06	55.71	60.94	62.57
Al ₂ O ₃	20.20	17.09	21.55	18.79	19.31
Fe ₂ O ₃	3.20	1.81	3.31	2.52	2.61
MgO	0.49	2.51	0.16	0.71	1.80
CaO	2.04	6.15	1.32	1.39	0.94
Na ₂ O	) 0.27				
K ₂ O					
TiO ₂	0.01	tr	0.02	0.06	0.01
H ₂ O- a/	6.4	6.7	9.0	5.5	4.1
SO ₃	1.57	1.05	2.13	1.73	0.49
Ignit Loss ^{b/}	13.66	13.91	2.78	4.24	4.41
Total	100.12	100.28	95.98	95.88	96.24
Class	52,41,5	51,32,16	56,35,3	61,29,4	63,28,5

a/ 105°C

b/ Loss on ignition minus hygroscopic H₂O

C Group

Kansas

A. Wallace Co. FLEISTOCENE, SANBORN fm. T 13 S, R 40 W, town of Sharon Springs.
Analyst, J. Stadler of Lehigh Portland Cement Co, Iola, Kans. Elias, M. K., 1931,
Kans GS B 18, p. 180.
Loess.

	A
SiO ₂	63.33
Al ₂ O ₃	12.92
Fe ₂ O ₃	3.34
MgO	1.96
CaO	5.44
Ignit Loss	9.62
Total	96.61
Class	63,20,12

C Group

Kansas

A-D: Washington Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay man. Analysts, R. Thompson and R. Runnels. Plummer, Norman and Romary, J. E., 1947, Kans GS B 67.

A. NE 1/4 NW 1/4 sec 13, T 5 S, R 1 E. Lab #W-57-A. Idem, p. 137, 139.

Composite of 8 measured beds. Total thickness, 23.7 ft, sectioned as follows:

Clay, slightly silty, lignitic, dark gray, some yellow stain; top 2.5 ft.

Silt, yellow and gray, 2.2 ft.

Clay, fairly plastic, gray with 2 yellow streaks, each 0.3 ft thick; 4.2 ft.

Clay, fairly plastic, gray, slight yellow stain, 2.6 ft.

Clay, slightly silty, gray; lignite fragments and some selenite; 2.5 ft.

Clay, plastic, light gray, some yellow on slickenside joints; small amount of gypsum; 1.7 ft.

Clay, fairly plastic, gray, some yellow stain on joints; fragments of lignite and some gypsum; 3.3 ft.

Clay, silty to very silty, gray, some yellow in upper 1.9 ft; contains particles of lignite and some small selenite crystals; 4.7 ft.

Ceramic tests, p. 143.

Possible use: Refractory, p. 140.

B. SE 1/4 SE 1/4 sec 27, T 2 S, R 2 E. Lab #W-16-1. Idem, p. 162, 165.

Clay, fairly plastic, gray to light gray, some lavender with red mottling and some yellow on slickenside joints. Some red and lavender in fine-veined or dendritic pattern. Thickness 13.1 to 13.8 ft. Ceramic tests, p. 166, 167.

Possible use: Refractory, p. 168.

C. SE 1/4 SE 1/4 sec 1, T 3 S, R 2 E. Lab #W-1-1. Idem, p. 99, 101.

Plastic fire clay, slightly silty, dark gray, very little stain; breaks out in thin lens-shaped "shells" when excavated. Thickness 5.6 ft. Ceramic tests, p. 102, 106. Physical properties, p. 60.

Possible use: Face bricks, p. 98.

D. SE 1/4 SE 1/4 sec 1, T 3 S, R 2 E. Lab #W-1-2. Idem.

Plastic fire clay, gray, slight yellow stain; lignite particles; pronounced conchoidal fracture. Thickness 4.7 to 5.5 ft. Ceramic tests, p. 102, 106. Physical properties, p. 60.

Possible use: Face bricks, p. 98.

	A	B	C	D
SiO ₂	68.17	65.44	67.20	60.95
Al ₂ O ₃	17.10	21.05	18.70	24.09
Fe ₂ O ₃	2.14	3.54	2.20	2.54
MgO	0.64	2.17	1.60	1.17
CaO	0.35	0.78	0.70	0.65
Na ₂ O)				
K ₂ O)	3.71	0.60	1.00	1.76
TiO ₂	2.35	0.40	1.40	0.33
Ignit Loss	5.65	6.08	7.10	8.44
Total	100.11	100.06	99.90	99.93
Class	68,24,2	65,31,0	67,26,4	61,33,4

C Group

Kansas

A-F: Washington Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem.

A. SE 1/4 SE 1/4 sec 1, T 3 S, R 2 E. Analysts, R. Thompson and R. Runnels. Lab #W-1-B. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 122, 123. Siliceous fire clay, composite sample. Total thickness 20 ft. Slightly silty to plastic, gray, small yellow stain, some lignite particles. Ceramic tests, p. 125, 129. Physical properties, p. 60.

Possible use: Refractory, p. 130.

B. NW 1/4 SE 1/4 sec 14, T 1 S, R 3 E. Analysts, R. Thompson and R. Runnels. Lab #W-5-A. Idem, p. 73, 79.

Ball clay, very plastic to plastic, light gray, brown mottling. Thickness 16.6 ft. Composite sample. Ceramic tests, p. 82. Physical properties, p. 60.

Possible use: Refractory, p. 81.

C. NW 1/4 SE 1/4 sec 14, T 1 S, R 3 E. Analysts, R. Thompson and R. Runnels. Lab #W-5-5. Idem.

Ball clay, plastic, light gray, some yellow stain; some lignite. Thickness 4 ft. Ceramic tests, p. 81, 82, 87. Physical properties, p. 60.

Possible use: Refractory, p. 81.

D. SE 1/4 sec 14, T 1 S, R 3 E. Analysts, E. Kinney and R. Thompson. Lab #W-5. Plummer, Norman and Romary, J. F., 1942, Kans GS B 41, pt 9, p. 335.

Clay, partly thin-bedded, contains fossil leaves; overlain by light gray and red mottled clay that grades upward into highly hematitic clay; underlain by gray, silty, lignitic clay, p. 336. Ceramic tests p. 335.

E. Cen S 1/2 SW 1/4 sec 28, T 1 S, R 3 E. Analysts, R. Thompson and R. Runnels. Lab #W-19-2. Kans GS B 67, p. 74, 79, 1947.

Ball clay, fairly plastic, gray, some yellow stain; contains lignite particles. Thickness 7.4 ft. Ceramic tests, p. 82. Physical properties, p. 60.

Possible use: Refractory, p. 81.

F. Cen S 1/2 SW 1/4 sec 28, T 1 S, R 3 E. Analysts, R. Thompson and R. Runnels. Lab #W-19-3. Idem.

Ball clay, plastic, yellow stain from slight to heavy; some lignite particles. Thickness 11.2 ft. Ceramic tests, p. 82. Physical properties, p. 60.

Possible use: Refractory, p. 81.

	A	B	C	D	E	F
SiO ₂	71.53	59.76	62.02	59.88	66.95	56.74
Al ₂ O ₃	17.58	26.15	26.54 <u>b/</u>	30.90	21.57	25.24
Fe ₂ O ₃	1.69	2.18	1.52	1.69	1.05	2.06
MgO	1.00	1.35	0.65		0.19	1.37
CaO	0.71	1.27	0.39	0.24	0.36	0.54
Na ₂ O		}2.70	}3.19		}1.83	}3.42
K ₂ O						
TiO ₂	0.71	1.06			1.76	2.27
Ignit Loss	5.68	7.20	7.45	7.26	6.48	7.50
Total	98.90	101.67 <u>a/</u>	101.76	99.97	100.19	99.14
Class	72,24,2	60,35,0	62,35,1	60,40,0	67,29,1	57,34,1

a/ 99.67 (sic text)

b/ Includes TiO₂

C Group

Kansas

A. Washington Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SW 1/4 sec 28, T 1 S, R 3 E. Analyst, R. Thompson. Lab #W-19-A. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 101, 102.

High-alumina clay. Mineral composition and tonnage estimate, p. 101, 102.
Possible use: Production of alumina, p. 99.

B. Washington Co. UPPER CRETACEOUS, DAKOTA ss. No locality given. Analyst, R. Thompson. Idem.

High-alumina clay. Mineral composition and tonnage estimate, p. 101, 102.
Possible use: Production of alumina, p. 99.

C. Washington Co. UPPER CRETACEOUS, GRANEROS sh. SW 1/4 SW 1/4 sec 1, T 3 S, R 1 E. Analyst, R. Runnels. Lab #W-65. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Shale, unoxidized, gray. 7.0 ft sampled out of 17.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 30. Blasting results in electric kiln, p. 39.

Possible use: Lightweight aggregate, p. 95.

D. Wilson Co. PENNSYLVANIAN, LANE-Bonner Springs sh. T 30 S, R 15 E, town of Neodesha. Analysts, Lathbury and Sparkman. Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 50, 56. Schrader, F. C., and Haworth, Erasmus, 1906, USGS B 296, p. 56, 57.

Shale. Screen, physical tests, and fired properties of cement mixture, Kans GS Ann B for 1902, p. 51.

See analysis for Wilson Co, idem, p. 56; and for Neodesha, USGS B 296, p. 57. CaO, 8.87, water, 5.37.

Suggested use: Cement material when mixed with limestone.

E. Wilson Co. PENNSYLVANIAN, Bonner Springs sh (?). T 30 S, R 15 E, town of Neodesha. Kans GS Ann B for 1902, p. 56. Emmons, S. F., and Hayes, C. W., 1905, USGS B 260, p. 509.

Shale.

Possible use: Cement material when mixed with limestone.

	A	B	C	D	E
SiO ₂	60.70	59.88	59.02	50.80	61.80
Al ₂ O ₃	28.44	31.11	17.97	16.75	} 22.7
Fe ₂ O ₃	2.88	1.69	6.78	4.83	
MgO			1.64	2.19	0.22 a/
CaO	0.27	0.24	0.65	8.83	8.20
Na ₂ O			0.19		} tr
K ₂ O			2.72		
TiO ₂			1.51		
P ₂ O ₅			0.19		
H ₂ O-				} 5.37	} 7.50
H ₂ O+					
SO ₃			0.36	none	
Ignit Loss	7.33	7.20	8.97	12.24	
Total	99.62	100.12	100.00	101.01	100.42
Class	61,39,0	60,40,0	59,31,5	31,27,15	62,30,0

a/ Rounded off to two decimal places

C group

Kansas

A. Wilson Co. PENNSYLVANIAN, Pedee group, WESTON sh. NW 1/4 SW 1/4 sec 11, T 29 S, R 14 E. Analyst, R. Runnels. Lab #WL-1. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 26. Kinney, E. D., 1952, Kans GS B 96, pt 7, p. 305, 306.

Shale, mostly unoxidized, red. 32.0 ft sampled out of 100.0 ft available.

Lightweight aggregate production in batch-type rotary kiln, Kans GS B 91, p. 26.

Screen analysis, idem, p. 30. Floating results, idem, p. 36. Results of lime-sinter process, Kans GS B 96, pt 7, p. 312, 315.

Possible uses: Production of alumina, idem, p. 327. Lightweight aggregate, Kans GS B 91, p. 95.

B. Wilson Co. PENNSYLVANIAN, DOUGLAS group, LAWRENCE sh. NW 1/4 SW 1/4 sec 12, T 27 S, R 15 E. Analyst, R. Runnels. Lab #WL-2. Idem, p. 20, 26.

Shale, unoxidized, red, gray. 25.0 ft sampled. Lightweight aggregate production in batch-type rotary kiln, p. 26. Screen analysis, p. 30. Floating results, p. 36.

Possible use: Lightweight aggregate, p. 95.

C. Wyandotte Co. PENNSYLVANIAN, IOLA ls, Muncie Creek sh mem. Sec 12, T 11 S, R 24 E. Analyst, R. Runnels. Lab #48-98. Runnels, R. T., 1949, Kans GS B 82, pt 2, p. 42, 44.

Shale, 3 ft thick. Composite sample from upper part.

Possible use: Agricultural fertilizer, p. 39, 47.

	A	B	C
SiO ₂	55.94	60.04	48.78
Al ₂ O ₃	22.42	19.13	14.54
Fe ₂ O ₃	7.47	6.94	5.40
MgO	1.93	1.86	2.65
CaO	0.49	0.42	2.31
Na ₂ O	0.67	1.31	
K ₂ O	3.14	3.04	
TiO ₂	1.76	1.60	1.03 <u>e/</u>
P ₂ O ₃	0.20	0.18	0.92
SO ₃	tr	tr	0.49
Ignit Loss	7.40 <u>a/</u>	5.94 <u>a/</u>	20.12 <u>d/</u>
Total	101.42 <u>b/</u>	100.46	96.24
Class	56,37,0	60,32,0	49,35,10

Qualitative spectrographic analysis by A. C. Reed. High purity graphite electrodes. Key to symbols, p. 45. (Higher numbers indicate greater abundance)

	C
B	6
V	9
Cr	7
Mn	9
Cu	7
Zn	6
Zr	4
Mo	5
Ag	5
Pb	7

a/ 140° to 1000°C

b/ 100.60 (sic text)

c/ Gravimetric method used

d/ 1000°C

Group C, 90-

[SiO₂ < 75%; SiO₂ > (R₂O₃·nH₂O) > Carbonates; SiO₂ + (R₂O₃·nH₂O) + Carbonates < 90%]

Kansas

A. Allen Co. PENNSYLVANIAN, KANSAS CITY group, LANE-Benner Springs sh. NE 1/4 SW 1/4 sec 33, T 25 S, R 18 E. Analyst, R. Runnels. Lab #AL-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 24.

Analysis shows 4.7% alkalies and 1.1% TiO₂; also suggests some feldspar.

Shale, unoxidized, dark gray. Silty. 30.0 ft sampled out of 50.0 ft available. Production of lightweight aggregate in batch-type rotary kiln, p. 24. Screen analysis, p. 31. Bloating results in electric kiln, p. 32.

Possible use: Low-density aggregate, p. 55, 95.

B. Bourbon Co. PENNSYLVANIAN, CHEROKEE sh, shale above Bevier coal. SW 1/4 SE 1/4 sec 18, T 27 S, R 25 E. Analyst, R. Runnels. Lab #48-297. Runnels, R. T., 1949, Kans GS B 82, pt 2, p. 42, 44, 45.

Partial analysis shows 1.2% TiO₂ and suggests 1.8% gypsum.

Composite sample. 6 ft thick.

Possible use: Agricultural fertilizer, p. 39, 47.

C. Brown Co. PENNSYLVANIAN, WABAUNSEE group, WILLARD sh (upper). NE 1/4 SE 1/4 sec 36, T 4 S, R 17 E. Analyst, R. Runnels. Lab #BR-6. Kans GS B 91, p. 20, 26.

Analysis shows 5.0% alkalies and 1.3% TiO₂; also suggests some feldspar.

Shale, unoxidized, black. 16.0 ft sampled out of 30.0 ft available. Screen analysis, p. 30, 31. Production of lightweight aggregate in batch-type rotary kiln, p. 26, 27. Bloating results in electric kiln, p. 32.

Possible use: Lightweight aggregate, p. 62.

D. Crawford Co. PENNSYLVANIAN, FORT SCOTT ls, Little Osage sh mem. SE 1/4 sec 12, T 30 S, R 22 E, Stark Quarry. Analyst, R. Runnels. Lab #48-295. Kans GS B 82, pt 2, p. 42, 43, 44, 45.

Partial analysis suggests 5.5% phosphate and 2.7% gypsum.

Composite sample.

Possible use: Agricultural fertilizer, p. 39, 47.

	A	B	C	D	Qualitative spectrographic analyses by A. C. Reed. Key to symbols, p. 45. (Higher numbers indicate greater abundance)			
SiO ₂	53.99	51.03	54.51	44.13				
Al ₂ O ₃	16.21	21.63	15.19	13.79				
Fe ₂ O ₃	6.18	7.61	6.83	4.29				
MgO	1.72	2.25	2.23	1.87				
CaO	6.60	2.44	6.37	5.06				
Na ₂ O	0.80		1.89		B	B e/	D	D e/
K ₂ O	3.93		3.07		B	-	6	6
TiO ₂	1.09	1.20 b/	1.26	0.29 b/	Na	6	-	7
P ₂ O ₅	0.18	tr	0.26	2.08	K	7	-	6
SO ₃	0.22	0.84	0.10	1.24	V	6	6	7
Ignit Loss	9.20	8.45 s/	8.69	20.22 e/	Cr	5	3	7
					Mn	8	10	6
					Cu	5	7	6
Total	100.12 e/	95.45	100.40 d/	92.97	Zn	3	-	5
Class	54,28,8	51,37,2	55,28,7	44,32,13	Zr	4	-	3
					Mo	-	-	-
					Ag	-	-	4
					Pb	-	3	-

a/ 100.00 (sic text)

b/ Gravimetric method used

c/ 1000cc

d/ 100.35 (sic text)

e/ High purity graphite electrodes

Kansas

A. Hodgeman Co. UPPER CRETACEOUS, DAKOTA ss, Terra Cotta clay mem. SW 1/4 sec 24, T 22 S, R 22 W. Analysts, R. Thompson and R. Runnels. Lab #H-1-0. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 82.

Analysis shows 4.7% TiO₂ and 3.5% alkalies.

Clay, channel sample, 5-3 ft thick. Firing and physical properties of ceramic slag, p. 83.

Possible uses: Railroad ballast, concrete aggregate, p. 95.

B. Logan Co. UPPER CRETACEOUS, PIERRE sh. Cen S 1/2 sec 8, T 12 S, R 36 W. Analyst, R. Runnels. Lab #L-0-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 28.

Analysis shows 3.1% alkalies and 1.6% TiO₂; also suggests 15.3% gypsum.

Shale, unoxidized, pink and gray. 25 ft sampled out of 30 ft available.

Lightweight aggregate production in batch-type rotary kiln, p. 29. Bloating results, p. 45. Screen analysis, p. 30.

Possible use: Lightweight aggregate, p. 95.

C. Logan Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Frye, J. C., et al, 1949, Kans GS B 82, pt 3, p. 84, 86, 88.

Analysis suggests 4.3% alkalies and some feldspar.

Silt, depth below top of section, 21 ft. Plastic and dry properties, p. 88.

Fired properties, p. 97.

Possible use: Ceramic slag, p. 83.

D. Logan Co. PLEISTOCENE, SANBORN fm, Peoria silt mem. NE 1/4 sec 32, T 12 S, R 37 W. Analyst, R. Runnels. Idem.

Analysis shows 2.9% K₂O and 1.7% TiO₂; also suggests some feldspar.

Silt. Depth below top of section, 16 ft. Plastic and dry properties, p. 88.

Fired properties, p. 97.

Possible use: Ceramic slag.

E. McPherson Co. PERMIAN, WELLINGTON fm. SW 1/4 sec 8, T 18 S, R 3 W. Analyst, R. Runnels. Lab #MP-7. Kans GS B 76, pt 4, p. 74, 80, 81.

Analysis shows 5.8% alkalies and suggests some feldspar.

Shale, channel sample, 8 ft thick. Firing and physical properties of ceramic slag, p. 80, 81.

Suggested use: Good material for ceramic slag.

	A	B	C	D	E	Qualitative spectrographic analysis by A. C. Reed. Carbon electrodes. Key to symbols, p. 87. (Higher numbers indicate greater abundance)
SiO ₂	59.13	52.16	67.19	65.37	52.59	
Al ₂ O ₃	15.30	13.46	13.61	11.61	15.76	
Fe ₂ O ₃	9.48	7.41	3.55	3.10	1.96	
MgO	0.91	0.90	1.99	1.79	6.31	
CaO	0.48	4.36	3.76	5.85	5.63	
Na ₂ O	) 3.54	0.46	1.37 <u>c/</u>	1.45 <u>c/</u>	) 5.80	<u>c</u>
K ₂ O	) 3.54	2.60	2.94	2.89	) 5.80	v 5
TiO ₂	4.66	1.58	0.84	1.69	0.57	Cr 3
P ₂ O ₅	n.d.	0.23	tr	0.10	0.32	Mn 8
SO ₃	n.d.	7.10	tr	tr	n.d.	Zn 6
Ignit Loss	5.92	10.79	4.75	6.15	10.23	Zr 6
H ₂ O- <u>a/</u>			(0.97)	(0.86)		Ag 4
Total	99.42	101.05 <u>b/</u>	100.00	100.00	99.17	
Class	59,31,0	52,26,5	67,21,1	65,18,5	53,22,12	

a/ Below 105° to 140°C, not included in total b/ 99.94 (sic text) c/ By difference

Group C, 90-

Kansas

A. Marion Co. PERMIAN, WELLINGTON fm. SW 1/4 SE 1/4 sec 34, T 21 S, R 1 E. Analyst, R. Runnels. Lab #M-5. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 47.

Analysis shows 3.2% alkalis and 1.1% TiO₂; also suggests some feldspar. Shale, 14 ft sampled. Bloating results, p. 37. Possible use: Lightweight aggregate, p. 95.

B. Reno Co. PERMIAN, NINNESCAH sh. NW 1/4 sec 8, T 25 S, R 5 W. Analyst, R. Runnels. Lab #RO-1-1. Plummer, Norman and Hladik, W. B., 1948, Kans GS B 76, pt 4, p. 74, 80, 81.

Analysis shows 6.4% TiO₂ and 4.6% alkalis; also suggests some feldspar. Shale, channel sample, 3 ft thick. Firing and physical properties of ceramic slag, p. 80, 81. Possible use: Ceramic slag, p. 81.

C. Reno Co. PERMIAN, NINNESCAH sh. Sec 21, T 25 S, R 6 W. Analyst, R. Runnels. Lab #RO-2. Kans GS B 91, p. 21, 26.

Analysis shows 3.9% alkalis and suggests some feldspar. Shale, oxidized, gray. 11.3 ft sampled out of 30.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 26. Screen analysis, p. 31. Possible use: Lightweight aggregate, p. 95.

D. Reno Co. PERMIAN (?) NINNESCAH sh (?), p. 61. NW 1/4 sec 8, T 25 S, R 5 W, p. 61. Analyst, R. Runnels. Lab #RO-1-2. Kans GS B 76, pt 4, p. 61, 74.

Analysis shows 5.6% TiO₂ and 3.7% alkalis; also suggests some feldspar. Use: Ceramic slag, p. 74.

	A	B	C	D
SiO ₂	44.33	58.39	52.36	52.00
Al ₂ O ₃	13.68	9.67	15.81	17.04
Fe ₂ O ₃	5.05	4.72	7.03	6.23
MgO	9.66	6.38	9.14	6.83
CaO	7.86	5.16	3.10	2.40
Na ₂ O	0.67	)4.55	0.65	)3.69
K ₂ O	2.51		3.28	
TiO ₂	1.10	6.35	0.91	5.59
P ₂ O ₅	0.18	none	nil	none
MnO		sl tr		sl tr
SO ₃	tr	n.d.	n.d.	n.d.
Ignit Loss	14.09	6.55	7.72	6.66
Total	99.13	99.77	100.00	100.44 <u>a/</u>
Class	44,23,19	58,19,4	52,29,4	52,29,2

a/ 100.40 (sic text)

Group C, 90-

Kansas

A. Rice Co. PLEISTOCENE, SANBORN fm, Loveland (?) silt mem. NW 1/4 NW 1/4 sec 22, T 20 S, R 7 W. Analyst, R. Runnels. Frye, J. C., and Fent, O. S., 1947, Kans GS B 70, pt 3, p. 38, 39.

Partial analysis.

Auger sample, 7 ft below surface. Mechanical analysis of acid insoluble fraction, p. 38. Solubility in HCl, 15.1%.

B. Shawnee Co. PENNSYLVANIAN, WARAINSEE group, Harveyville sh. SW 1/4 SW 1/4 sec 30, T 11 S, R 14 E. Analyst, R. Runnels. Lab #SH-3. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 20, 26.

Analysis shows 5.5% alkalis and 1.1% TiO₂; also suggests some feldspar.

Shale, partially oxidized, black. 12.0 ft sampled out of 12.0 ft available. Production of lightweight aggregate in batch-type rotary kiln, p. 26. Screen analysis, p. 31. Bloating results, p. 36.

Possible use: Lightweight aggregate, p. 95.

C. Wallace Co. PLEISTOCENE, OGALLALA fm. SW 1/4 sec 19, T 12 S, R 41 W. Analyst, R. Thompson. Lab #WC-1. Idem, p. 21, 28.

Analysis shows 4.6% alkalis and suggests 1.3% phosphate and some feldspar.

Shale, unoxidized, red, brown. 10.0 ft sampled out of a possible 14.0 ft available. Lightweight aggregate production in batch-type rotary kiln, p. 28. Screen analysis, p. 31. Bloating results, p. 45.

D. Wyandotte Co. PENNSYLVANIAN, Cherryvale sh, Quivira mem. Sec 12, T 11 S, R 24 E. Analyst, R. Runnels. Lab #48-99. Runnels, R. T., 1949, Kans GS B 82, pt 2, p. 42, 43, 44.

Analysis shows 3.9% alkalis and suggests 4.5% phosphate.

Shale, 3 ft thick. Composite sample from upper part.

Possible use: Agricultural fertilizer, p. 39, 47.

	A	B	C	D	Qualitative spectrographic analysis by A. C. Reed. Key to symbols, p. 45. (Higher numbers indicate greater abundance)
SiO ₂	65.38	59.30	54.90	61.21	
Al ₂ O ₃		16.73	13.63	18.91	
Fe ₂ O ₃		5.10	5.97	3.98	
R ₂ O ₃	18.52				
MgO		2.63	3.43	2.19	D
CaO	3.94	3.56	7.06	2.50	
Na ₂ O		1.98	0.54		B 5
K ₂ O		3.51	4.10	3.87	Na 7
TiO ₂		1.10	0.64	0.86 d/	V 10
P ₂ O ₅		0.21	0.48	1.65 e/	Cr 8
SO ₃		tr	0.12	0.13	Mn 4
Ignit Loss	5.24 a/	6.85	9.09	5.46 f/	Cu 6
Total	93.08 b/	100.97 c/	99.96	100.76	Zn 6
Class	65,23,1	59,27,3	55,25,9	61,28,0	Ag 6

a/ Determined after drying to 140°C

b/ 93.09 (sic text)

c/ 100.54 (sic text)

d/ Gravimetric method used

e/ 1.64, p. 43

f/ 1000°C

D Group, $[SiO_2 < 75\%; SiO_2 > \text{Carbonates} > (R_2O_3 \cdot nH_2O)]$

Kansas

A-F: Analyzed in lab of Corps of Engineers, Kansas City Mo. Swinford, Ada, 1947, Kans GS B 70, pt 4, p. 90, 91.

A. Ellsworth Co. LOWER CRETACEOUS, KIOWA sh. SE 1/4 sec 19, T 16 S, R 6 W. Lab #8973.

Calcareous sandstone. Sample from ledge. Solubility in HCl, 34.04%. Physical tests, p. 90. Tonnage estimate, p. 97.

Use: Dam construction, p. 97. Possible use: Concrete aggregate, p. 93.

B. Ellsworth Co. LOWER CRETACEOUS, KIOWA sh. SE 1/4 sec 19, T 16 S, R 6 W. Lab #12709.

Calcareous sandstone. Sample of rock dust from crusher. Solubility in HCl, 32.00%. Physical tests, p. 90. Tonnage estimate, p. 97.

C. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Sec 6, T 12 S, R 7 W. Lab #6128.

Calcareous sandstone. Physical tests on ledge rock, p. 90.

Possible use: Concrete aggregate, p. 93.

D. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Sec 6, T 12 S, R 7 W. Lab #9819.

Calcareous sandstone. Physical tests on sample of crushed rock, p. 90.

Possible use: Concrete aggregate, p. 93.

E. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Sec 6, T 12 S, R 7 W. Lab #9820.

Calcareous sandstone. Physical tests, p. 90.

Possible use: Concrete aggregate, p. 93.

F. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Sec 6, T 12 S, R 7 W. Lab #247711.

Calcareous sandstone. Physical tests, p. 90.

Possible use: Concrete aggregate, p. 93.

	A	B	C	D	E	F
SiO ₂	62.42	65.12	61.10	63.50	62.70	60.62
Al ₂ O ₃	1.12	1.34	1.32	1.86	1.84	0.03
Fe ₂ O ₃	0.16	1.34	0.50	0.64	0.42	1.48
MgO	0.60	1.05	0.87	0.37	0.37	0.00
CaO	19.18	17.06	19.92	18.08	18.22	21.24
H ₂ O-						0.04
SO ₃		0.07	0.09	0.00	0.00	0.00
Ignit Loss	16.20	12.65	15.68	15.20	16.00	16.31
Total	99.68	98.63	99.48	99.65	99.55	99.72
Class	62,2,36	65,3,27	61,2,34	64,3,33	63,4,33	61,2,37

D Group

Kansas

A-E: Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Swineford, Ada, 1947, Kans GS B 70, pt 4.

Calcareous sandstone.

Possible use: Concrete aggregate, p. 93.

A. NE 1/4 sec 12, T 12 S, R 8 W. Analyzed in lab of Corps of Engineers, Kansas City, Mo. Lab #23934. Idem, p. 90, 91.

Sample from ledge rock. Sol in HCl, 34.91%. Physical tests, p. 90. Bulk density, 2.63.

B. NE 1/4 sec 12, T 12 S, R 8 W. Analyzed in lab of Corps of Engineers. Lab #247717. Idem.

Sample from ledge rock. Sol in HCl, 37.54%. Physical tests, p. 90.

C. NE 1/4 sec 12, T 12 S, R 8 W. Analyzed in lab of Corps of Engineers. Lab #9819. Idem.

Occurs in lentils in secs 12, 13, 14, 23, and 24, T 12 S, R 8 W, p. 98. Sol in HCl, 35.27%. Bulk density, 2.62. Physical tests, p. 90.

D. NE 1/4 sec 12, T 12 S, R 8 W. Analyzed in lab of Corps of Engineers. Lab #23934. Idem.

Sample from material lost in Los Angeles abrasion test. Sol in HCl, 35.00%.

E. Sec 13, T 12 S, R 8 W. Analyst, R. Runnels. Idem, p. 74.

Sol in HCl, 39.74%.

	A	B	C	D	E
SiO ₂	63.11	64.42	64.02	62.26	58.02
Al ₂ O ₃	1.75	0.08	1.07	0.95	1.49
Fe ₂ O ₃	0.00	0.92	0.83	0.21	0.08
MgO	0.37	0.00	0.38	0.55	0.44
CaO	19.82	18.46	19.12	20.60	21.05
Na ₂ O	} 0.09		} 0.03 <u>a/</u>		
K ₂ O					
TiO ₂					0.59
H ₂ O-		0.04			
SO ₃	0.00	0.00	0.00	0.00	0.03
BaSO ₄					0.00
Ignit Loss	14.95	15.74	14.55	15.24	16.60
Total	100.09	99.66	100.00	99.81	98.30
Class	63,2,33	64,2,33	64,2,32	62,1,34	58,2,37

a/ Average of two tests

D Group

Kansas

A-E: Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. Swineford, Ada, 1947, Kans GS B 70, pt 4.

Calcareous sandstone.

Possible use: Concrete aggregate, p. 93.

A. NE 1/4 sec 7, T 12 S, R 10 W. Analyzed in lab of Corps of Engineers, Kansas City, Mo. Lab #11562. Idem, p. 90, 91.
Ledge rock sample. Sol in HCl, 35.22%. Physical tests, p. 90. Bulk density, 2.61.

B. NE 1/4 sec 7, T 12 S, R 10 W. Analyzed in lab of Corps of Engineers. Lab #23997. Idem.

Area contains large lentil of hard sandstone 1/2 mi in diameter and up to 50 ft thick, Quartzite Stone Company quarry. Sol in HCl, 37.97%. Physical tests, p. 90. Bulk density, 2.60. Tonnage estimate, p. 98.

C. NE 1/4 sec 7, T 12 S, R 10 W. Analyzed in lab of Corps of Engineers. Lab #27423. Idem.

Sample from crushed rock. Sol in HCl, 34.04%. Physical tests, p. 90. Bulk density, 2.56.

D. NE 1/4 sec 7, T 12 S, R 10 W. Analyzed in lab of Corps of Engineers. Idem. Crushed rock sample. Sol in HCl, 35.01%.

E. NE 1/4 sec 7, T 12 S, R 10 W. Analyst, R. Runnels. Idem, p. 74. Dolomite cement. Sol in HCl, 37.13%.

	A	B	C	D	E
SiO ₂	64.38	60.86	63.32	63.30	60.95
Al ₂ O ₃	1.98	2.40	0.98	1.08	0.76
Fe ₂ O ₃	0.18	1.62	2.66	1.52	0.25
MgO	5.64	5.07	3.68	5.61	6.31
CaO	11.58	12.93	14.14	12.22	13.74
Na ₂ O		}0.10		}0.12	
K ₂ O					
TiO ₂					0.82
SO ₃	0.00	0.00	0.01	0.00	0.00
BaSO ₄					0.00
Ignit Loss	16.16	16.92	15.04	15.70	16.73
Total	99.92	99.90	99.83	99.55	99.56
Class	64,3,32	61,5,34	63,5,31	63,3,32	61,1,35

D Group

Kansas

A. McPherson Co. LOWER CRETACEOUS, KIOWA sh. Sec 25, T 17 S, R 1 W. Analyst, R. Runnels. Swineford, Ada, 1947, Kans GS B 70, pt 4, p. 74.
Sandstone, calcite-barite cement. Sol in HCl, 35.45%.

B. McPherson Co. LOWER CRETACEOUS, KIOWA sh. Sec 19, T 17 S, R 2 W. Analyst, R. Runnels. Idem.
Sandstone, dolomite cement. Isolated outcrop. Sol in HCl, 36.08%.

C. McPherson Co. LOWER CRETACEOUS, KIOWA sh. Sec 1, T 18 S, R 2 W. Analyst, R. Runnels. Idem.
Sandstone, dolomite cement. Sol in HCl, 41.34%.
Possible use: Concrete aggregate, p. 93.

D. Osborne Co. UPPER CRETACEOUS, NICORARA fm, FORT HAYS ls men. Sec 31, T 9 S, R 12 W. Analyst, R. Runnels. Lab #Ob-3-1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.
Composite sample from lower part of basal bed. Insoluble residue, 71.08%, p. 12.

E. Rawlins Co. PLIOCENE, OGALLALA fm. NW 1/4 NW 1/4 sec 33, T 3 S, R 34 W. Analyst, R. Runnels. Lab #RWV-3B. Carey, J. S., et al, 1952, Kans GS B 96, pt 1, p. 17, 21.
Sample from upper 3 ft of 6 ft bed, see RWV-3A in "C" Group, p. 71 for analysis of lower 3 ft. Sand and silt occur below the ash. Screen analysis, p. 25. Tonnage estimate, p. 62.
Possible uses: Abrasive, filler, ceramic glaze, lightweight aggregate, p. 30-40.

F. Rawlins Co. PLIOCENE, OGALLALA fm. Sec 10, T 4 S, R 36 W. Analyzed in lab of Corps of Engineers, Kansas City, Mo. Frye, J. C., and Swineford, Ada, 1946, Kans GS B 64, pt 2, p. 63, 71.
Quartzite, gray to white to cream-colored; mottled on exposed surface. Physical tests, p. 63. Bulk density, 2.21.
Possible uses: Railroad ballast, riprap, road metal, p. 62.

	A	B	C	D	E	F
SiO ₂	60.29	61.61	55.88	50.54	60.64	55.08
Al ₂ O ₃	2.07 <u>a/</u>	1.31	2.37 <u>a/</u>	7.66 <u>a/</u>	9.32	1.07
Fe ₂ O ₃	0.19	0.52	0.50	6.02	1.96	0.11
MgO	1.42	5.75	6.92	0.22	0.55	0.80
CaO	17.82	16.07	13.51	18.13	10.37	22.50
Na ₂ O					} 5.06 <u>c/</u>	
K ₂ O						
TiO ₂		0.18			0.58	
P ₂ O ₅				tr	nil	
SO ₃	0.36	0.00	0.07		sl tr	0.00
BaSO ₄	2.95		0.00			
S				nil		
Ignit Loss	13.61	16.48	18.35	14.35 <u>b/</u>	11.52	20.32
Total	98.71	101.92	97.60	96.92	100.00	99.88
Class	60,3,29	62,2,35	56,4,37	50,17,25	61,14,20	55,3,42

a/ Includes TiO₂

b/ Between 140° and 1000°C

c/ By difference

D Group

Kansas

A. Rice Co. LOWER CRETACEOUS, KIOWA sh. Sec 26, T 20 S, R 10 W, near town of Raymond. Analyst, R. Runnels. Swineford, Ada, 1947, Kans GS B 70, pt 4, p. 74.
Sandstone, calcite-cement. Outcrop in valley of Arkansas River. 5 ft thick.
Sol in HCl, 34.58%.
Possible use: Concrete aggregate, p. 93.

B. Rocks Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. SW 1/4 sec 34, T 7 S, R 19 W. Analyst, R. Runnels. Lab #Ro-4-A 1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.
Chalk, lower part of basal bed. Insoluble residue, 51.46%, p. 13.
Analysis of coarser portion of insoluble residue: SiO₂, 90.40; Al₂O₃, 2.38; Fe₂O₃, 1.98; MgO, 0.29; CaO, 0.42; Na₂O, nil 1/; K₂O, 3.05; TiO₂, 0.87; Ignit Loss, 0.61; Total, 100.00, p. 8, 23.

C. Smith Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NE 1/4 sec 32, T 5 S, R 13 W. Analyst, R. Runnels. Lab #Sm-1-1a. Iden, p. 8, 9, 22, 35.
Chalk, composite sample from first foot of basal bed. Insoluble residue, 62.16%, p. 13.
Analysis of coarser portion of insoluble residue: SiO₂, 90.20; Al₂O₃, 3.76; Fe₂O₃, 1.87; MgO, 0.40; CaO, 0.45; Na₂O, 0.58 1/; K₂O, 1.91; TiO₂, 0.67; Ignit Loss, 0.46; Total, 100.30, p. 8, 23.

D. Wallace Co. PLIOCENE, OGALLALA fm. SW 1/4 sec 19, T 12 S, R 41 W. Analyst, R. Thompson. Kinney, E. D., 1942, Kans GS B 41, pt 10, p. 356, 358.
Alkali bentonite, pale olive green streaked with CaCO₃. Thickness sampled, 10 ft. Immersion, gelation, and other physical tests, p. 364-374.
Possible uses: Oil field drilling mud, core for earth fill dams, p. 375.

E. Washington Co. UPPER CRETACEOUS, DAKOTA ss. Sec 11, T 3 S, R 4 E. Analyst, R. Runnels. Kans GS B 70, pt 4, p. 74.
Sandstone, calcite cement. Sol in HCl, 34.28%.
Possible use: Concrete aggregate, p. 93.

1/ Determined by difference, (sic text) p. 23.

	A	B	C	D	E
SiO ₂	62.57	46.36	47.95	44.91	62.56
Al ₂ O ₃	1.06	4.80	6.53	16.07	2.12 <u>a/</u>
Fe ₂ O ₃	0.90	3.17 <u>a/</u>	2.60 <u>a/</u>	2.14	1.49
MgO	0.20	0.45	0.62	1.77	0.72
CaO	20.39	23.45	22.73	11.26	16.71
Na ₂ O				} 2.95	
K ₂ O					
TiO ₂	0.21			0.01	
P ₂ O ₅		0.56	nil		
H ₂ O-				5.40	
SO ₃	0.00			0.26	0.00
BaSO ₄	0.00				0.00
S		nil	nil		
Ignit Loss	13.99	19.03 <u>b/</u>	16.87 <u>b/</u>	10.80 <u>c/</u>	14.17
Total	99.32	97.82	97.30	95.57	97.77
Class	63,2,31	46,10,39	48,11,33	45,24,24	63,5,30

a/ Includes TiO₂ b/ 1400 to 1000°C c/ 900°C, loss on ignition less hygroscopic water

Group D, 90-

[$\text{SiO}_2 < 75\%$; $\text{SiO}_2 > \text{Carbonates} > (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O})$; $\text{SiO}_2 + (\text{R}_2\text{O}_3 \cdot n\text{H}_2\text{O}) + \text{Carbonates} < 90\%$]

Kansas

A. Smith Co. UPPER CRINACEOUS, NIORARA fm, FORT HAYS ls mem. SW 1/4 sec 36, T 4 S, R 15 W, Cedar quarry. Analyst, R. Runnels. Lab #Sm-2-1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 23.

Partial analysis.

Composite sample 2 ft from base. Insoluble residue 72.45%, p. 13.

	A
SiO_2	56.01
Al_2O_3	3.66
Fe_2O_3	1.50 <u>a/</u>
MgO	2.73
CaO	16.10
P_2O_5	tr
S	nil
Ignit Loss	13.29 <u>b/</u>
Total	93.29
Class	56,6,26

a/ Includes TiO_2

b/ Between 140° and 1000°C

E Group $[(R_2O_3 \cdot nH_2O) > SiO_2; (R_2O_3 \cdot nH_2O) > \text{Carbonates}]$

Kansas

A. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss. NE 1/4 sec 32, T 10 S, R 6 W. Analysts, R. Thompson and R. Runnels. Lab #L-30-4. Plummer, Norman and Romary, J. F., 1947, Kans GS B 67, p. 62, 64, 65.

Kaolin, white, conchoidal fracture. 0.6 ft thick. Ceramic tests, p. 65.

Possible use: "If mined with underlying or overlying fire-clay beds, the quality of the fire-clay would be increased considerably.", p. 64.

B. Lincoln Co. UPPER CRETACEOUS, DAKOTA ss 1/. Sec 32, T 10 S, R 6 W. Analyst, R. Thompson. Lab #L-30-4, see "A". Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 101, 102.

High-alumina clay. Mineral composition and tonnage estimate, p. 101, 102.

Possible use: Production of alumina, p. 99.

C. Osage Co. Stratigraphic position not given. T 14 S, R 15 E, town of Carbondale. Saunders, W. H., 1896, Kans Acad Sci Trans, v 3, p. 99.

Fire-clay. Above coal bed.

1/ Kans GS B 67, p. 213.

	A	B	C
SiO ₂	45.83	45.60	27.50
Al ₂ O ₃	37.75	39.50	39.50
Fe ₂ O ₃	0.05	0.67	
FeO			18.05
MgO	0.80		0.18 <u>a/</u>
CaO	0.58	0.16	1.61 <u>a/</u>
Na ₂ O	) 1.20		
K ₂ O			
TiO ₂	0.34		
H ₂ O-			8.50 <u>b/</u>
SO ₃			2.66 <u>a/</u>
Ignit Loss	13.41	14.00	
Organic			2.00
Total	99.96	99.93	100.00
Class	46,50,3	46,54,0	28,68,0

a/ Calculated from reported MgSO₄ and/or CaSO₄

b/ At 100°C

F Group [Carbonates < 75%; Carbonates > SiO₂; Carbonates > (R₂O₃·nH₂O)]
 Kansas

- A. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. Cement works N of town of Fort Scott. Analyst, E. Bartow. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 67. From base of stratum, approx 4 ft thick. Use: Cement rock.
- B. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. Cement works N of town of Fort Scott. Analyst, E. Bartow. Idem. From top of stratum, approx 4 ft thick. Use: Cement rock.
- C. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. NE of town of Fort Scott. Analyst, E. Bartow. Idem. From base of stratum. Use: Cement rock.
- D. Cherokee Co. MISSISSIPPIAN, WARSAW ls or KEOKUK ls (?). T 32 S, R 25 E, town of Galena. Analyst, J. Robertson. Lab #355. Winslow, Arthur, 1894, Mo GS, v 7, pt 2, p. 731. Haworth, Erasmus, et al, 1904, Kans GS v 8, p. 79. Cherty limestone.
- E. Ellis Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 27, T 11 S, R 18 W. Analyst, R. Runnels. Lab #EL-3-1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22. From lower part of basal bed. Insoluble residue, 32.1%, p. 12.
- F. Hamilton Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 25, T 22 S, R 43 W. Analyst, R. Runnels. Lab #Ha-1-1a. Idem. Bluish gray, p. 33. From lower part of basal bed. Outcrops few in number. Insoluble residue, 28.31%, p. 12. Analysis of coarser portion of insoluble residue: SiO₂, 85.92; Al₂O₃, 5.09; Fe₂O₃, 0.62; MgO, 0.32; CaO, 0.30; Na₂O, 3.79; K₂O, 0.93; TiO₂, 2.79; ignit loss (140° to 1000°C) 0.72; total, 100.48. Na₂O determined by difference (sic text) p. 23. P, tr and Mn, tr, spectrographic analysis, p. 17.

	A	B	C	D	E	F
SiO ₂	32.07	18.45	24.25	47.95	18.76	20.18
Al ₂ O ₃	3.99	8.47	2.28	} 0.62	5.32 <u>b/</u>	6.57 <u>b/</u>
Fe ₂ O ₃	3.40	2.17	5.04		4.18	2.03
MgO	2.28 <u>a/</u>	2.12 <u>a/</u>	7.59 <u>a/</u>	0.22 <u>a/</u>	0.29	1.16
CaO	30.70 <u>a/</u>	36.76 <u>a/</u>	28.64 <u>a/</u>	28.54 <u>a/</u>	39.02	38.93
P ₂ O ₅					nil	nil
H ₂ O-		} 0.44	} 0.63			
H ₂ O+						
S					nil	nil
Ignit Loss					30.95 <u>c/</u>	31.85 <u>c/</u>
Total	72.44	68.41	68.43	77.33	98.52	100.74
Class	32,9,58	18,11,70	24,8,67	48,1,51	19,12,65	20,11,67
Ca/Mg	mag calc	mag calc	calc dol	calcite	calcite	calcite

a/ Calculated from reported MgCO₃ or CaCO₃
b/ Includes TiO₂
c/ 140° to 1000°C

F Group

Kansas

A. Jewell Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 sec 9, T 2 S, R 7 W. Analyst, R. Runnels. Lab #Jw-2-1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

From lower part of basal bed. Insoluble residue, 29.33%, p. 12.

Analysis of coarser portion of insoluble residue: SiO₂, 87.68; Al₂O₃, 4.06; Fe₂O₃, 1.16; MgO, 0.39; CaO, 0.30; Na₂O, 2.06; K₂O, 2.73; TiO₂, 1.02; Ignit loss (140° to 1000°C) 0.60; total, 100.00. Na₂O determined by difference, p. 23. P, tr and Mn, tr, spectrographic analysis, p. 17.

B. Jewell Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 27, T 4 S, R 8 W. Analyst, R. Runnels. Lab #Jw-3-1a. Idem.

Insoluble residue, 33.03%, p. 12.

C. Lyon Co. PENNSYLVANIAN, Dover ls. NW 1/4 SW 1/4 sec 25, T 16 S, R 12 E. O'Connor, H. G., et al, 1953, Kans GS v 12, p. 25.

Composite of entire bed, 1.5 ft.

D. Rooks Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 26, T 10 S, R 17 W. Analyst, R. Runnels. Lab #Ro-3-1a. Kans GS B 82, pt 1, p. 8, 9, 22.

From first ft above underlying Codell ss in 56 ft section of chalk, p. 25, 35. Insoluble residue, 25.57%.

E. Wallace Co. PLIOCKNE, OGALLALA fm. SW 1/4 sec 19, T 12 S, R 41 W. Analyst, R. Thompson. Lab #10b. Kinney, E. D., 1942, Kans GS B 41, pt 10, p. 357, 358.

Alkali sub-bentonite, pale greenish white. Immersion, gelation, bleaching, and other tests, p. 364-374.

F. Wallace Co. PLIOCKNE, OGALLALA fm. SE 1/4 sec 2, T 12 S, R 42 W, draw 1/4 mi S of Roy C. Johnson ranch. Analyst, R. Thompson. Lab #14. Idem.

Alkali sub-bentonite, pale greenish white. 5 ft sampled; overburden, 2 ft. Immersion, gelation, bleaching, and other tests, p. 364-374.

	A	B	C	D	E	F
SiO ₂	18.84	25.04	36.62	16.71	11.68	33.14
Al ₂ O ₃	) 6.48 a/	6.48 a/	5.67 c/	4.64 a/	4.17	10.94
Fe ₂ O ₃		2.05	1.86	1.60	0.99	1.54
MgO		1.40	0.92	lost	0.83	0.77
CaO	40.61	38.00	29.39	41.84	38.12	21.05
TiO ₂					0.02	0.04
P ₂ O ₅	nil	nil	0.13	0.10		
H ₂ O-					0.85	3.90
SO ₃			nil		2.60	1.00
S	0.01	nil		nil		
Ignit Loss	31.92 b/	28.53 b/	23.84	32.95 b/	36.84 d/	21.17 d/
Total	97.86	101.50	98.43	97.84	96.10	93.55
Class	19,8,69	25,11,60	37,9,50	17,8,71	12,12,70	33,20,39
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite

a/ Includes TiO₂
b/ 140° to 1000°C

c/ Includes MnO and TiO₂
d/ 900°C, loss on ignit less hygroscopic water

Group F, 90-

[Carbonates < 75%; Carbonates > SiO₂; Carbonates > (R₂O₃·nH₂O); SiO₂ + (R₂O₃·nH₂O) + Carbonates < 90%]

Kansas

A. Saline Co. Recent surface deposit. T 14 S, R 3 W, town of Salina. Analyst, E. Franklin Grimsley, G. P., and Bailey, E. H. S., 1899, Univ GS of Kans, v 5, p. 152.

Partial analysis indicates 43% gypsum.

Gypsite.

B. Sumner Co. PERMIAN, WELLINGTON sh. SW 1/4 NW 1/4 sec 26, T 32 S, R 1 W. Analyst, R. Runnels. Lab #SU-2. Plummer, Norman and Hladik, W. B., 1951, Kans GS B 91, p. 21, 47.

Analysis shows 2.0% alkalies and suggests some feldspar.

Shale. 11 ft sampled. Bloating results, p. 37.

C. Wallace Co. FLIOCENE, OCALLALA fm. SW 1/4 sec 19, T 12 S, R 41 W. Analyst, R. Thompson. Lab #10C. Kinney, E. D., Kans GS B 41, pt 10, p. 357, 358.

Partial analysis suggests 5% gypsum.

Clay, greenish white, high in calcium carbonate. Grab sample. Immersion, gelation, bleaching and other tests, p. 364-374.

	A	B	C
SiO ₂	34.35 <u>b/</u>	34.84	21.93
Al ₂ O ₃	) 4.11	9.92	8.22
Fe ₂ O ₃		4.09	1.22
MgO	5.03 <u>c/</u>	14.46	1.63
CaO	18.72 <u>c/</u>	12.05	25.00
Na ₂ O		0.36	
K ₂ O		1.63	
TiO ₂		0.94	0.04
P ₂ O ₅		0.18	
H ₂ O- <u>a/</u>			3.90
SO ₃	20.22 <u>c/</u>	tr	2.35
Ignit Loss		21.56	26.79 <u>d/</u>
Total	82.43	100.08	91.08
Class	34, 5, 38	35, 18, 37	22, 19, 48
Ca/Mg	calc dol	dolomite	mag calc

a/ At 105°C

b/ Includes insoluble residue

c/ Calculated from reported MgCO₃, CaCO₃, and/or CaSO₄

d/ At 900°C, loss on ignition minus hygroscopic H₂O

G Group, Carbonates from 75% to 90%

Kansas

A. Allen Co. PENNSYLVANIAN, IOLA ls, RAYTOWN mem. ^{1/} T 24 S, R 18 E, town of Iola. Analyst, E. Bailey, collector, G. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Iola Marble Co. Physical properties. Bulk density, 2.68.

Use: Building stone. Suggested use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

B. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, quarries in SE part of town of Fort Scott. Analyst, E. Bartow. Kans GS Ann B for 1897, p. 67.

From bottom of stratum.

Use: Cement rock.

C. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, quarries in SE part of town of Fort Scott. Analyst, E. Bartow. Idem.

From middle of stratum.

Use: Cement rock.

D. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, quarries in SE part of town of Fort Scott. Analyst, E. Bartow. Idem.

From top of stratum.

Use: Cement rock, p. 66.

E. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, town of Fort Scott. Analyst, E. Bartow. Idem.

Use: Cement rock.

F. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, town of Fort Scott. Analyst, E. Bartow. Idem.

Use: Best rock in area for cement rock.

G. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, town of Fort Scott. Idem.

Use: Cement rock.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E	F	G
SiO ₂	2.75 ^{b/}	13.34	16.64	18.75	11.08	13.84	15.21 ^{c/}
Al ₂ O ₃	} 5.91	1.51	3.09	2.15	1.77	2.47	4.56
Fe ₂ O ₃		6.57	4.43	2.32	1.69	1.68	
MgO ^{a/}		10.00	5.84	1.08	1.59	1.56	5.09
CaO ^{a/}	50.99	31.04	35.32	41.43	45.57	43.64	36.53
H ₂ O-		} 0.29	} 0.26	} 0.37			
H ₂ O+							
SO ₃	0.14						
Total	59.79	62.75	65.58	66.10	61.70	63.19	61.39
Class	3,7,88	13,8,76	17,8,75	19,5,76	11,4,84	14,5,81	15,6,76
Ca:Mg	calcite	calc dol	mag calc	calcite	calcite	calcite	mag calc

^{a/} Calculated from reported MgCO₃ or CaCO₃

^{b/} Reported as insoluble residue

^{c/} Includes insoluble residue

G Group

Kansas

A. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, cement works N of town of Fort Scott. Analyst, E. Bertow. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 67.

From middle of stratum.

Use: Cement rock.

B. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, NE of town of Fort Scott. Analyst, E. Bertow. Idem.

From middle of stratum.

Use: Cement rock.

C. Bourbon Co. PENNSYLVANIAN, FORT SCOTT ls. T 25 S, R 25 E, NE of town of Fort Scott. Analyst, E. Bertow. Idem.

From top of stratum.

Use: Cement rock.

D. Brown Co. PENNSYLVANIAN, WABAUNSEE group. $\frac{1}{2}$ T 4 S, R 17 E, town of Horton. Analyst, E. Bailey, collector, S. Williston. Idem, p. 79. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Frey Bros quarry. Physical properties. Bulk density, 2.63.

Use: Building stone.

E. Chase Co. PENNSYLVANIAN, FORAKER ls, Long Creek mem. NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec 24, T 21 S, R 9 E. O'Connor, H. G., et al, 1951, Kans GS v 11, pt 2, p. 17.

Composite of lower 9.75 ft.

Possible uses: Agricultural ls, riprap, p. 19.

$\frac{1}{2}$ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	16.27	11.75	15.48	11.83 $\frac{b}{2}$	13.69
Al ₂ O ₃	2.91	2.06	2.71	} 5.53	1.53
Fe ₂ O ₃	3.87	4.59	2.98		0.38
MgO	5.26 $\frac{a}{2}$	12.72 $\frac{a}{2}$	8.27 $\frac{a}{2}$	0.75 $\frac{a}{2}$	4.22
CaO	36.38 $\frac{a}{2}$	29.78 $\frac{a}{2}$	33.73 $\frac{a}{2}$	45.89 $\frac{a}{2}$	41.66
TiO ₂					0.23
P ₂ O ₅					0.06
H ₂ O-		} 0.33	} 0.31		
H ₂ O+					
SO ₃				0.05	
SO ₄ +S					0.12
Ignit Loss					37.20
Total	64.69	61.23	63.48	64.05	99.09
Class	16,8,74	12,7,80	15,6,78	12,7,78	14,2,82
Ca:Mg	mag calc	calc dol	calc dol	calcite	mag calc

$\frac{a}{2}$ Calculated from reported MgCO₃ or CaCO₃

$\frac{b}{2}$ Reported as insoluble residue

G Group

Kansas

A. Chase Co. PERMIAN, Grenola ls, NEVA mem. SW 1/4 NW 1/4 sec 23, T 19 S, R 8 E. O'Connor, H. G., 1951, Kans GS v 11, pt 2, p. 17.

Composite of middle part of Neva ls, 3.8 ft thick.

Uses: Agricultural ls, road metal, crushed stone.

Possible uses: Building stone, riprap, p. 19.

B. Chase Co. PERMIAN, Beattie ls, COTTONWOOD mem. 1/2 T 19 S, R 8 E, town of Cottonwood Falls. Analyst, E. Bailey, collector, S. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Foraminiferal ls, light buff-gray, even textured. Quarried by Rettiger Bros. Physical properties. Bulk density, 2.59.

Use: Building stone.

C. Chase Co. PERMIAN, Nolans ls, Krider mem. NW 1/4 NE 1/4 sec 3, T 22 S, R 6 E. Kans GS v 11, pt 2, p. 17.

Spot sample in upper part of bed 0.8 ft thick.

D. Chase Co. PERMIAN, Nolans ls, HERINGTON mem. NW 1/4 NE 1/4 sec 3, T 22 S, R 6 E. Idem.

Composite of 4 spot samples.

Uses: Road metal, crushed stone. Possible uses: Agricultural ls, riprap, p. 19.

E. Clay Co. PERMIAN, Nolans ls, HERINGTON mem. 1/2 T 8 S, R 3 E, town of Clay Center. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 77. USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Average from 3 blocks. Physical properties. Bulk density, 2.73.

Use: Building stone.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	6.05	8.57 <u>b/</u>	10.27	13.35	9.50 <u>b/</u>
Al ₂ O ₃	2.31 <u>a/</u>	} 3.62	1.62	1.71	} 6.40
Fe ₂ O ₃	0.21		1.32	1.37	
MgO	0.75	0.84 <u>c/</u>	18.72	18.83	11.82 <u>c/</u>
CaO	50.04	47.46 <u>c/</u>	26.68	25.50	33.64 <u>c/</u>
TiO ₂			0.77	0.55	
P ₂ O ₅	0.09		0.09	0.17	
SO ₃	0.22	0.90	tr	tr	
Ignit Loss	37.04		40.49	38.93	
Total	96.71	61.39	99.96	100.41	61.36
Class	6,3,83	9,5,83	10,4,83	13,4,80	10,8,80
Ca:Mg	calcite	calcite	dolomite	dolomite	calc dol

a/ Includes TiO₂

b/ Reported as insoluble residue

c/ Calculated from reported MgCO₃ or CaCO₃

G Group

Kansas

A. Crowley Co. PERMIAN, Barneston ls, FORT RILEY mem. 1/ T 3¹/₄ S, R 4 E, town of Arkansas City. Analyst, E. Bailey, collector, S. Williston. Howarth, Erasmus, 1898, Kans GS Ann B for 1897, p. 77. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Limestone. Fine grained, homogeneous. Physical properties. Bulk density, 2.65.

Use: Building stone.

B. Douglas Co. PENNSYLVANIAN, OREAD ls, probably upper part of PLATTSMOUTH mem. 1/ T 12 S, R 20 E, town of Lawrence. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 79. USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Physical properties. Bulk density, 2.67.

Use: Building stone.

C. Ellis Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 13, T 11 S, R 19 W. Analyst, R. Runnels. Lab #E1-2-1a. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

From lower part of basal bed. Insoluble residue, 15.3%, p. 12.

Possible use: Whiting, p. 32.

D. Ellis Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 11, T 13 S, R 20 W. Analyst, R. Runnels. Lab #E1-1-1a. Idem.

Chalk deposit 33 ft thick. Sample 1 1/2 ft from base of lowest bed, p. 25.

Petrographic analysis, p. 14. Insoluble residue, 17.40%, p. 12.

Possible use: Whiting, p. 32.

E. Ellis Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 11, T 13 S, R 20 W. Analyst, R. Runnels. Lab #E1-1-1b. Idem.

Chalk deposit 33 ft thick. Sample 4 ft from base of lowest bed, p. 25.

Petrographic analysis, p. 14. Insoluble residue, 10.21%, p. 12.

Possible use: Whiting, p. 32.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	13.60 <u>b/</u>	8.02 <u>b/</u>	7.52	9.02	6.59
Al ₂ O ₃	} 2.55	} 2.05	2.79	2.78	1.14
Fe ₂ O ₃			2.42 <u>d/</u>	2.82	1.77
MgO	3.65 <u>c/</u>	0.62 <u>c/</u>	0.38	0.97	0.52
CaO	42.67 <u>c/</u>	49.60 <u>c/</u>	48.53	47.30	49.84
P ₂ O ₅			0.10	tr	tr
S			nil	tr	tr
Ignit Loss ^{a/}			38.07	36.82	39.78
Total	62.47	60.29	99.81	99.71	99.64
Class	14,3,82	8,3,89	8,7,83	9,7,80	7,4,89
Ca:Mg	mag calc	calcite	calcite	calcite	calcite

a/ 140° to 1000°C

b/ Reported as insoluble residue

c/ Calculated from reported MgCO₃ or CaCO₃

d/ Includes TiO₂

G Group

Kansas

A. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. T 24 S, R 40 W, ledge SE of town of Syracuse. Analyst, W. Wheeler. Darton, N. H., 1920, USGS Folio 212, p. 8. Wells, R. C., 1937, USGS B 878, p. 53.

Limestone.

Possible use: Cement material, USGS Folio 212, p. 8.

B. Hamilton Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 25, T 22 S, R 43 W. Analyst, R. Runnels. Lab #Ha-1-1b. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

From upper part of basal bed. Petrographic analysis, p. 14. Insoluble residue, 11.56%, p. 12.

Possible use: Whiting, p. 32.

C. Jackson Co. No stratigraphic position given. No locality given. Analyst, E. Bailey, collector, S. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 305.

Limestone. Quarried by A. W. Charles. Physical properties. Bulk density, 2.62.

Use: Building stone.

D. Jewell Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 SW 1/4 sec 10, T 2 S, R 8 W, 8 mi N of town of Mankato. Analyst, R. Runnels. Lab #Jw-1-1. Kans GS B 82, pt 1, p. 8, 9, 22.

From basal bed in quarry face 39 ft thick, p. 33.

Possible use: Whiting, p. 32.

	A	B	C	D
SiO ₂	18.56 <u>a/</u>	6.47	10.93 <u>a/</u>	5.14
Al ₂ O ₃		2.31 <u>b/</u>	) 2.02	2.14
Fe ₂ O ₃		0.78		2.72 <u>b/</u>
MgO	0.39	0.95	1.27 <u>c/</u>	0.32
CaO	42.75	50.81	47.05 <u>c/</u>	49.36
P ₂ O ₅		nil		tr
SO ₃			0.14	
S		nil		0.22
Ignit Loss	35.18	39.13 <u>d/</u>		38.65 <u>d/</u>
Total	96.88	100.45	61.41	98.55
Class	19,177	6,487	11,386	5,685
Ca:Mg	calcite	calcite	calcite	calcite

a/ Reported as insoluble residue

b/ Includes TiO₂

c/ Calculated from reported MgCO₃ or CaCO₃

d/ 140° to 1000°C

G Group

Kansas

A-B: Leavenworth Co. PENNSYLVANIAN, OREAD ls. ^{1/} Analyst, E. Bailey, collector, S. Williston.

Limestone. Physical properties.

Use: Building stone.

A. Probably PLATTSMOUTH mem. ^{1/} Soldiers' Home, town of Wadsworth. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Bulk density, 2.57.

B. T 9 S, R 23 E, town of Lansing. Kans GS Ann B for 1897, p. 77. USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Bulk density, 2.73.

Possible use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

^{1/} Letter from Kans GS, 7/16/53

	A	B
SiO ₂ ^{a/}	17.49	12.97
Al ₂ O ₃ ^{b/}	4.09	3.06
Fe ₂ O ₃ ^{b/}	1.46	0.55
MgO ^{b/}	38.69	43.95
SO ₃	0.37	2.32
Total	62.10	62.85
Class	17,5,72	13,4,80
Cs:Mg	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

G Group

Kansas

A-F: Lyon Co. PENNSYLVANIAN. O'Connor, H. G., et al, 1953, Kans GS v 12, p. 25.

- A. Silver Lake sh (?). NE 1/4 NE 1/4 sec 30, T 19 S, R 13 E.
Limestone. From ls conglomerate filling channel cut down into White Cloud sh. Composite of \pm 20 ft.
Possible uses: Agricultural ls, road metal.
- B. Wakarusa ls. SW 1/4 SE 1/4 sec 9, T 19 S, R 12 E.
Limestone. Composite of 3 ledges, 4.3 ft thick.
Use: Concrete aggregate, p. 27.
- C. Reading ls. SW 1/4 SE 1/4 sec 33, T 21 S, R 11 E.
Limestone. Composite of bed 2.75 ft thick.
Use: Building stone. Possible use: Agricultural ls, p. 26.
- D. Reading ls. SE 1/4 SE 1/4 sec 12, T 17 S, R 12 E.
Limestone. Composite of bed 2.8 ft thick.
Use: Building stone. Possible use: Agricultural ls, p. 26.
- E. Grandhaven ls. SW 1/4 SW 1/4 sec 15, T 17 S, R 12 E.
Limestone. Composite of lower bed 2.6 ft thick.
Use: Concrete aggregate. Possible use: Agricultural ls, p. 26.
- F. Brownville ls. NW 1/4 NW 1/4 sec 21, T 16 S, R 12 E.
Limestone. Composite of bed 3.0 ft thick.
Uses: Building stone, road metal, p. 26.

	A	B	C	D	E	F
SiO ₂	6.06	5.32	4.44	6.53	9.56	6.19
Al ₂ O ₃ <u>a/</u>	1.54	1.60	1.56	1.43	2.93	1.38
Fe ₂ O ₃	2.79	3.24	3.44	1.38	3.08	1.83
MgO	2.02	3.94	2.74	0.93	2.04	2.09
CaO	47.76	45.26	47.55	49.45	44.36	47.65
P ₂ O ₅	0.19	0.08	0.10	0.09	0.15	0.29
SO ₃	0.20	0.16	0.13	0.47	0.01	0.69
Ignit Loss	39.56	40.22	40.53	39.48	37.41	39.19
Total	100.12	99.82	100.49	99.76	99.54	99.31
Class	6,5,87	5,6,87	4,6,88	7,4,88	10,8,81	6,4,87
Ca:Mg	mag calc	mag calc	mag calc	calcite	mag calc	mag calc

a/ Includes MnO and TiO₂

G Group

Kansas

- A. Lyon Co. PERMIAN, Beattie ls, COTTONWOOD mem. SE 1/4 NW 1/4 sec 17, T 16 S, R 11 E. O'Connor, H. G., et al, 1953, Kans GS v 12, p. 25.
Limestone. Composite of upper 5.3 ft of mem.
Uses: Building stone, concrete aggregate, road metal.
Possible use: Agricultural ls, p. 26.
- B. Lyon Co. PERMIAN, GARRISON sh, CROUSE ls mem. NE 1/4 NW 1/4 sec 15, T 16 S, R 10 E. Idem.
Limestone. Composite of upper bed 5.6 ft thick.
Uses: Building stone, road metal. Possible use: Agricultural ls, p. 26.
- C. Lyon Co. PERMIAN, Funston ls. NW 1/4 NE 1/4 sec 18, T 16 S, R 10 E. Idem.
Limestone. Composite of lower 5.6 ft of upper bed.
Use: Building stone. Possible use: Agricultural ls, p. 26.
- D. Marion Co. PERMIAN, CHASE group. 1/2 T 19 S, R 4 E, town of Marion. Analyst, E. Bailey, collector, S. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 77. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504.
Limestone, dark gray; not homogeneous, occasional spots. Produced by I. Kuhn and Co. Physical properties. Bulk density, 2.68.
Use: Building stone.
- E. Marshall Co. PERMIAN, CHASE group, probably WINFIELD ls. 1/2 T 2 S, R 9 E, town of Beattie. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 77. USGS 16th Ann Rept for 1894-95, pt 4, p. 504.
Limestone. Average from 5 blocks. Physical properties. Bulk density, 2.54.
Use: Building stone.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	9.70	14.09	7.90	13.51 <u>b/</u>	13.89 <u>b/</u>
Al ₂ O ₃	0.97 <u>a/</u>	2.76 <u>a/</u>	1.49 <u>a/</u>	) 1.65	) 4.29
Fe ₂ O ₃	0.51	1.03	0.70		
MgO	0.73	1.01		10.86 <u>c/</u>	0.48 <u>c/</u>
CaO	48.30	43.71	49.11	34.53 <u>c/</u>	44.87 <u>c/</u>
P ₂ O ₅	0.12	0.05	0.04		
SO ₃	0.39	0.06	0.15		0.39
Ignit Loss	38.70	36.47	39.24		
Total	99.42	99.18	98.63	60.55	63.92
Class	10,2,87	14,5,80	8,3,88	14,2,84	14,5,79
Ca:Mg	calcite	calcite	calcite	calc dol	calcite

a/ Includes MnO and TiO₂

b/ Reported as insoluble residue

c/ Calculated from reported MgCO₃ or CaCO₃

G Group

Kansas

A. Marshall Co. PERMIAN, CHASE group, probably WINFIELD ls. $\frac{1}{2}$ T 2 S, R 9 E, town of Beattie. Analyst, E. Bailey, collector, S. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Limestone. Average from 5 blocks. Physical properties. Bulk density, 2.61.
Use: Building stone.

B. Marshall Co. PERMIAN, CHASE group, probably WINFIELD ls. $\frac{1}{2}$ T 2 S, R 9 E, town of Beattie. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 78. USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Limestone. Average from 4 blocks. Physical properties. Bulk density, 2.62.
Use: Building stone.

C. Montgomery Co. PENNSYLVANIAN, LANSING group. $\frac{1}{2}$ T 32 S, R 16 E, town of Independence. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 79. USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Physical properties. Bulk density, 2.72.
Use: Building stone.

D. Nemaha Co. PERMIAN, Beattie ls, COTTONWOOD mem $\frac{1}{2}$ T 2 S, R 14 E, town of Sabetha. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 79. USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Physical properties. Bulk density, 2.59.
Use: Building stone.

E. Osborne Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 31, T 9 S, R 12 W. Analyst, R. Runnels. Lab #Ob-3-lb. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

From upper part of basal bed. Insoluble residue, 9.03%, p. 12.
Possible use: Whiting, p. 32.

$\frac{1}{2}$ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	8.75 <u>a/</u>	14.01 <u>a/</u>	16.15 <u>a/</u>	11.97 <u>a/</u>	4.63
Al ₂ O ₃	} 2.37	} 1.34	} 1.91	} 3.59	2.32 <u>c/</u>
Fe ₂ O ₃					1.87
MgO	1.34 <u>b/</u>	1.85 <u>b/</u>	0.86 <u>b/</u>	0.57 <u>b/</u>	0.25
CaO	47.51 <u>b/</u>	44.99 <u>b/</u>	44.40 <u>b/</u>	45.93 <u>b/</u>	50.74
P ₂ O ₅					tr
H ₂ O-	0.25			0.29	
SO ₃	0.78			0.55	
S					nil
Ignit Loss					40.06 <u>a/</u>
Total	61.00	62.19	63.32	62.90	99.87
Class	9,3,88	14,2,84	16,2,81	12,4,83	5,6,86
Ca:Mg	calcite	mag calc	calcite	calcite	calcite

a/ Reported as insoluble residue

b/ Calculated from reported MgCO₃ or CaCO₃

c/ Includes TiO₂

d/ 140° to 1000°C

G Group

Kansas

A. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 19, 20, 29, 30, T 10 S, R 15 W. Analyst, R. Runnels. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 23.

From lower part of basal bed. Outcrop not measured because of local faults, p. 34. Insoluble residue, 14.76%, p. 12.
Possible use: Whiting, p. 32.

B. Phillips Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. SE 1/4 SW 1/4 sec 36, T 4 S, R 18 W. Analyst, R. Runnels. Lab #Ph-1-1a. Idem.

From lower part of basal bed.

Use: Development improbable because of small outcrops, distance from roads, and nearness of other quarries.

C. Rice Co. PERMIAN, STONE CORRAL dol. T 20 S, R 6 W. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 111.

Conveniently situated for stripping operations. Tonnage estimate, p. 111.

Possible use: Magnesium, p. 110.

D. Trego Co. UPPER CRETACEOUS, NIOBRARA fm, probably SMOKY HILL mem. 1/ T 12 S, R 23 W, near town of Wakeensy. Analyst, F. Clarke. USGS lab #212. Clarke, F. W., 1900, USGS B 168, p. 263. Clarke, F. W., 1915, USGS B 591, p. 234.

Marl, weathered. Large surface deposit.

E. Trego Co. UPPER CRETACEOUS, NIOBRARA fm, SMOKY HILL mem. 1/ 300 to 320 miles W of Kansas City, within 3 mi of the Union Pacific Ry. Analyst, G. Patrick. Patrick, G. E., 1875, Kans Acad Sci Trans v 4, p. 14. Elias, Maxim, K., 1931, Kans GS B 18, p. 38.

Lower half of Smoky Hill mem, poorest specimen of chalk in area. Light yellowish tinge.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	6.55	14.27	4.26	14.06	11.40 c/
Al ₂ O ₃	2.29	3.48 a/	5.34		} 0.97
Fe ₂ O ₃	2.94 a/	2.37	0.98	5.10	
FeO					1.75 d/
MgO	0.12	0.26	16.33	0.50	
CaO	48.13	43.97	29.66	43.05	47.17 e/
P ₂ O ₅	nil	nil			
H ₂ O-				} 1.77	0.58
H ₂ O+					
CO ₂				35.03	
S	nil	nil			
Ignit Loss	37.63 b/	35.15 b/	41.02		
Total	97.66	99.50	97.59	99.51	61.87
Class	7,7,83	14,7,77	4,8,84	14,7,79	11,3,84
Ca:Mg	calcite	calcite	calc dol	calcite	calcite

a/ Includes TiO₂

b/ 1400 to 1000°C

c/ Reported as insoluble residue

d/ Calculated from reported FeCO₃

e/ Calculated from reported CaCO₃

G Group

Kansas

A. Wabaunsee Co. PERMIAN, Beattie ls, COTTONWOOD mem. 1/ T 12 S, R 10 E, town of Alma. Analyst, E. Bailey, collector, S. Williston. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Quarried by A. Zechser. Physical properties. Bulk density, 2.58.
Use: Building stone.

B. Wabaunsee Co. PERMIAN, Beattie ls, COTTONWOOD mem. 1/ No locality given. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 78. USGS 16th Ann Rept for 1894-95, pt 4, p. 504.

Limestone. Physical properties. Bulk density, 2.49.
Use: Building stone.

C. Woodson Co. PENNSYLVANIAN, OREAD ls, TORONTO mem or STANTON ls, STONER mem. 1/ T 25 S, R 15 E, town of Yates Center. Analyst, E. Bailey, collector, S. Williston. Kans GS Ann B for 1897, p. 79. USGS 16th Ann Rept for 1894-95, pt 4, p. 505.

Limestone. Physical properties. Bulk density, 2.69.
Use: Building stone.

1/ Letter from Kans GS, 7/16/53

	A	B	C
SiO ₂ <u>a/</u>	9.12	10.37	6.80
Al ₂ O ₃)	0.70	2.49	2.60
Fe ₂ O ₃)			
MgO <u>b/</u>	0.60	1.12	0.98
CaO <u>b/</u>	49.61	47.36	49.32
SO ₃			0.21
Total	60.03	61.34	59.91
Class	9,1,90	10,3,86	7,3,89
Ca:Mg	calcite	calcite	calcite

a/ Reported as insoluble residue

b/ Calculated from reported MgCO₃ or CaCO₃

H Group [Carbonates from 90% to 100%]

Kansas

A-D: Allen Co. PENNSYLVANIAN, IOIA ls. ^{1/} Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4. Haworth, Erasmus, 1898, Kans GS Ann B for 1897.

Limestone. Physical properties.

Use: Building stone.

A. RAYTOWN mem. ^{1/} T 26 S, R 18 E, town of Humboldt. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 79.
Bulk density, 2.66.

B. RAYTOWN mem. ^{1/} T 26 S, R 18 E, town of Humboldt. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 79.
Bulk density, 2.70.

C. RAYTOWN mem. ^{1/} No locality given. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 78.
Bulk density, 2.66.

Possible use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

D. T 26 S, R 18 E, town of Humboldt. USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Kans GS Ann B for 1897, p. 77.

Possible use: Cement material, Kans GS Ann B for 1902, p. 53.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂ ^{a/}	3.79	1.99	2.63	1.53
Al ₂ O ₃)	1.07	1.21	1.76	1.75
Fe ₂ O ₃)				
MgO ^{b/}	0.48	0.53	0.74	1.30
CaO ^{b/}	52.21	53.33	52.72	52.73
SO ₃	0.20			
Total	57.75	57.06	57.85	57.31
Class	4,1,94	2,2,96	3,2,95	2,2,96
Ca:Mg	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Anderson Co. PENNSYLVANIAN, PLATTSBURG ls, Spring Hill mem. Garnett Rock Company, town of Garnett. Analysts, E. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 87.

16 ft thick. Chemical analysis also given of calcined base, p. 91.

Possible uses: Lime, metallurgical ls, p. 89, 92, 94, 101.

B. Anderson Co. PENNSYLVANIAN, PLATTSBURG ls, Spring Hill mem. SW 1/4 sec 29, T 20 S, R 21 E. Analysts, E. Runnels and J. Schleicher. Idem, p. 85, 87.

19 ft thick. Chemical analysis also given of calcined base, p. 91.

Possible uses: Lime, metallurgical ls, p. 89, 92, 94, 101.

C. Anderson Co. PENNSYLVANIAN, STANTON ls. 1/2 T 20 S, R 20 E, town of Garnett. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79.

Limestone. Physical properties. Bulk density, 2.69.

Use: Building stone.

D. Anderson Co. PENNSYLVANIAN, STANTON ls. T 20 S, R 20 E, town of Garnett. Analyst, E. Bailey; collector, S. Williston. Kans GS Ann B for 1897, p. 79. USGS 16th Ann Rept for 1894-95, p. 505.

Limestone. Physical properties. Bulk density, 2.47.

Use: Building stone.

E. Anderson Co. PENNSYLVANIAN, STANTON ls. T 19 S, R 21 E, town of Greeley. Analyst, E. Bailey; collector, S. Williston. Kans GS Ann B for 1897, p. 77. USGS 16th Ann Rept for 1894-95, p. 504.

Limestone. Physical properties. Bulk density, 2.59.

Use: Building stone.

1/2 Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	0.99	0.68	4.30 <u>d/</u>	0.61 <u>d/</u>	1.18 <u>d/</u>
Al ₂ O ₃	0.58 <u>a/</u>	0.64 <u>a/</u>	)0.81	1.51	)3.09
Fe ₂ O ₃	0.71	0.49			
FeO					
MgO	1.19	0.43	0.45 <u>a/</u>	0.15 <u>a/</u>	1.26 <u>a/</u>
CaO	53.37	55.06	51.97 <u>a/</u>	54.52 <u>a/</u>	51.94 <u>a/</u>
P ₂ O ₅	0.04 <u>b/</u>	0.02 <u>b/</u>			
H ₂ O-			0.43		
SO ₃			0.23	0.43	
S	0.05	0.04			
Ignit Loss	43.24 <u>c/</u>	43.00 <u>c/</u>			
Total	100.17	100.36	58.19	57.22	57.47
Class	1,2,97	1,1,97	4,1,94	1,2,98	1,4,94
Ca:Mg	calcite	calcite	calcite	calcite	calcite

a/ Includes TiO₂ and MnO when present
b/ Rounded off to two decimal places
c/ 105° to 1000°C

d/ Reported as insoluble residue. Reported as SiO₂, USGS B 260, p. 509, USGS B 296, p. 57
e/ Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Barber Co. No stratigraphic position given. No locality given. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79. Limestone. Average from 6 blocks. Physical properties. Bulk density, 2.62. Use: Building stone.

B. Brown Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS mem. SW 1/4 NW 1/4 sec 36, T 4 S, R 15 W. Leonard, A. R., 1952, Kans GS B 98, p. 23, 24. Chalk. From small quarry. Uses: Building stone, whiting.

C. Butler Co. PERMIAN, Barneston ls, FORT RILEY mem. ^{1/} T 26 S, R 5 E, town of El Dorado. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95, p. 504. Kans GS Ann B for 1897, p. 77. Limestone. Physical properties. Bulk density, 2.61. Use: Building stone.

D. Chase Co. PERMIAN, RED EAGLE ls, Glenrock mem. NE 1/4 SW 1/4 sec 26, ^{2/} T 19 S, R 7 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1950, Kans GS B 90, pt 5, p. 85, 88. Limestone. Bed 6 ft thick, composite of upper 5.95 ft. Analyses of both raw and calcined bases, p. 91. Possible uses: Lime, flux, idem, p. 102. Uses: Road metal, crushed stone, O'Connor, H. G., 1951, Kans GS v 11, pt 2, p. 19.

E. Chase Co. PERMIAN, Grenola ls, NEVA mem. SW 1/4 NW 1/4 sec 23, T 19 S, R 8 E. Idem. Composite of upper bed, 5.1 ft thick. Uses: Agricultural ls, road metal, crushed stone. Possible uses: Building stone, riprap, p. 19.

^{1/} Letter from Kans GS, 7/16/53
^{2/} SE 1/4 NW 1/4 sec 26, Kans GS v 11, pt 2, p. 17, 19.

	A	B	C	D	E
SiO ₂	1.85 ^{a/}	1.09	5.04 ^{a/}	2.85	5.09
Al ₂ O ₃	} 1.95	0.50	} 0.96	0.90 ^{a/}	1.03 ^{a/}
Fe ₂ O ₃		0.10 ^{c/}		0.32	0.42
MgO	0.67 ^{b/}	1.08	0.51 ^{b/}	1.05	0.56
CaO	53.01 ^{b/}	55.01	52.28 ^{b/}	52.86	50.97
P ₂ O ₅		tr		0.14	0.11
SO ₃					0.21
S				0.05	
Ignit Loss		42.96 ^{d/}		42.05 ^{f/}	41.38
Total	57.48	100.74	58.79	100.22	99.77
Class	2,2,95	1,1,97	5,1,93	3,1,95	5,2,92
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

^{c/} Includes TiO₂

^{d/} 140° to 1000°C

^{e/} Includes MnO and TiO₂ when present

^{f/} 105° to 1000°C

H Group

Kansas

A. Chase Co. PENNSYLVANIAN, ESKRIDGE sh. SW 1/4 NW 1/4 sec 23, T 19 S, R 8 E. O'Connor, H. G., 1951, Kans GS v 11, pt 2, p. 17.
Composite of complete lower ls bed, 3.9 ft thick.
Uses: Agricultural ls, road metal, crushed stone. Possible use: Riprap, p. 19.

B. Chase Co. PERMIAN, Beattie ls, COTTONWOOD mem. SE 1/4 SE 1/4 sec 30, T 19 S, R 7 E. Idem, p. 17, 18.
Composite of complete member, 5 ± ft thick.
Uses: Agricultural ls, building stone. Prosser, C. S. and Beede, J. W., 1904, USGS Folio, 109, p. 5. Possible use: Riprap.

C. Chase Co. PERMIAN, Beattie ls, COTTONWOOD mem. NE 1/4 NW 1/4 sec 36, T 19 S, R 8 E. Kans GS v 11, pt 2, p. 17, 18.
Composite of complete member, 5 ± ft thick.
Uses: Agricultural ls, building stone. USGS Folio 109, p. 5.
Possible use: Riprap.

D. Chase Co. PERMIAN, Beattie ls, COTTONWOOD mem. NW 1/4 SW 1/4 sec 3, T 22 S, R 9 E. Kans GS v 11, pt 2, p. 17, 18.
Composite of complete bed, 3.2 ft thick.
Uses: Agricultural ls, building stone. USGS Folio 109, p. 5.
Possible use: Riprap.

E. Chase Co. PERMIAN, Beattie ls, COTTONWOOD mem. ^{1/} T 19 S, R 8 E, town of Strong City. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78.

Limestone. Average from 6 blocks. Physical properties. Bulk density, 2.61.

Use: Building stone.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	1.62	5.50	4.75	6.85	7.30 ^{b/}
Al ₂ O ₃	1.30	1.74	0.98 ^{a/}	1.18 ^{a/}	} 1.05
Fe ₂ O ₃	0.36	0.49	0.28	0.59	
MgO	0.57	0.65	1.35	1.78	0.76 ^{c/}
CaO	52.78	50.09	50.55	49.53	50.42 ^{c/}
TiO ₂		0.69			
P ₂ O ₅	0.12	0.15	0.17	0.20	
SO ₃	0.12	0.32	tr	tr	0.03
Ignit Loss	42.96	40.71	41.13	40.24	
Total	99.85	100.34	99.21	100.37	59.56
Class	2,3,95	6,3,91	5,2,92	7,2,90	7,1,91
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Includes TiO₂
^{b/} Reported as insoluble residue

^{c/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Chase Co. PERMIAN, Crouse ls. NW 1/4 NW 1/4 sec 4, T 18 S, R 9 E. O'Connor, E. G., et al, 1951, Kans GS v 11, pt 2, p. 17.

Composite of entire 3.1 ft of lower part of Crouse ls.

Uses: Road metal, crushed stone. Possible uses: Agricultural ls, building stone, riprap, p. 19.

B. Chase Co. PERMIAN, Crouse ls. NW 1/4 NW 1/4 sec 4, T 18 S, R 9 E. Idem.

Composite of lower massive 2.75 ft of upper part of Crouse ls.

Uses: Road metal, crushed stone. Possible uses: Agricultural ls, building stone, riprap, p. 19.

C. Chase Co. PERMIAN, WRETFORD ls, Threemile mem. NW 1/4 NE 1/4 sec 18, T 19 S, R 8 E. Idem.

Composite of upper 13.3 ft; no chart.

Use: Ballast, p. 19.

D. Chase Co. PERMIAN, Barneston ls, FORT RILEY mem. NW 1/4 NE 1/4 sec 6, T 22 S, R 6 E. Idem.

Composite of 8.85 ft, lower part of Fort Riley mem.

Uses: Building stone, road metal, crushed stone. Possible use: Riprap, p. 18, 19.

E. Chase Co. PERMIAN, DOYLE sh, TOWANDA ls mem. NW 1/4 NW 1/4 SW 1/4 sec 24 ^{1/}, T 21 S, R 6 E. Analysts, R. Runnels and J. Schleicher. Idem, p. 17, 19. Runnels, R. T., 1950, Kans GS B 90, pt 5, p. 85, 88.

Limestone, 9.7 ft thick. Composite of 10 spot samples. Analyses of raw and calcined bases. Idem, p. 91.

Uses: Road metal, crushed stone. Kans GS v 11, pt 2, p. 19.

Possible uses: Lime, flux. Kans GS B 90, pt 5, p. 102.

F. Chase Co. PERMIAN, WINFIELD ls, Crosswell mem. SW 1/4 NW 1/4 sec 16, T 22 S, R 6 E. Kans GS v 11, pt 2, p. 17.

Composite of complete member, 12.8 ft thick.

Uses: Road metal, crushed stone. Possible uses: Agricultural ls, riprap, p. 19.

^{1/} SW 1/4 SW 1/4 sec 24, Kans GS v 11, pt 2, p. 17

	A	B	C	D	E	F
SiO ₂	4.41	4.94	1.72	5.69	2.84	6.34
Al ₂ O ₃	0.83	0.83	0.30	1.65	1.11 ^{a/}	0.85
Fe ₂ O ₃	0.58	1.49	0.32	0.65	0.27	0.76
MgO	0.74	0.28	0.48	0.66	0.65	1.89
CaO	51.48	50.83	54.56	50.18	52.59	50.04
TiO ₂	0.41	0.43	tr	0.15	0.17	0.21
P ₂ O ₅	tr	tr	tr	tr	0.03	0.14
SO ₃	tr	tr	nil	tr		
S					0.08	
Ignit Loss	41.20	40.46	42.92	40.44	41.88 ^{b/}	40.01
Total	99.65	99.30	100.30	99.42	99.62	100.24
Class	4,2,90	5,3,91	2,1,97	6,3,90	3,2,94	6,2,89
Ca:Mg	calcite	calcite	calcite	calcite	calcite	mag calc

^{a/} Includes MnO when present

^{b/} 105 to 1000° C

H Group

Kansas

A. Chase Co. PERMIAN, WINFIELD ls, Cresswell mem. NE 1/4 NW 1/4 sec 17, T 22 S, R 7 E. O'Connor, H. G., et al. 1951, Kans GS v 11, pt 2, p. 17.
Composite of lower 5.6 ft.

Uses: Road metal, crushed stone. Possible uses: Agricultural ls, riprap, p. 19.

B. Cherokee Co. MISSISSIPPIAN, presumably BURLINGTON ls. Short Creek, near Spring River. Analyst, L. Eakins. USGS lab no. 1184. Clarke, F. W., USGS B 78, 1891, p. 125. Clarke, F. W., 1915, USGS B 591, p. 234.
Limestone.

C. Cherokee Co. MISSISSIPPIAN, KEOKUK ls. NW 1/4 NE 1/4 sec 2, T 35 S, R 25 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 87, 89.

Limestone, gray-white, massive, crinoidal; appears crystalline on freshly broken surface, p. 100, 101. 14 ft thick. Lies 35 to 50 ft below Short Creek oolite; considered equivalent to "M" bed in Tri-State lead and zinc district. Tested for color of quick and hydrated lime and slaking time, p. 89. Chemical analysis of calcined base also given, p. 91.

Possible uses: Lime, metallurgical ls, glass, glass fiber.

D. Cherokee Co. MISSISSIPPIAN, KEOKUK ls. ^{1/}T 34 S, R 25 E, town of Galena. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78.

Limestone crystalline. Physical properties. Bulk density, 2.66.

Use: Building stone. Suggested use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

^{1/}Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂	5.30	0.32 ^{a/}	0.29	8.00 ^{a/}
Al ₂ O ₃	1.72	0.17	0.08 ^{b/}	}0.69
Fe ₂ O ₃	0.14		0.16	
FeO		0.20		
MgO	0.68	0.35	0.43	0.38 ^{d/}
CaO	50.06	55.25	55.00	51.16 ^{e/}
TiO ₂	0.56			
P ₂ O ₅	0.20		0.01	
MnO		0.02		
CO ₂		43.79		
SO ₃	0.26			
S			0.02	
Ignit Loss	41.01		43.81 ^{e/}	
Total	99.93	100.10	99.80	60.23
Class	5,3,91	0,0,99	0,0,99	8,1,89
Ca:Mg	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Includes TiO₂ and MnO when present

^{c/} 105° to 1000° C

^{d/} Calculated from reported MgCO₃ or CaCO₃

^{e/} Calculated from reported CaCO₃, Haworth, E., 1904, Kans GS v 8, p. 77. CaCO₃ reported as 97.32 (CaO, 54.52) USGS 16th Ann B for 1894-95, pt 4, p. 505; Kans GS Ann B for 1897, p. 78.

H Group

Kansas

A. Clark Co. PERMIAN, DAY CREEK dol. T 32 S, R 23 W. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 111.
 Approx 2 1/2 ft thick. Tonnage estimate, p. 111.
 Possible use: Magnesium, p. 110.

B. Clay Co. PERMIAN, Barneston ls, FORT RILEY mem. NE 1/4 SW 1/4 sec 17, T 9 S, R 4 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 88.
 Creamy to light gray; sugary texture. 10.7 ft thick. Chemical analysis of calcined base also given, p. 91.
 Possible use: Lime, p. 102.

C. Cowley Co. PERMIAN, WINFIELD ls. ^{1/} T 32 S, R 4 E, town of Winfield. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 77.
 Limestone. Physical properties. Bulk density, 2.52.
 Use: Building stone.

D. Cowley Co. PERMIAN, Barneston ls, FORT RILEY mem. ^{1/} T 34 S, R 5 E, town of Silverdale. Analyst, C. Catlett. USGS lab no. 967. Clarke, F. W., 1890, USGS B 64, p. 46. Clarke, F. W., 1915, USGS B 591, p. 234.
 Limestone.

E. Cowley Co. No stratigraphic position given. T 31 S, R 7 E, town of Cambridge. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 78.
 Limestone. Quarried by H. Heddeman; average from 5 blocks. Physical properties. Bulk density, 2.63.
 Use: Building stone.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	1.64	2.31	4.25 ^{d/}	5.27	3.34 ^{d/}
Al ₂ O ₃	1.28	0.61 ^{a/}	} 0.85	1.07	} 1.69
Fe ₂ O ₃	1.98	0.34		0.71	
FeO				0.32	
MgO	18.02	0.77	0.30 ^{a/}	0.56	0.45 ^{a/}
CaO	31.54	52.82	52.69 ^{a/}	50.36	52.65 ^{a/}
Na ₂ O				0.20	
K ₂ O				0.10	
P ₂ O ₅		0.02 ^{b/}		0.06	
H ₂ O-				} 0.78	
H ₂ O+					
CO ₂				40.34	
SO ₃				0.07	
S		0.05			
Ignit Loss	46.34	42.48 ^{e/}			
Total	100.80	99.40	58.09	99.84	58.13
Class	2,5,94	2,1,96	4,1,95	3,3,91	3,2,94
Ca:Mg	calc dol	calcite	calcite	calcite	calcite

^{a/} Includes TiO₂ and MnO when present
^{b/} Rounded off to two decimal places
^{c/} 105° to 1000° C
^{d/} Reported as insoluble residue
^{e/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Crawford Co. PENNSYLVANIAN, CHEROKEE sh, ARDMORE ls mem. Sec 32, T 27 S, R 25 E. Analyst, G. Steiger. Pierce, W. G., and Courtier, W. H., 1937, Kans GS B 24, p. 31, 32.

Limestone. Dark portion of mottled rock. Soluble in 1 HCl + 5H₂O, boiling 5 minutes. See "A", p. 137 for analysis of light portion of same rock.

Analysis of insoluble fraction: SiO₂, 2.35; Al₂O₃, 0.71; Fe₂O₃, 0.71; MgO, 0.17; CaO, none; TiO₂, 0.04.

B. Crawford Co. PENNSYLVANIAN, ALTAMONT ls. NE 1/4 NE 1/4 sec 5, T 29 S, R 23 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1931, Kans GS B 90, pt 3, p. 85, 87.

10 ft thick. Contains minor amounts of chert. Chemical analysis of calcined base also given, p. 91.

Possible use: Lime, p. 102.

C. Douglas Co. PENNSYLVANIAN, STANTON ls, STONER ls mem. NE 1/4 NE 1/4 sec 4, T 13 S, R 21 E. Analysts, R. Runnels and J. Schleicher. Idem, p. 85, 88, 89.

14 ft thick. Moderate sized quarry. Chemical analysis of calcined base also given, p. 91.

Possible uses: Lime, flux, p. 102.

D. Douglas Co. PENNSYLVANIAN, OREAD ls, probably lower part of PLATTEMOUTH mem. ^{1/2} T 12 S, R 20 E, town of Lawrence. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79.

Limestone. Physical properties. Bulk density, 2.67.

Use: Building stone.

E. Douglas Co. PENNSYLVANIAN, OREAD ls. ^{1/4} T 12 S, R 20 E, town of Lawrence. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Kans GS Ann B for 1897, p. 77.

Limestone. Physical properties. Bulk density, 2.68.

Use: Building stone.

Suggested use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

^{1/2} Letter from Kans GS, 7/16/53

	A	B	C	D	E	
SiO ₂	0.11	4.46	2.11	2.29 ^{d/}	3.53 ^{d/}	
Al ₂ O ₃	0.18	0.16 ^{c/}	0.52 ^{c/}	} 1.79	} 1.07	
Fe ₂ O ₃	none	0.16	0.63			
FeO	0.80					^{a/}
MgO	1.23	0.32	0.82	0.38 ^{e/}	0.55 ^{e/}	Rounded off to two
CaO	50.92	53.28	52.79	53.23 ^{e/}	52.76 ^{e/}	decimal places
TiO ₂	none					^{b/} At 1000°C
P ₂ O ₅ ^{a/}		0.03	0.04			^{c/} Includes TiO ₂ and
MnO	0.19					^{d/} MnO when present
S		0.06	0.08			Reported as insol-
Ignit Loss ^{b/}		41.96	42.50			^{e/} uble residue
Total	53.43	100.43	99.49	57.69	57.91	Calculated from re-
Class	0,1,93	4,0,95	2,1,96	2,2,93	4,1,95	ported MgCO ₃ or
Ca:Mg	calcite	calcite	calcite	calcite	calcite	CaCO ₃

Kansas

H Group

A. Douglas Co. PENNSYLVANIAN, DEER CREEK ls, Ozawie mem. Cen S line sec 36, T 11 S, R 17 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p 85, 87, 91, 97.

5 ft thick. Chemical analysis of calcined base also given, p. 91.
Possible uses: Lime, flux, p. 102.

B. Douglas Co. PENNSYLVANIAN, DEER CREEK ls, Ervine Creek mem. SE 1/4 SW 1/4 sec 32, T 11 S, R 18 E. Analysts, R. Runnels and J. Schleicher. Idem.

8 ft thick. Chemical analysis of calcined base also given, p. 91.
Possible uses: Lime, flux, p. 102.

C. Elk Co. PENNSYLVANIAN, DEER CREEK ls. ^{1/}T 31 S, R 10 E, town of Moline. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79.

Limestone. Physical properties. Bulk density, 2.66.
Use: Building stone.

D. Ellis Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Sec 27, T 11 S, R 18 W. Analyst, R. Runnels. Lab #E1-3-1b. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

From upper part of bed. Insoluble residue, 8.02%, p. 12.
Possible use: Whiting, p. 32.

E. Ellis Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Sec 3, T 13 S, R 18 W. Analyst, R. Runnels. Lab #E1-6-0. Idem.

Possible use: Whiting, p. 32.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	2.11 <u>a/</u>	2.70	0.66 <u>d/</u>	4.32	2.30
Al ₂ O ₃	0.71	0.55 <u>a/</u>	} 2.13	1.71 <u>f/</u>	0.47
Fe ₂ O ₃	0.89	1.69		1.41	1.48
MgO		0.54	1.45 <u>e/</u>	0.23	0.17
CaO	53.27 <u>b/</u>	53.35 <u>b/</u>	52.37 <u>e/</u>	51.53	53.43
P ₂ O ₅	0.04	0.02		nil	nil
SO ₃			0.36		
S	0.04 <u>c/</u>	0.07 <u>c/</u>		nil <u>g/</u>	nil
Ignit Loss	41.88 <u>c/</u>	41.90 <u>c/</u>		40.29 <u>g/</u>	41.23 <u>g/</u>
Total	98.94	100.82	56.97	99.49	99.08
Class	2,2,94	3,3,94	1,3,96	4,4,90	2,2,93
Ca:Mg	calcite	calcite	calcite	calcite	calcite

a/ Includes TiO₂ and MnO when present

b/ Rounded off to two decimal places

c/ 105° to 1000°C

d/ Reported as insoluble residue

e/ Calculated from reported MgCO₃ or CaCO₃

f/ Includes TiO₂
g/ 140° to 1000°C

H Group

Kansas

A-H: Ellis Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem.
 Analyst, R. Runnels. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1.
 Possible use: Whiting, p. 32.

- A. Sec 13, T 11 S, R 19 W. Lab #E1-2-1b. Idem p. 8, 9, 22.
From upper part of bed. Insoluble residue, 7.40%, p. 12.
- B. Sec 36, T 11 S, R 19 W. Lab #E1-4-0. Idem, p. 9, 22.
Composite sample of two beds.
- C. Sec 36, T 11 S, R 19 W. Lab #E1-4-5. Idem.
- D. Sec 36, T 11 S, R 19 W. Lab #E1-4-6. Idem, p. 8, 9, 22.
- E. Sec 36, T 11 S, R 19 W. Lab #E1-4-7. Idem, p. 9, 22.
- F. Sec 36, T 11 S, R 19 W. Lab #E1-4-8. Idem.
- G. Sec 36, T 11 S, R 19 W. Lab #E1-4-9. Idem, p. 8, 9, 17, 22.
- H. Sec 11, T 13 S, R 20 W. Lab #E1-1-3. Idem, p. 8, 9, 22.

	A	B	C	D	E	F	G	H
SiO ₂	3.69	1.09	2.12	2.66	4.99	3.87	3.79	3.46
Al ₂ O ₃	2.75 ^{b/}	0.48 ^{b/}	0.62 ^{b/}	0.34 ^{b/}	2.91 ^{b/}	2.62 ^{b/}	1.47 ^{b/}	1.90
Fe ₂ O ₃		0.43	1.17	1.60 ^{b/}			1.97 ^{b/}	1.56
MgO	0.38	0.13	0.12					0.81
CaO	51.76	54.63	53.21	52.63	50.63	51.64	52.04	51.53
P ₂ O ₅	0.20	nil	nil	nil	nil	nil	nil	tr
S	nil	0.13	nil	0.02	0.01	0.10	0.01	nil
Ignit loss ^{a/}	40.70	42.34	41.81	41.79	40.47	40.70	40.69	40.11
Total	99.48	99.23	99.03	99.04	99.01	98.93	99.97	99.37
Class	4,3,91	1,1,96	2,2,94	3,2,94	5,4,90	4,3,91	4,4,91	3,4,89
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} 140° to 1000°C
^{b/} Includes TiO₂

Spectrographic analysis, graphite electrodes used, key to symbols, p. 17
 (Higher numbers indicate greater abundance)

P	2
Ti	1
Mn	2

H Group

Kansas

A. Ellis Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 11, T 13 S, R 20 W. Analyst, R. Runnels. Lab #El-1-5. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 17, 22.
Possible use: Whiting, p. 32.

B. Ellis Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 11, T 13 S, R 20 W. Analyst, R. Runnels. Lab #El-1-7. Idem, p. 9, 22.
Insoluble residue, 3.60%, p. 12.
Possible use: Whiting, p. 32.

C. Ellis Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Sec 11, T 13 S, R 20 W. Analyst, R. Runnels. Lab #El-1-11. Idem, p. 8, 9, 22.
Possible use: Whiting, p. 32.

D. Finney Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. SW 1/4 NW 1/4 sec 22, T 22 S, R 30 W. Analyst, R. Runnels. Lab #Fn-1-0. Idem.
Chalk, white. Spot sample from above lowest visible bed; lower Fort Hays contact not seen. From quarry, reserves moderate, p. 33.
Use: Building blocks. Possible uses: Lime, whiting, p. 95, 102.

E. Finney Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. SW 1/4 NW 1/4 sec 22, T 22 S, R 30 W. Analyst, R. Runnels. Lab #Fn-1-1. Idem.
Chalk, white. Spot sample from above lowest visible bed; lower Fort Hays contact not seen. From quarry, reserves moderate, p. 33.
Use: Building blocks. Possible uses: Lime, whiting, p. 95, 102.

F. Franklin Co. PENNSYLVANIAN, LANSING group, probably PLATTSBURG ls. ^{1/}
T 16 S, R 21 E, town of Lane. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79.
Limestone, quarried by Hanway. Physical properties. Bulk density, 2.68.
Use: Building stone.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E	F
SiO ₂	3.47	2.58	1.87	3.48	3.58	1.18 ^{c/}
Al ₂ O ₃	1.29 ^{b/}	1.57 ^{b/}	0.79 ^{b/}	0.92	1.17 ^{b/}	} 2.38
Fe ₂ O ₃	1.12	0.56	1.00	0.43 ^{b/}	0.51 ^{b/}	
MgO	nil	0.59	0.17		0.34	0.51 ^{a/}
CaO	52.88	52.48	53.56	52.34	53.31	53.09 ^{a/}
P ₂ O ₅	nil	nil	nil	0.07	nil	
S	nil	nil	nil	nil	nil	
Ignit Loss ^{a/}	40.43	40.95	41.59	41.07	41.76	
Total	99.19	98.53	98.98	98.31	100.47	57.16
Class	3,3,91	2,3,92	2,2,93	3,2,93	3,2,94	1,3,96
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} 140° to 1000°C
^{b/} Includes TiO₂
^{c/} Reported as insoluble residue; reported as SiO₂, USGS B 260, p. 509; USGS B 296, p. 57
^{d/} Calculated from reported MgCO₃ or CaCO₃

Spectrographic analysis, graphite electrodes used, key to symbols, p. 17
(Higher numbers indicate greater abundance)

A	
Ti	2
Mn	1

H Group

Kansas

A. Franklin Co. PENNSYLVANIAN, LANSING group, probably PLATTSBURG ls. ^{1/}
 T 18 S, R 21 E, town of Lane. Analyst, E. Bailey; collector, S. Williston.
 Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus,
 1898, Kans GS Ann B for 1897, p. 79.

Limestone, quarried by Hanway. Physical properties. Bulk density, 2.72.
 Use: Building stone.

B. Franklin Co. PENNSYLVANIAN, LANSING group, probably PLATTSBURG ls. ^{1/}
 T 18 S, R 21 E, town of Lane. Analyst, E. Bailey; collector, S. Williston.
 USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 79.

Limestone, quarried by Hanway. Physical properties. Bulk density, 2.69.
 Use: Building stone.

C. Franklin Co. PENNSYLVANIAN, LANSING group, probably PLATTSBURG ls. ^{1/}
 T 18 S, R 21 E, town of Lane. Analyst, E. Bailey; collector, S. Williston.
 USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 79.

Limestone, quarried by Hanway. Physical properties. Bulk density, 2.69.
 Use: Building stone.

D. Franklin Co. PENNSYLVANIAN, STANTON ls, STONER mem. T 16 S, R 19 E,
 town of Ottawa. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans
 GS B 90, pt 5, p. 85, 87.

12 ft thick. Bed close to surface; from Rose Quarry. Chemical analysis
 of calcined base also given, p. 91.

Possible use: Lime, p. 95, 99, 102.

E. Franklin Co. No stratigraphic position given. T 16 S, R 19 E, town of
 Ottawa. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95,
 pt 4, p. 504. Kans GS Ann B for 1897, p. 77.

Limestone. Physical properties. Bulk density, 2.65.

Use: Building stone. Suggested use: Cement material, Haworth, Erasmus,
 1903, Kans GS Ann B for 1902, p. 53.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	3.82 ^{a/}	3.94 ^{a/}	4.79 ^{a/}	1.72	8.00 ^{a/}
Al ₂ O ₃		} 1.20	} 1.18	0.39 ^{c/}	} 1.35
Fe ₂ O ₃				0.50	
FeO	0.77 ^{b/}				
MgO	0.62 ^{b/}	0.57 ^{b/}	0.60 ^{b/}	0.51	0.06 ^{b/}
CaO	52.78	52.44	52.27	53.97 ^{a/}	50.42 ^{b/}
P ₂ O ₅				0.02 ^{a/}	
SO ₃					0.02
S				0.03 ^{e/}	
Ignit Loss				42.50 ^{e/}	
Total	57.99	58.15	58.84	99.64	59.85
Class	4,1,95	4,2,94	5,1,93	2,1,96	8,2,90
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue; reported as

^{b/} SiO₂, USGS B 260, p. 509; USGS B 296, p. 57

^{c/} Calculated from reported MgCO₃ or CaCO₃

^{d/} Includes TiO₂ and MnO when present

^{e/} Rounded off to two decimal places

^{f/} 105° to 1000°C

H Group

Kansas

A. Greenwood Co. PENNSYLVANIAN, OREAD ls. ^{1/} SE 1/4 sec 13, T 28 S, R 12 E.
Analyst, G. Steiger, USGS lab #2295. Clarke, F. W., 1915, USGS B 591, p. 234.
Limestone.

B. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. T 24 S, R 39 W, from
quarry, NW of town of Kendall. Analyst, W. Wheeler. Darton, N. H., 1920, USGS
Folio 212, p. 8. Wells, R. C., 1937, USGS B 878, p. 53
Limestone.

Possible use: Cement material, p. 8.

C. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. T 24 S, R 40 W, quarry,
town of Syracuse. Analyst, W. Wheeler. USGS Folio 212, p. 8. USGS B 878,
p. 53.

Limestone.

Possible use: Cement material, p. 8.

D. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. Ledge SW of town of
Syracuse. Analyst, W. Wheeler. USGS Folio 212, p. 8. USGS B 878, p. 53.

Limestone.

Possible use: Cement material, p. 8.

E. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. 18 mi SW of town of
Syracuse. Analyst, W. Wheeler. USGS Folio 212, p. 8. USGS B 878, p. 53.

Limestone.

Possible use: Cement material, p. 8.

F. Hamilton Co. UPPER CRETACEOUS, GREENHORN ls. T 23 S, R 43 W, town of
Coolidge. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS
16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897,
p. 78.

Limestone.

Use: Building stone

^{1/} Letter from Kans GS, 7/16/53

	A	B ^{a/} b/	C ^{a/} b/	D ^{a/} b/	E ^{a/} b/	F
SiO ₂	2.56	3.61	3.18	2.72	1.79	4.81
Al ₂ O ₃	1.55					}3.07
Fe ₂ O ₃	0.50					
FeO	0.47					
MgO	0.06	0.32	0.47	0.49	0.40	0.40 ^{a/} c/
CaO	51.98	52.58	52.26	52.26	52.99	50.77 ^{a/} c/
H ₂ O-	}1.36					0.08
H ₂ O+						---
CO ₂	41.13					
Ignit Loss		42.04	42.35	42.32	43.39	
Total	99.61	98.55	98.26	97.79	98.57	59.13
Class	3,4,93	4,0,95	3,1,94	3,1,94	2,1,95	5,3,91
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} USGS B 878, p. 53
^{b/} Reported as insoluble residue

^{c/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Hamilton Co. UPPER CRETACEOUS, NIORARA fm, FORT HAYS ls mem. Sec 3, T 22 S, R 43 W. Analyst, R. Runnels. Lab #Ha-2-6. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

Chalk, bluish-gray; from above lowest visible bed; lower Fort Hays contact not seen. Few isolated outcrops.

B. Hamilton Co. UPPER CRETACEOUS, NIORARA fm, FORT HAYS ls mem. Sec 3, T 22 S, R 43 W. Analyst, R. Runnels. Lab #Ha-2-7. Idem.

Chalk, bluish-gray; from above lowest visible bed; lower Fort Hays contact not seen. Few isolated outcrops.

C. Hodgeman Co. UPPER CRETACEOUS, GREENHORN ls. ^{1/} T 23 S, R 23 W, town of Jetmore. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895; USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78.

Use: Building stone.

D. Jefferson Co. PENNSYLVANIAN, BURLINGAME ls. T 8 S, R 19 E, town of Winchester. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Kans GS Ann B for 1897, p. 79.

Limestone. Physical properties. Bulk density, 2.72.

Use: Building stone.

E. Jewell Co. UPPER CRETACEOUS, NIORARA fm, FORT HAYS ls mem. NW 1/4 sec 9, T 2 S, R 7 W. Analyst, R. Runnels. Lab #Jw-2-1b. Kans GS B 82, pt 1, p. 8, 9, 22.

Chalk, from upper part of basal bed. Insoluble residue, 7.73%, p. 12. Petrographic analysis, p. 14.

Possible use: Whiting, p. 32.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	2.48	2.28	5.06 ^{c/}	6.98 ^{c/}	3.70
Al ₂ O ₃)	1.37 ^{b/}	1.10 ^{b/}	2.08	1.04	3.60 ^{b/}
Fe ₂ O ₃)					
MgO	0.43	0.32	0.42 ^{d/}	0.79 ^{d/}	
CaO	53.56	54.00	51.15 ^{d/}	50.43 ^{d/}	51.45
P ₂ O ₅	nil	nil			nil
H ₂ O-			0.44		
S	nil	nil			nil
Ignit Loss ^{a/}	41.73	42.04			40.48
Total	99.57	99.74	59.15	59.24	99.23
Class	2,2,94	2,1,95	5,3,92	7,1,92	4,5,90
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} 140° to 1000°C
^{b/} Includes TiO₂

^{c/} Reported as insoluble residue
^{d/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A-G: UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Analyst, R. Runnels. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

- A. Jewell Co. NW 1/4 SW 1/4 sec 10, T 2 S, R 8 W. Lab #Jw-1-4a.
Chalk, from lower part of bed. Insoluble residue, 4.09%, p. 12.
Possible use: Whiting, p. 32.
- B. Jewell Co. NW 1/4 SW 1/4 sec 10, T 2 S, R 8 W. Lab #Jw-1-6.
Chalk, 39 ft thick in quarry face. Insoluble residue, 2.92%, p. 12.
Possible use: Whiting, p. 32.
- C. Jewell Co. NW 1/4 SW 1/4 sec 10, T 2 S, R 8 W. Lab #Jw-1-9.
Chalk. Insoluble residue 7.05%, p. 12.
Possible use: Whiting, p. 32.
- D. Jewell Co. NW 1/4 SW 1/4 sec 10, T 2 S, R 8 W. Lab #Jw-1-10.
Chalk. Insoluble residue 8.65%, p. 12.
Possible use: Whiting, p. 32.
- E. Jewell Co. Sec 27, T 4 S, R 8 W. Lab #Jw-3-1a.
Chalk. From lower part of basal bed. Insoluble residue 38.03%, p. 12.
Possible use: Whiting, p. 32.
- F. Lane Co. Sec 28, T 20 S, R 27 W. Lab #Ln-1-1a.
Chalk, from lowest part of basal bed. No extensive outcrop in Lane Co.
p. 34. Insoluble residue 8.69%, p. 12. Petrographic analysis, p. 14.
- G. Lane Co. Sec 28, T 20 S, R 27 W. Lab #Ln-1-1b.
Chalk, from upper part of basal bed. Insoluble residue 6.67%, p. 12.
Petrographic analysis, p. 14.

	A	B	C	D	E	F	G
SiO ₂	1.73	1.51	3.63	4.62	3.35	5.27	3.55
Al ₂ O ₃	0.74	0.75	1.28	1.00	1.44	0.67	0.97
Fe ₂ O ₃	1.20 ^{b/}	0.55 ^{b/}	1.34 ^{b/}	2.51 ^{b/}	1.12	1.54 ^{b/}	1.82 ^{b/}
MgO	0.65	0.20	0.26	0.06	nil	0.30	0.11
CaO	53.23	54.54	52.73	51.65	51.52	51.01	51.78
PaO ₅	tr	nil	nil	nil	0.04	0.14	0.13
S	0.23	0.01	tr	0.01	nil	nil	nil
Ignit Loss ^{a/}	41.38	41.56	40.64	39.64	40.26	40.02	41.11
Total	99.16	99.12	99.88	99.49	97.73	98.95	99.47
Class	2,2,93	2,2,94	4,3,91	5,4,88	3,3,90	5,3,90	4,3,92
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} 140° to 1000°
^{b/} Includes TiO₂

H Group

Kansas

A. Leavenworth Co. PENNSYLVANIAN, Wyandotte ls, Farley mem. T 11 S, R 23 E, town of Bonner Springs, Loring quarries. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 87.

Limestone. 22 ft thick. Chemical analysis of calcined base also given, p. 91

Possible uses: Whiting, lime, p. 95, 102.

B. Leavenworth Co. PENNSYLVANIAN, STANTON ls. ^{1/} T 9 S, R 23 E, town of Lansing. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 77.

Limestone. Physical properties. Bulk density, 2.70.

Use: Building stone. Suggested use: Cement material, Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 53.

C. Leavenworth Co. PENNSYLVANIAN, STANTON ls. ^{1/} T 9 S, R 23 E, town of Lansing. Analyst, E. Bailey; collector, S. Williston. USGS 16th Ann Rept for 1894-95, pt 4, p. 504. Kans GS Ann B for 1897, p. 77.

Limestone. Physical properties. Bulk density 2.71.

Use: Building stone. Suggested use: Cement material, Kans GS Ann B for 1902, p. 53.

D. Linn Co. PENNSYLVANIAN, HERTHA ls, Sniabar mem. SW 1/4 sec 27, T 21 S, R 24 E. Analysts, R. Runnels and J. Schleicher. Kans GS B 90, pt 5, p. 85, 87.

Limestone. 5 ft thick. Chemical analysis of calcined base also given, p. 91.

Possible uses: Whiting, lime, p. 95, 102; quality of rock makes quarrying doubtful.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂	1.30	5.91	6.20	2.54
Al ₂ O ₃	0.30	} 2.47	} 3.31	0.72
Fe ₂ O ₃	0.39			
MgO	0.98	0.53	0.90	0.53
CaO	54.04	50.35	49.39	53.33
P ₂ O ₅	tr			0.10
H ₂ O-			0.04	
SO ₃		0.38	0.28	
S	0.07			0.03
Ignit Loss	42.87			42.02
Total	99.95	59.64	60.12	99.54
Class	1,1,97	6,3,90	6,3,90	3,2,95
Ca:Mg	calcite	calcite	calcite	calcite

^{a/} 105° to 1000°C

^{b/} Includes TiO₂ and MnO when present

^{c/} Reported as insoluble residua

^{d/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

- A. Lyon Co. PENNSYLVANIAN, Reading ls. SW 1/4 SE 1/4 sec 33, T 21 S, R 11 E. O'Connor, H. G., et al, 1953, Kans GS v 12, p. 25.
Limestone. Composite of upper part of bed 5 ft thick.
Use: Building stone. Possible use: Agricultural ls, p. 26.
- B. Lyon Co. PENNSYLVANIAN, Grandhaven ls. SE 1/4 SW 1/4 sec 29, T 19 S, R 11 E. Idem.
Limestone. Composite of upper 7.5 ft of upper bed of formation.
Use: Concrete aggregate. Possible use: Agricultural ls, p. 26.
- C. Lyon Co. PENNSYLVANIAN, Grandhaven ls. NE 1/4 NE 1/4 sec 21, T 17 S, R 12 E. Idem.
Limestone. Composite of upper bed of formation, 2.6 ft thick.
Use: Concrete aggregate. Possible use: Agricultural ls, p. 26.
- D. Lyon Co. PENNSYLVANIAN, Aspinwall ls. NE 1/4 SW 1/4 sec 16, T 18 S, R 11 E. Idem.
Limestone. Composite of upper 4.6 ft of bed.
Use: Road metal. Possible use: Agricultural ls, p. 26.
- E. Lyon Co. PENNSYLVANIAN FORAKER ls, AMERICUS mem. SW 1/4 SE 1/4 sec 4, T 20 S, R 10 E. Idem.
Limestone. Composite of lower bed 1.8 ft thick.
Use: Building stone, p. 26.
- F. Lyon Co. PERMIAN, RED EAGLE ls, Howe ls mem. SE 1/4 NE 1/4 sec 34, T 15 S, R 11 E. Idem.
Limestone. Composite of lower 4 ft of 4.4 ft bed.
Possible uses: Building stone, agricultural ls, p. 26.

	A	B	C	D	E	F
SiO ₂	4.75	4.22	3.55	1.99	4.25	5.40
Al ₂ O ₃ ^{a/}	0.73	1.49	0.98	0.61	0.75	0.74
Fe ₂ O ₃	0.99	2.12	1.23	1.24	0.72	0.27
MgO	0.70	0.79	0.81	0.62	0.73	0.73
CaO	51.75	51.60	52.19	53.12	51.63	51.97
P ₂ O ₅	0.11	0.07	0.04	0.06	0.39	0.01
SO ₃	0.08	nil	0.19	0.04	0.14	0.07
Ignit Loss	40.67	40.54	41.63	42.17	40.68	41.33
Total	99.78	100.83	100.62	99.85	99.29	100.52
Class	5,2,91	4,5,90	4,3,93	2,2,95	4,2,91	5,1,93
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} Includes TiO₂ and MnO when present

H Group

Kansas

- A. Lyon Co. PERMIAN, NEVA ls. NW 1/4 SW 1/4 sec 20, T 16 S, R 11 E. O'Connor, H. G., et al, 1953, Kans GS v 12, p. 25. Limestone. Composite of middle bed 5.7 ft thick. Uses: Building stone, road metal. Possible use: Agricultural ls, p. 26.
- B. Lyon Co. PERMIAN, NEVA ls mem. NW 1/4 SW 1/4 sec 20, T 16 S, R 11 E. Idem. Limestone. Composite of upper bed of formation, 1.7 ft thick. Uses: Building stone, road metal. Possible use: Agricultural ls, p. 26.
- C. Lyon Co. PERMIAN, Beattie ls, COTTONWOOD ls mem. SW 1/4 NW 1/4 sec 7, T 18 S, R 10 E. Idem. Limestone. Composite of upper 4.7 ft. Uses: Building stone, road metal, concrete aggregate. Possible use: Agricultural ls, p. 26.
- D. Lyon Co. PERMIAN, Beattie ls, MORRILL ls mem. SW 1/4 NE 1/4 sec 17, T 16 S, R 11 E. Idem. Limestone. Composite of bed 2.4 ft thick. Possible use: Agricultural ls, p. 26.
- E. Lyon Co. PERMIAN, GARRISON sh, CROUSE ls mem. NE 1/4 NW 1/4 sec 15, T 16 S, R 10 E. Idem. Limestone. Composite of lower 2.9 ft of bed. Uses: Building stone, road metal. Possible use: Agricultural ls, p. 26.
- F. Lyon Co. PERMIAN, Funston ls. NW 1/4 NE 1/4 sec 18, T 16 S, R 10 E. Idem. Limestone. Composite of middle detrital bed 2.0 ft thick. Use: Building stone. Possible use: Agricultural ls, p. 26.

	A	B	C	D	E	F
SiO ₂	3.92	4.18	5.97	5.65	3.61	4.99
Al ₂ O ₃ ^{a/}	0.93	0.62	1.09	0.37	0.98	1.25
Fe ₂ O ₃	0.53	0.46	0.37	0.42	1.12	1.01
MgO	0.77	0.64	0.65	0.82	0.74	0.79
CaO	52.07	52.25	51.22	51.93	51.78	50.72
P ₂ O ₅	0.05	0.03	0.08	0.05	0.03	0.06
SO ₃	0.02	0.03	0.12	0.08	0.09	0.02
Ignit Loss	41.53	41.42	40.65	41.14	41.25	40.46
Total	99.82	99.63	100.15	100.46	99.60	99.30
Class	4,2,93	4,1,93	6,2,91	6,1,93	4,3,92	5,3,90
Ce:Mg	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} Includes TiO₂ and MnO when present

H Group

Kansas

A-G: Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 504, 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 77, 79.

Limestone. Physical properties.

Use: Building stone.

- A. Marion Co. PERMIAN, Barneston ls, FORT RILEY man. $\frac{1}{2}$ T 19 S, R 4 E, 5 mi NE of town of Marion.
Average of 5 blocks, produced by I. Kuhn and Co. Bulk density, 2.73.
- B. Marion Co. PERMIAN, CHASE group. $\frac{1}{2}$ T 19 S, R 4 E, town of Marion.
Dolomitic; gray, fine-grained, smooth surface. Bulk density, 2.67.
- C. Marion Co. PERMIAN, CHASE group. $\frac{1}{2}$ T 19 S, R 4 E, town of Marion.
Bulk density, 2.72.
- D. Marion Co. PERMIAN, CHASE group. $\frac{1}{2}$ No locality given.
Bulk density, 2.69.
- E. Miami Co. PENNSYLVANIAN, Dennis or Swope ls. $\frac{1}{2}$ T 19 S, R 23 E, town of Fontana.
Bulk density, 2.50.
- F. Miami Co. PENNSYLVANIAN, Dennis or Swope ls. $\frac{1}{2}$ T 19 S, R 23 E, town of Fontana.
Bulk density, 2.65.
- G. Miami Co. PENNSYLVANIAN, Dennis or Swope ls. $\frac{1}{2}$ T 19 S, R 23 E, town of Fontana.
Bulk density, 2.33.

$\frac{1}{2}$ Letter from Kans GS, 7/16/53

	A	B	C	D	E	F	G
SiO ₂ ^{a/}	6.75	5.13	6.85	5.51	1.50	1.35	2.44
Al ₂ O ₃)	1.59	3.15	1.91	1.24	0.95	1.32	0.82
Fe ₂ O ₃)							
MgO ^{b/}	19.36	18.32	14.38	0.77	0.35	0.48	0.38
CaO ^{b/}	26.60	29.78	33.17	51.26	54.06	53.83	53.54
H ₂ O-			0.90				
SO ₃			0.95				
Total	56.30	56.38	58.16	58.78	56.86	56.98	57.18
Class	7,2,91	5,4,90	7,3,89	6,2,93	2,1,97	1,2,97	2,1,96
Ca:Mg	dolomite	dolomite	calc dol	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

H Group

Kansas

A. Miami Co. PENNSYLVANIAN, STANTON ls, STONER mem. Killough quarry, town of Wellsville. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 88.

Limestone, 14 ft thick; contains clay impurities, p. 99. Characteristics of lime, p. 89. Chemical analysis of calcined base also given, p. 91. Possible uses: Whiting, lime, p. 95, 102.

B. Mitchell Co. No stratigraphic position given. T 6 S, R 10 W, "Great Spirit" Spring, 2 1/2 mi SE of town of Cawker. Analyst, G. Patrick. Patrick, G. E., 1881, Kans Acad Sci Trans, v 7, p. 25.

Limestone, porous. Hardness ranges from 4-5.

C. Neosho Co. PENNSYLVANIAN, IOLA ls, Raytown mem. T 27 S, R 18 E, Ash Grove Lime and Cement Company, town of Chanute. Analysts, R. Runnels and J. Schleicher. Kans GS B 90, pt 5, p. 85, 88.

Limestone, 25 ft thick. Quality marginal, quantity good. Characteristics of lime, p. 89. Chemical analysis of calcined base also given, p. 91. Possible uses: Whiting, lime, p. 95, 102.

D. Ness Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Sec 33, T 18 S, R 26 W. Analyst, R. Runnels. Lab #Ns-1-2. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22, 34.

Chalk. Above lowest visible bed; lower Fort Hays contact not seen.

E. Ness Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Sec 33, T 18 S, R 26 W. Analyst, R. Runnels. Lab #Ns-1-3. Idem.

Chalk. Above lowest visible bed; lower Fort Hays contact not seen.

	A	B	C	D	E
SiO ₂	2.73 ^{a/}	2.03	2.51 ^{a/}	2.90	3.25
Al ₂ O ₃	0.88 ^{a/}		0.72 ^{a/}	1.50	1.52
Fe ₂ O ₃	0.70		0.93	0.70 ^{e/}	0.56 ^{e/}
FeO		1.07			
MgO	0.52	1.32	1.59	1.47	0.74
CaO	52.94 ^{b/}	52.99	51.50	51.21	52.17
P ₂ O ₅	0.03 ^{b/}		0.06	nil	nil
CO ₂		42.59 ^{d/}			
S	0.03		0.08	nil	nil
Ignit loss	42.15 ^{e/}		42.30 ^{e/}	41.85 ^{e/}	41.69 ^{e/}
Total	99.98	100.00	99.69	99.63	99.93
Class	3,2,95	2,1,96	3,2,95	3,3,93	3,3,93
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Includes TiO₂ and MnO when present

^{b/} Rounded off to two decimal places

^{c/} 105° to 1000°C

^{d/} Presumably by difference

^{e/} Includes TiO₂

^{f/} 140° to 1000°C

H Group

Kansas

A. Norton Co. TERTIARY, ^{1/} Loup Fork beds. ^{1/} T 2 S, R 23 W, town of Norton. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 78. Limestone. Average from 4 blocks. Physical properties. Bulk density, 2.51. Use: Building stone.

B. Osage Co. PENNSYLVANIAN, TOPEKA ls, Curzon mem. Sec 14, T 18 S, R 14 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1951, Kans GS B 90, pt 5, p. 85, 88.

Limestone, 8 ft thick. Composite of two samples. Chemical analysis of calcined base also given, p. 91.

Possible uses: Whiting, lime, p. 95, 102.

C. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Secs 19, 30, T 9 S, R 12 W. Analyst, R. Runnels. Lab #Ob-4-7. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22, 25, 34.

Chalk in 33 ft section. Insoluble residue, 2.67%, p. 12.

Possible use: Whiting, p. 32.

D. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Secs 19, 30, T 9 S, R 12 W. Analyst, R. Runnels. Lab #Ob-4-10. Idem.

Chalk in 33 ft section. Insoluble residue, 7.10%, p. 13.

Possible use: Whiting, p. 32.

E. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 sec 13, T 7 S, R 15 W. Analyst, R. Runnels. Lab #Ob-1-2. Idem, p. 8, 9, 23, 34.

40 ft of chalk in locality. Above lowest visible bed; lower Fort Hays contact not seen.

Possible use: Whiting, p. 32.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	8.29 ^{a/}	2.14 ^{c/}	1.00 ^{e/}	4.38 ^{e/}	2.47
Al ₂ O ₃		0.50 ^{c/}	0.49 ^{e/}	1.40 ^{e/}	} 2.26 ^{e/}
Fe ₂ O ₃		0.67	0.79	1.03	
FeO	0.90 ^{b/}				
MgO	0.96 ^{b/}	0.75	0.22	0.16	0.32
CaO	49.86 ^{b/}	53.20	54.26	51.92	53.34
P ₂ O ₅		0.07	tr	nil	nil
S		0.03 ^{d/}	nil ^{f/}	nil ^{f/}	nil ^{f/}
Ignit Loss		42.35 ^{d/}	42.67 ^{f/}	40.95 ^{f/}	41.56 ^{f/}
Total	60.01	99.71	99.43	99.84	99.95
Class	8,1,90	2,1,95	1,2,96	4,3,92	2,3,93
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

^{c/} Includes TiO₂ and MnO when present

^{d/} 105° to 1000°C

^{e/} Includes TiO₂

^{f/} 140° to 1000°C

H Group

Kansas

A. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 sec 13, T 7 S, R 15 W. Analyst, R. Runnels. Lab #Ob-1-3. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 23, 34.

Chalk.

Possible use: Whiting, p. 32.

B. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 sec 13, T 7 S, R 15 W. Analyst, R. Runnels. Lab #Ob-1-4. Idem, p. 8, 9, 17, 23, 34.

Chalk.

Possible use: Whiting, p. 32.

C. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. NW 1/4 sec 13, T 7 S, R 15 W. Analyst, R. Runnels. Lab #Ob-1-5. Idem.

Chalk.

Possible use: Whiting, p. 32.

D. Osborne Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Secs 19, 20, 29, 30, T 10 S, R 15 W. Analyst, R. Runnels. Lab #Ob-2-1b. Idem, p. 8, 9, 23, 34.

Chalk, from upper part of basal bed. Insoluble residue, 6.77%, p. 12.

Possible use: Whiting, p. 32.

E. Phillips Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. SE 1/4 SW 1/4 sec 36, T 4 S, R 18 W. Analyst, R. Runnels. Lab #Ph-1-1b. Idem, p. 8, 9, 23.

Chalk from upper part of basal bed. Petrographic analysis, p. 14.

Use: Development improbable; small outcrops, other quarries nearby. p. 34.

	A	B	C	D	E
SiO ₂	3.14	3.43	0.93	2.53	3.05
Al ₂ O ₃	} 1.91 b/	} 3.92 b/	} 0.96 b/	0.83	0.85 b/
Fe ₂ O ₃				1.90 b/	1.80
MgO	0.18	0.40	0.30	0.14	0.36
CaO	52.73	51.67	54.63	52.59	52.60
P ₂ O ₅	nil	nil	nil	nil	nil
S	nil	nil	nil	nil	nil
Ignit Loss a/	41.46	40.78	42.73	40.72	41.08
Total	99.42	100.20	99.55	98.71	99.74
Class	3,2,93	3,5,90	1,1,97	3,3,91	3,3,92
Ca:Mg	calcite	calcite	calcite	calcite	calcite

a/ 140° to 1000°C

b/ Includes TiO₂

Spectrographic analyses, graphite electrodes used, key to symbols, p. 17
(Higher numbers indicate greater abundance)

	B	C
P	2	2
Ti	1	2
Mn	1	1

H Group

Kansas

- A. Rice Co. PERMIAN, STONE CORRAL dol. T 20 S, R 6 W. Jewett, J. M., and Schoewe, W. H., 1942, Kans GS B 41, pt 3, p. 111.
Rock conveniently situated for stripping. Tonnage estimate, p. 111.
Possible use: Magnesium, p. 110.
- B. Rice Co. PERMIAN, STONE CORRAL dol. T 20 S, R 6 W. Idem.
Rock conveniently situated for stripping. Tonnage estimate, p. 111.
Possible use: Magnesium, p. 110.
- C. Rice Co. PERMIAN, STONE CORRAL dol. T 20 S, R 6 W. Idem, p. 110, 111.
Rock conveniently situated for stripping. Tonnage estimate, p. 111.
Possible use: Magnesium, p. 110.
- D. Rice Co. PERMIAN, STONE CORRAL dol. T 20 S, R 6 W, Idem.
Rock conveniently situated for stripping. Tonnage estimate, p. 111.
Possible use: Magnesium, p. 110.
- E. Rocks Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 26, T 10 S, R 17 W. Analyst, R. Runnels. Lab #Ro-3-A4. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.
Approx 16 ft from base of 56 ft section in roadcut south of Codell, p. 25.
Insoluble residue 3.89%, p. 13.
Possible use: Whiting, p. 35.
- F. Rocks Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 26, T 10 S, R 17 W. Analyst, R. Runnels. Lab #Ro-3-6. Idem.
Approx 20 ft from base of 56 ft section in roadcut south of Codell, p. 25.
Insoluble residue 3.95%, p. 13.
Possible use: Whiting, p. 35.
- G. Rocks Co. UPPER CRETACEOUS, NIOBRARA fm, FORT HAYS ls mem. Sec 26, T 10 S, R 17 W. Analyst, R. Runnels. Lab #Ro-3-11. Idem.
Middle of 56 ft section in roadcut south of Codell, p. 25. Insoluble residue 4.96%, p. 13.
Possible use: Whiting, p. 35.

	A	B	C	D	E	F	G
SiO ₂	2.68	2.48	2.52	3.04	1.52	1.93	2.13
Al ₂ O ₃	2.54	2.61	2.89	1.43	1.03 ^{a/}	1.27 ^{a/}	0.79 ^{a/}
Fe ₂ O ₃	0.54	0.35	0.35	0.53	0.94	1.79	1.03
MgO	15.35	14.08	13.52	14.40	0.23	0.40	0.13
CaO	33.82	35.92	36.44	36.22	54.00	52.61	53.41
P ₂ O ₅					nil	nil	nil
S					nil	nil	nil
Ignit Loss	43.25	43.46	43.29	41.40	42.11 ^{b/}	42.02 ^{b/}	41.55 ^{b/}
Total	98.18	98.90	99.01	97.02	99.83	100.02	99.04
Class	3,4,91	2,4,92	3,4,91	3,2,88	2,2,95	2,4,94	2,2,93
Ca:Mg	calc dol	calc dol	calc dol	calc dol	calcite	calcite	calcite

^{a/} Includes TiO₂

^{b/} 140° to 1000°C

H Group

Kansas

A-H: Rooks Co. UPPER CRETACEOUS, NIORRARA fm, FORT HAYS ls mem. Analyst, R. Runnels. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1. Possible use: Whiting, p. 32, 35.

A. Sec 26, T 10 S, R 17 W. Lab #Ro-3-22. Idem, p. 8, 9, 22. Approx 13 ft from top of 56 ft section in roadcut, south of Codell, p. 25. Insoluble residue 7.50%, p. 13.

B. Sec 26, T 10 S, R 17 W. Lab #Ro-3-26. Idem. Top of 56 ft section in roadcut south of Codell, p. 25. Insoluble residue 7.46%, p. 13. Petrographic analysis, p. 14.

C. Sec 35, T 10 S, R 17 W. Lab #Ro-1-1. Idem. From basal bed.

D. Sec 35, T 10 S, R 17 W. Lab #Ro-1-2w. Idem.

E. Sec 35, T 10 S, R 17 W. Lab #Ro-1-4w. Idem.

F. Sec 35, T 10 S, R 17 W. Lab #Ro-1-5w. Idem, p. 8, 9, 23.

G. Sec 35, T 10 S, R 17 W. Lab #Ro-1-6w. Idem.

H. Sec 34, T 7 S, R 19 W. Lab #Ro-4-a-1b. Idem. From upper part of basal bed.

	A	B	C	D	E	F	G	H
SiO ₂	1.70	4.08	3.14	2.53	2.15	2.97	4.00	4.32
Al ₂ O ₃	3.12 ^{b/}	2.88 ^{b/}	1.78 ^{b/}	1.76	0.67	0.72	0.75	0.42
Fe ₂ O ₃	2.57	1.21	0.68	1.32 ^{b/}	1.35 ^{b/}	1.73 ^{b/}	2.33 ^{b/}	3.64 ^{b/}
MgO	0.26	lost	0.07	0.07	0.58	0.82	0.81	0.13
CaO	52.51	51.07	51.85	50.98	52.16	51.37	50.45	50.15
F ₂ O ₅	nil	0.07	tr	0.10	0.06	0.10	0.16	0.09
S	nil	nil	nil	0.10	tr	tr	0.02	nil
Ignit Loss ^{a/}	40.74	40.15	41.64	41.24	41.89	41.46	40.65	39.39
Total	100.90	99.46	99.09	98.10	98.86	99.17	99.17	98.14
Class	2,7.89	4,5.90	3,2.93	3,4.91	2,3.94	3,3.93	4,4.90	4,5.87
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

^{a/} 140° to 1000°C

^{b/} Includes TiO₂

H Group

Kansas

A-G: Smith Co. UPPER CRETACEOUS, NEBRARA fm, FORT HAYS ls mem. Analyst, R. Runnels. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1.

A-F: Possible use: Whiting, p. 35.

A. NE 1/4 sec 32, T 5 S, R 13 W. Lab #Sm-1-1b. Idem, p. 8, 9, 17, 22, 24. From upper part of basal bed 6 ft above top of Codell ss. Insoluble residue 7.27%, p. 13.

B. NE 1/4 sec 32, T 5 S, R 13 W. Lab #Sm-1-2. Idem. Insoluble residue 4.17%, p. 13.

C. NE 1/4 sec 32, T 5 S, R 13 W. Lab #Sm-1-6. Idem. Insoluble residue 2.36%, p. 13.

D. NE 1/4 sec 32, T 5 S, R 13 W. Lab # Sm-1-9. Idem. Insoluble residue 2.91%, p. 13.

E. NE 1/4 sec 32, T 5 S, R 13 W. Lab # Sm-1-12. Idem. Insoluble residue 4.17%, p. 13.

F. NE 1/4 sec 32, T 5 S, R 13 W. Lab # Sm-1-13. Idem. From top bed; 32 ft above top of Codell ss.

G. SW 1/4 sec 36, T 4 S, R 15 W. Lab #Sm-2-1b. Idem, p. 8, 9, 22. Chalk, mined in small quarry, p. 35. 6 ft from bottom of basal bed, p. 24. Insoluble residue 7.88%, p. 13. Petrographic analysis, p. 14. Use: Whiting, p. 35.

	A	B	C	D	E	F	G
SiO ₂	3.37	1.68	1.02	1.38	1.58	1.78	4.10
Al ₂ O ₃	1.74	0.82	0.49	0.57	1.05	0.63	1.71
Fe ₂ O ₃ a/	1.77	1.14	0.48	1.09	0.85	0.65	0.66
MgO	0.79	0.03	0.25	0.30	1.29	0.10	2.63
CaO	51.88	53.25	53.91	53.58	52.02	54.62	50.39
P ₂ O ₅	nil	nil	nil	nil	nil	tr	tr
S	nil	nil	nil	nil	nil	tr	nil
Ignit Loss b/	40.87	42.49	42.91	42.62	42.22	41.30	40.52
Total	100.42	99.41	99.06	99.54	99.01	99.08	100.01
Class	3,4,91	2,3,95	1,1,97	1,2,96	2,2,94	2,2,93	4,3,90
Ca:Mg	calcite	calcite	calcite	calcite	calcite	calcite	mag calc

a/ Includes TiO₂

b/ 140° to 1000°C

Spectrographic analyses, graphite electrodes used, key to symbols, p. 17 (Higher numbers indicate greater abundance)

	F	G
P	nil	1
Ti	2	1
Mn	1	1

H Group

Kansas

A-E: Smith Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem.
Possible use: Whiting.

A. SW 1/4 sec 36, T 4 S, R 15 W. Analyst, R. Runnels. Lab #Sm-2-4.
Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 17, 22, 24.
Insoluble residue 10.12%, p. 13.

B. SW 1/4 sec 36, T 4 S, R 15 W. Analyst, R. Runnels. Lab #Sm-2-9. Idem.
Insoluble residue 4.59%, p. 13.

C. SW 1/4 sec 36, T 4 S, R 15 W. Analyst, R. Runnels. Lab #Sm-2-14. Idem.
Insoluble residue, 1.96%, p. 13.

D. SW 1/4 sec 36, T 4 S, R 15 W. Analyst, R. Runnels. Lab #Sm-2-15. Idem.
Insoluble residue 3.79%, p. 13.

E. No locality given. Analyst, R. Thompson. Jewett, J. M., and Schoewe, W. H.,
1942, Kans GS B 41, pt 3, p. 128.
Chalk. Tonnage estimate, p. 128.

	A	B	C	D	E
SiO ₂	5.84	2.51	1.09	2.43	1.50
Al ₂ O ₃	1.74 <u>a/</u>	0.64 <u>a/</u>	0.50 <u>a/</u>	1.20 <u>a/</u>	1.35
Fe ₂ O ₃	0.65	0.53	0.10	0.46	0.55
MgO	1.38	1.05	1.08	1.11	0.55
CaO	49.75	52.65	55.01	53.64	54.80
P ₂ O ₅	tr	tr	tr	tr	
S	nil <u>b/</u>	nil <u>b/</u>	nil <u>b/</u>	nil <u>b/</u>	
Ignit Loss	39.86	41.75	42.96	42.01	42.18
Total	99.22	99.13	100.74	100.85	100.93
Class	6,3,89	3,1,94	1,1,97	2,2,94	2,2,95
Ca:Mg	calcite	calcite	calcite	calcite	calcite

a/ Includes TiO₂

b/ 140° to 1000°C

Spectrographic analyses, graphite electrodes used, key to symbols, p.17
(Higher numbers indicate greater abundance)

	B	C	D
P	2	nil	1
Ti	1	2	1
Mn	1	1	1

H Group

Kansas

A. Trego Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. NE 1/4 SE 1/4 sec 1, T 15 S, R 23 W. Analyst, R. Runnels. Lab #Tr-1-15. Runnels, R. T., and Dubins, I. M., 1949, Kans GS B 82, pt 1, p. 8, 9, 22.

Chalk; incomplete section measures 55 ft, p. 35.

Possible use: Whiting, p. 32.

B. Trego Co. UPPER CRETACEOUS, NIobrARA fm, FORT HAYS ls mem. Secs 4, 5, 8, 9, T 15 S, R 23 W. Analyst, R. Runnels. Lab #Tr-2-1. Idem.

Chalk from basal bed.

Possible use: Whiting, p. 35.

C. Trego Co. UPPER CRETACEOUS, NIobrARA fm, SMOKY HILL chalk mem. 1/2 300 to 320 miles W of Kansas City within 3 mi of Kansas Pacific RR. Analyst, G. Patrick. Patrick, G. E., 1875, Kans Acad Sci Trans, v 4, p. 14. Elias, M. K., 1931, Kans GS B 18, p. 38.

Chalk, lower half of member. Fine-grained, snowy white.

Possible uses: Whiting, putty, calcimine, cement ingredient.

D. Webbaunsee Co. PERMIAN, Beattie ls, COTTONWOOD mem. 1/2 T 11 S, R 10 E, town of McFarland. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895, USGS 16 Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898, Kans GS Ann B for 1897, p. 79.

Limestone. Average from 5 blocks. Physical properties. Bulk density, 2.50.

Use: Building stone.

1/ Letter from Kans GS, 7/16/53

	A	B	C	D
SiO ₂	1.66	2.82	0.69 g/	3.27 g/
Al ₂ O ₃	0.29 b/	} 1.41 b/	} 0.43	} 2.61
Fe ₂ O ₃	0.64			
FeO			0.09 g/	
MgO	0.19	0.49		0.77 g/
CaO	53.45	52.91	55.17 g/	51.82 g/
P ₂ O ₅	nil	nil		
H ₂ O-			0.34	
S	tr	nil		
Ignit Loss g/	41.61	41.48		
Total	97.84	99.11	56.72	58.47
Class	2,1,94	3,2,93	1,1,98	3,3,93
Ca:Mg	calcite	calcite	calcite	calcite

a/ 140° to 1000°C

b/ Includes TiO₂

c/ Reported as insoluble residue

d/ Calculated from reported carbonate constituents

e/ Calculated from reported MgCO₃ or CaCO₃

Spectrographic analysis, graphite electrodes used, key to symbols, p. 17
(Higher numbers indicate greater abundance)

P	2
Ti	2
Mn	1

H Group

Kansas

A. Wabaunsee Co. PERMIAN, Beattie ls, COTTONWOOD mem. $\frac{1}{2}$ T 12 S, R 10 E, town of Alma. Analyst, E. Bailey; collector, S. Williston. Day, W. C., 1895. USGS 16th Ann Rept for 1894-95, pt 4, p. 505. Haworth, Erasmus, 1898. Kans GS Ann B for 1897, p. 78.

Limestone. Physical properties. Bulk density, 2.67.
Use: Building stone.

B. Wilson Co. PENNSYLVANIAN, PLATTSBURG ls. T 30 S, R 16 E, town of Needlesha. Analysts, Lathbury and Spackman. Haworth, Erasmus, 1903, Kans GS Ann B for 1902, p. 30. Schrader, F. C., and Haworth, Erasmus, 1906, USGS B 296, p. 56.

Limestone. Screen, physical tests, and fired properties of cement mixture, Kans GS Ann B for 1902, p. 51.

Suggested use: Cement material when mixed with shale.

C. Wilson Co. PENNSYLVANIAN, STANTON ls. T 27 S, R 17 E, town of Villas. Schrader, F. C., and Haworth, Erasmus, 1905, USGS B 260, p. 509. USGS B 296, p. 57.

Limestone.

D. Wyandotte Co. PENNSYLVANIAN, Wyandotte ls, Argentine ls mem. Sec 23, T 11 S, R 23 E. Analysts, R. Runnels and J. Schleicher. Runnels, R. T., 1931, Kans GS B 90, pt 5, p. 85, 88.

13 ft thick. Chemical analysis of calcined base also given, p. 91

Possible use: Lime, p. 97, 102. Sample meets minimum chemical specifications.

E. Wyandotte Co. PENNSYLVANIAN, STANTON ls, STONER ls mem. SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec 36, T 10 S, R 23 E. Analysts, R. Runnels and J. Schleicher. Idem.

12 ft thick. Chemical analysis of calcined base also given, p. 91. Characteristics of lime, p. 89.

Possible use: Lime, p. 97, 102. Sample meets minimum chemical specifications.

$\frac{1}{2}$ Letter from Kans GS, 7/16/53

	A	B	C	D	E
SiO ₂	6.22 ^{a/}	3.11 ^{c/}	2.02	2.98	3.15
Al ₂ O ₃	1.74	1.06	2.65	1.61 ^{d/}	0.88 ^{d/}
Fe ₂ O ₃	)	)	)	0.48	1.32
MgO	0.95 ^{b/}	tr	0.05 ^{b/}	0.08	1.30
CaO	50.24 ^{b/}	52.40	53.82 ^{b/}	52.69	51.35
P ₂ O ₅				0.12	0.03
SO ₃		none			
S					0.05
Ignit Loss		42.45		41.51 ^{e/}	41.82 ^{e/}
Total	59.15	99.02	58.54	99.47	99.88
Class	6,2,92	3,2,94	2,3,93	3,3,93	3,3,93
Ca:Mg	calcite	calcite	calcite	calcite	calcite

^{a/} Reported as insoluble residue

^{b/} Calculated from reported MgCO₃ or CaCO₃

^{c/} Includes insoluble residue

^{d/} Includes TiO₂ and MnO when present
^{e/} 105° to 1000°C

Group H, 90- [Carbonates from 90% to 100%; $SiO_2 + (H_2O_3 \cdot nH_2O) + Carbonates < 90\%$]

Kansas

A. Crawford Co. PENNSYLVANIAN, CHEROKEE group, ARDMORE ls mem. Sec 32, T 27 S, R 25 E. Analyst, G. Steiger. Pierce, W. G., and Courtier, W. H., 1937, Kans GS B 24, p. 31, 32.

Partial analysis suggests 7.2% ferrous carbonate.

Limestone. Light portion of mottled rock, soluble in 1 HCl + 5 H₂O, boiling 5 minutes.

See "A", p.116 for analysis of dark portion of same rock. Analysis of insoluble fraction: SiO_2 , 8.66; Al_2O_3 , 3.32; Fe_2O_3 , 0.76; MgO, 0.35; CaO, none; TiO_2 , 0.13.

A	
SiO_2	0.23
Al_2O_3	0.93
Fe_2O_3	none
FeO	4.44
MgO	6.00
CaO	36.02
TiO_2	none
MnO	0.18
Total	47.80
Class	0,7,77
Ca:Mg	mag calc

Miscellaneous Sedimentary Rocks

[Predominant constituents other than SiO_2 , $\text{R}_2\text{O}_n \cdot \text{H}_2\text{O}$, and $(\text{Ca}, \text{Mg}) \text{CO}_3$]

I Calcium Sulfate Rocks

Kansas

A. Barber Co. PERMIAN, BLAINE fm, MEDICINE LODGE gypsum mem. At Kling, NW corner of County. Analysts, E. Bailey and M. Whitten. Bailey, E. H. S., and Whitten, M. W., 1896, Kans Univ Quart v 6, p. 30. Grimsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 147.

Gypsum, white, 25 ft thick. Upper part, sugary texture; lower part, compact. Areal extent and geologic section, idem, p. 70, 71, 72.

Uses: Plaster, terra alba, idem, p. 70.

B. Barber Co. PERMIAN, BLAINE fm, MEDICINE LODGE gypsum mem. At Kling, NW corner of county. Analyzed in lab of U. S. Bureau of Standards, Washington, D. C. Stone, R. W., 1920, USGS B 697, p. 28.

Gypsum from bed 20 to 25 ft thick; quarried by Best Bros. Bottom 3 ft hard, darker; not quarried. Overburden, 30 ft, p. 118.

C. Butler Co. Recent (?) surface deposit. T 23 S, R 4 E, 7 1/2 mi SW of town of Burns, near Davis Creek. Analysts, E. Bailey, and D. McFarland. Kans GS v 5, p. 154.

Gypsite, whiter than any other known gypsite deposits; contains uniform-sized, perfect, minute gypsum crystals. Averages 6 ft thick over 2 acres; thinner beyond.

Use: Plaster manufactured by Kansas Southern Cement Plaster Co., p. 67, 68.

D. Clay Co. PERMIAN, WELLINGTON fm (?). T 10 S, R 1 E, town of Longford. Analysts, E. Bailey and O. Stafford. Kans Univ Quart, v 6, p. 53.

Gypsum.

E. Clay Co. Recent (?) surface deposit. T 10 S, R 1 E, town of Longford. Analysts, E. Bailey, and O. Stafford. Kans GS v 5, p. 152.

Gypsite, near creek 4 miles E of mill. From 2 to 10 ft thick over area of 60 acres.

Use: Plaster manufactured by Agatite Cement Plaster Co., p. 65.

	A	B	C	D	E
SiO_2 ^{a/}	0.19	none	2.31	18.69	10.23
Al_2O_3 }	0.10		0.37	1.21	1.12
Fe_2O_3					
MgO	0.16		0.25	0.43	0.45
CaO	32.53	32.72	34.52	26.71	30.78
H ₂ O	20.46	20.80	17.72	15.29	17.10
SO ₃	45.73	46.53	39.95	33.27	34.56
Total	99.17	100.05	95.12	95.60	94.24

^{a/} Includes insoluble residue

I Calcium Sulfate Rocks

Kansas

A. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Hope or Solomon gypsum bed. T 16 S, R 3 E, 1 3/4 mi W of town of Hope. Analysts, E. Bailey and M. Whitten. Bailey, E. H. S., and Whitten, M. W., 1896, Kans Univ Quart v 6, p. 30. Grinsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 146, 147.

Gypsum, composite sample from five cars at entrance of Hope shaft. About 5 ft thick, white, compact; associated with satin spar. Thin deposit of black, impure shaly gypsum overlies bed, idem, p. 59, 60.

Use: Plaster, p. 59.

B. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Hope or Solomon gypsum bed. T 16 S, R 3 E, 1 3/4 mi W of town of Hope. Analysts, E. Bailey and M. Whitten. Kans Univ Quart v 6, p. 30. Kans GS v 5, p. 146, 147.

Gypsum from shaft 80 ft deep; 1/4 mi W of Hope quarry. About 14 ft thick, white; traversed by wavy dark lines giving gneissic appearance. Lower part contains rounded selenite crystals with dark mottled surfaces.

Use: Plaster, idem, p. 60.

C. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Solomon gypsum bed. T 16 S, R 2 E, 4 mi S of town of Dillon. Analysts, E. Bailey and E. Franklin. Kans GS v 5, p. 146.

Gypsum.

D. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Solomon gypsum bed. T 16 S, R 3 E, small quarry south of town of Dillon. Analysts, E. Bailey and M. Whitten. Idem.

E. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Solomon gypsum bed. T 14 S, R 1 W, 1/4 mi E of Solomon mill. Analysts, E. Bailey and M. Whitten. Kans Univ Quart v 6, p. 31. Kans GS v 5, p. 148.

Gypsum.

Use: Plaster, idem, p. 148.

F. Dickinson Co. PERMIAN, SUMNER group, WELLINGTON sh, Solomon gypsum bed. T 14 S, R 1 W, 6 mi SW of town of Solomon. Analysts, E. Bailey and M. Whitten. Kans Univ Quart v 6, p. 31. Kans GS v 5, p. 148.

Gypsum from mine, abandoned in 1898, at Solomon mill. Lower part of worked layer very compact, filled with oval crystals of yellowish brown selenite. Conchoidal fracture. Upper part white, less compact, no crystals. Geologic section, idem, p. 58.

Use: Plaster, idem, p. 58, 59.

	A	B	C	D	E	F
SiO ₂ ^{a/}	0.52	0.34	1.18	0.35	0.38	0.55
Al ₂ O ₃)	0.26	0.16	0.15	0.12	0.16	0.23
Fe ₂ O ₃)						
MgO	0.98	0.62	0.25 ^{b/}	0.27 ^{b/}	0.46	0.22
CaO	32.28	32.64	32.35 ^{b/}	32.61 ^{b/}	32.04	32.64
H ₂ O	19.47	19.63	20.00	19.96	20.37	19.54
SO ₃	44.61	45.28	45.89 ^{b,c/}	46.10 ^{b/}	45.77	45.95
Total	98.12	98.67	99.82	99.41	99.18	99.13

^{a/} Includes insoluble residue

^{b/} Calculated from reported MgCO₃, CaCO₃, and/or CaSO₄

^{c/} CaSO₄ reported as 78.20, Stone, R. W., 1920, USGS B, 697, p. 28

I Calcium Sulfate Rocks

Kansas

A. Dickinson Co. PERMIAN, SUMMER group, WELLINGTON sh, Greeley gypsum bed. T 16 S, R 3 E, quarry 1 1/2 mi W of town of Hope. Analysts, E. Bailey and M. Whitten. Bailey, E. H. S., and Whitten, W. M., 1896, Kans Univ Quart v 6, p. 30. Grimsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 146, 147.

Gypsum; below buff, soft, shaly limestone.

Use: Plaster, *idem*, p. 146.

B. Dickinson Co. Recent (?) surface deposit. T 16 E, R 2 E, 3 1/2 mi SW of town of Dillon. Analysts, E. Bailey and M. Whitten. Kans GS v 5, p. 150.

Gypsite, 5 ft layer; part under water. Map of deposit, plate 18.

Use: Plaster, manufactured by Aluminite Cement Plaster Co., p. 65.

C. Dickinson Co. Recent (?) surface deposit. T 16 S, R 2 E, 3 1/2 mi SW of town of Dillon. Analysts, E. Bailey and O. Stafford. *Idem*.

Gypsite.

D. Dickinson Co. Recent (?) surface deposit. T 16 S, R 3 E, near town of Dillon. Analysts, E. Bailey and M. Whitten. *Idem*, p. 149.

Gypsite.

Use: Plaster, manufactured by Salina Cement Plaster Co., p. 149.

E. Dickinson Co. Recent (?) surface deposit. T 16 S, R 3 E, near town of Dillon. Analyst, E. Bailey. *Idem*, p. 82.

Gypsite from deposit covering 40 acres. Max thickness 18 ft. Impurities of sand, clay, and lime. Thin soil overburden.

Use: Plaster, manufactured by Agatite Cement Plaster Co., p. 64.

F. Marion Co. Recent (?) surface deposit. T 17 S, R 2 E, Rhodes farm. Analyst, P. Wilkinson. *Idem*, p. 150.

Gypsite, base of bed.

	A	B	C	D	E	F
SiO ₂ ^{a/}	0.41	17.10	3.18	12.13	6.49	15.76
Al ₂ O ₃ } Fe ₂ O ₃ }	0.29	2.04	0.95	0.99	1.04	0.49
MgO	0.29	0.59	0.15	0.42	0.13 ^{b/}	
CaO	32.53	27.62	32.16	29.14	31.07 ^{b/}	27.57 ^{b,c/}
H ₂ O	19.70	15.16	19.44	16.75	18.56 ^{b/}	18.64 ^{b/}
SO ₃	46.03	33.28	41.00	37.49	38.80 ^{b/}	35.24 ^{b/}
Total	99.25	95.79	96.88	96.92	96.09	97.70

^{a/} Includes insoluble residue

^{b/} Calculated from reported MgCO₃, CaCO₃, and/or CaSO₄

^{c/} Includes some MgO

I Calcium Sulfate Rocks

Kansas

A-G: Marion Co. Recent (?) surface deposit. T 17 S, R 2 E, Rhodes farm.

A. Analyst, P. Wilkinson. Grimsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 150.

Gypsite, 8 ft from surface.

B. Analyst, P. Wilkinson. Idem.

Gypsite, 4 ft from surface.

C. Analysts, E. Bailey and O. Stafford. Idem, p. 151.

Gypsite.

D. Analysts, E. Bailey and M. Whitten. Idem, p. 150. Bailey, E. H. S., and Whitten, M. W., 1896, Kans Univ Quart v 6, p. 32.

Gypsite.

E. Analysts, E. Bailey and O. Stafford. Kans GS v 5, p. 151.

Gypsite.

Use: Acts as a retarder in plaster when mixed with other gypsite.

F. Analysts, E. Bailey and O. Stafford. Idem.

Gypsite, 6 to 10 ft thick. Average of 8 samples from different parts of bed at depths of 2 1/2 to 3 1/2 ft.

Use: Plaster, manufactured by Acme Cement Plaster Co., p. 65.

G. Analyst, P. Wilkinson. Idem, p. 150.

Gypsite, average of one acre.

	A	B	C	D	E	F	G
SiO ₂ ^{a/}	4.82	4.25	11.78	3.06	6.33	7.68	8.78
Al ₂ O ₃)	0.79	0.53	1.87	0.34	0.53	0.89	1.98
Fe ₂ O ₃)							
MgO	0.16 ^{b/}	0.10 ^{b/}	0.48	0.43 ^{b/}	0.42	0.88	0.54 ^{b/}
CaO	30.60 ^{b/}	30.62 ^{b/}	28.64	33.91 ^{b/}	30.70	30.23	28.05 ^{b/}
H ₂ O	20.41	20.82	18.25	17.24	19.23	17.77	20.66
SO ₃	40.07 ^{b/}	40.88 ^{b/}	35.04	39.59 ^{b/}	32.77	37.28	34.26 ^{b/}
Total	96.85	97.20	96.06	94.57	89.98	94.73	94.27

^{a/} Includes insoluble residue

^{b/} Calculated from reported MgCO₃, CaCO₃ and/or CaSO₄

I Calcium Sulfate Rocks

Kansas

A. Marion Co. Recent (?) surface deposit. T 17 S, R 2 E, Rhodes farm. Analysts, E. Bailey and O. Stafford. Grimsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 151.

Gypsite, average crude material as used in manufacture of plaster.

B. Marshall Co. PERMIAN, COUNCIL GROVE group, Easley Creek sh. T 4 S, R 7 E, 2 1/2 mi NW of town of Blue Rapids. Analyst, E. Bartow. Idem, p. 145.

Gypsum, 8 1/2 ft thick; at Fowler's mine, oldest gypsum workings in Kans. Gray mottled rock traversed irregularly by blue clay seams; vertical, slightly curved white selenite needles at top of bed. Overburden, 30 ft. Geologic section, p. 53.

Use: Plaster, p. 53.

C. Marshall Co. PERMIAN, COUNCIL GROVE group, Easley Creek sh. T 4 S, R 7 E, 1 mi N of town of Blue Rapids. Analyst, E. Bartow. Idem.

Gypsum, 8 1/2 ft thick; at Great Western mine. Similar to rock described above in "B"; same sugary texture; no perfect crystals. Geologic section, p. 54. Approx 28 ft above Cottonwood ls; overburden, 105 ft, Stone, R. W., 1920, USGS B 697, p. 112.

D. Marshall Co. PERMIAN, COUNCIL GROVE group, Easley Creek sh. T 4 S, R 7 E, 2 mi W of town of Blue Rapids. Analyst, E. Bartow. Kans GS v 5, p. 145.

Gypsum, 8 1/2 ft thick; at Winter's mine. Similar to rock described above in "C". Overburden, 38 ft. Geologic section, p. 56.

E. Marshall Co. PERMIAN, COUNCIL GROVE group, Easley Creek sh. T 4 S, R 7 E, town of Blue Rapids. Analyzed in lab of U. S. Gypsum Co. USGS B 697, p. 28.

	A	B	C	D	E
SiO ₂ ^{a/}	5.14	0.35	0.65	0.40	0.70
Al ₂ O ₃)					
Fe ₂ O ₃)	0.67	0.12	0.17	0.19	0.35
MgO	0.53	0.12	0.19	0.17	0.17 ^{b/}
CaO	31.56	32.44	33.51	32.28	32.23 ^{b/}
H ₂ O	19.95	20.52	18.84	20.36	20.50 ^{b/}
SO ₃	39.20	46.24	46.65	45.96	45.69 ^{b/}
Total	97.05	99.79	100.01	99.36	99.64

^{a/} Includes insoluble residue

^{b/} Calculated from reported MgCO₃, CaCO₃, and/or CaSO₄

I Calcium Sulfate Rocks

Kansas

A. Saline Co. Recent (?) surface deposit. T 15 S, R 1 W, near Gypsum City. Analysts, E. Bailey and M. Whitten. Bailey, E. H. S., and Whitten, M. W., 1896, Kans Univ Quart v 6, p. 32. Grimsley, G. P., and Bailey, E. H. S., 1899, Kans GS v 5, p. 153.

Gypsite, contains organic matter; like loess in texture; tends to break in smooth planes. Overlies layer of clay which overlies black gypsum. Covers area of 12 acres, averages 8 ft thick, Idem, p. 63, 64.

B. Saline Co. Recent (?) surface deposit. T 15 S, R 1 W, near Gypsum City. Analyst, E. Franklin. Idem, p. 153.

Gypsite, center of bed, 4 ft below surface, p. 153.

Use: Manufacture of plaster.

C. Saline Co. Recent (?) surface deposit. T 15 S, R 1 W, near Gypsum City. Analyst, E. Franklin. Idem.

Gypsite, surface of bed, p. 153.

Use: Manufacture of plaster.

D. Saline Co. Recent (?) surface deposit. T 15 S, R 1 W, near Gypsum City. Analyst, E. Franklin. Idem.

Gypsite described as "quick setting dirt", p. 153.

Use: Manufacture of plaster.

E. Saline Co. Recent (?) surface deposit. T 15 S, R 1 W, near Gypsum City. Analyst, E. Franklin. Idem.

Gypsite, average material, p. 153.

Use: Manufacture of plaster.

F. Saline Co. Recent (?) surface deposit. Near town of Salina. Analyst, E. Franklin. Idem, p. 152.

Gypsite.

G. Sedgwick Co. Recent (?) surface deposit. T 29 S, R 2 E, 2 1/2 mi NE of town of Milvans. Analysts, E. Bailey and D. McFarland. Idem p. 155.

Gypsite, approx 12 ft thick. Tonnage estimate, p. 68.

Use: Plaster, manufactured by American Cement Plaster Co., p. 69.

	A	B	C	D	E	F	G
SiO ₂ ^{a/}	4.54	7.65	13.50	15.08	3.62	9.73	2.17
Al ₂ O ₃)	0.54	0.52	1.05	0.44	0.45	0.78	0.24
Fe ₂ O ₃)			0.56 ^{b/}		0.16 ^{b/}		0.45
MgO	0.28	0.30 ^{b/}	0.56 ^{b/}	28.86 ^{b,c/}	31.92 ^{b/}	30.55 ^{b/}	32.42
CaO	32.31	31.20 ^{b/}	29.03 ^{b/}	28.86 ^{b,c/}	31.92 ^{b/}	30.55 ^{b/}	32.42
H ₂ O	17.82	18.39 ^{b/}	17.05 ^{b/}	17.46 ^{b/}	19.87 ^{b/}		19.40
SO ₃	42.10	38.06 ^{b/}	35.44	35.58	42.31	40.16 ^{b/}	44.18
Total	97.59	96.12	96.43	97.42	98.33	81.22	98.86

^{a/} Includes insoluble residue

^{b/} Calculated from reported MgCO₃, CaCO₃, and/or CaSO₄

^{c/} Includes some MgO

Miscellaneous Sedimentary Rocks
 /Predominant constituents other than SiO₂, R₂O₃n·H₂O, and (Ca,Mg) CO₃/

II Salines

Kansas

A. Ellsworth Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 15 S, R 8 W, town of Kanopolis. Analysts, E. Bailey and E. Case. Bailey, E. H. S., 1902, Kans GS v 7, p. 73, 74.

Rock salt.

B. Ellsworth Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 15 S, R 8 W, town of Kanopolis. Analysts, E. Bailey and E. Case. Iden.

Rock salt.

C. Ellsworth Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 15 S, R 8 W, town of Kanopolis. Analysts, E. Bailey and E. Case. Iden.

Rock salt.

D. Ellsworth Co. Presumably PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 15 S, R 8 W, town of Kanopolis. Analyst, R. Gardiner. Phalen, W. C., 1919, USGS B 669, p. 216.

Rock salt. Composite sample from floor to roof in working face of Crystal Rock Salt Co. mine. Collected by company in 1911.

E. Ellsworth Co. Presumably PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 15 S, R 8 W, town of Kanopolis. Analyst, R. Gardiner. Iden.

Rock salt. Composite sample from floor to roof in working face of Royal Rock Salt Co. mine. Collected by company in 1911.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E
Mg				tr	0.1
MgCl ₂	0.12	0.05	0.24		
Ca				0.8	0.4
CaSO ₄	2.60	1.78	2.04		
Na				38.4	38.6
Na ₂ SO ₄		0.10	0.41		
NaCl	96.99	97.94	97.23		
K				tr	0.1
SO ₂				0.8	0.8
Cl				60.0	60.0
Insol in acid	0.29	0.13	0.08		
Total	100.00 ^{a/}	100.00 ^{a/}	100.00 ^{a/}	100.0 ^{b/}	100.0 ^{b/}

^{a/} Analysis after moisture driven off

^{b/} Analysis of H₂O- soluble material

II Salines

Kansas

A. Ellsworth Co. Presumably PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 15 S, R 8 W, town of Ellsworth. Analyst, E. Bailey. Bailey, E. H. S., 1899, Kans Acad Sci Trans, v 11, p. 9.

Rock salt, crystalline; in 2 beds at depth of 730 ft; upper bed 50 ft thick, lower bed 90 ft thick, separated by 5 ft gray shale.

B. Kingman Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 27 S, R 7 W, town of Kingman. Analysts, E. Bailey and E. Case. Bailey, E. H. S., 1902, Kans GS v 7, p. 73.

Rock salt.

C. Kingman Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 27 S, R 7 W, town of Kingman. Analysts, E. Bailey and E. Case. Idem. Clarke, F. W., 1924, USGS B 770, p. 221.

Rock salt.

D. Kingman Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} T 27 S, R 7 W, town of Kingman. Analysts, E. Bailey and E. Case. Kans GS v 7, p. 73.

Rock salt.

E. Miami Co. Recent spring deposit. T 18 S, R 22 E, town of Ossawatimie. Analyst, C. Jackson. Mudge, B. F., 1866, First Ann Rept on Geology of Kans, p. 47. Salt. Incrustation at saline spring.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E ^{b/}
Fe ₂ O ₃			0.11		} 0.50
FeO					
MgSO ₄	0.09				
MgCl ₂		0.05	0.10	0.12	0.48
CaSO ₄	1.21	0.07	1.51	0.07	
CaCl ₂	0.99				0.71
CaCO ₃	tr				
Na ₂ SO ₄			0.57	0.28	0.36
NaCl	95.76	99.87	97.51	99.44	97.95
KCl	0.67				
H ₂ O -)	0.19				
H ₂ O +)					
Insol in acid	0.27	0.01	0.20	0.09	
Total	99.18	100.00 ^{a/}	100.00 ^{a/}	100.00 ^{a/}	100.00

^{a/} Analysis after moisture driven off

^{b/} Figures rounded off to two decimal places

II Salines

Kansas

A-C: Reno Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 23 S, R 6 W, town of Hutchinson, Analyst, C. Jobs, Carey Salt Co. Runnels, R. T., Reed, A. C., and Schleicher, J. A., 1952, Kans GS B 96, pt 4, p. 189, 197.
Rock salt, Carey Salt Co.

AA-CC: Analyses of samples A-C in lab of Kans GS.

A and AA. Lab #50-35. From 0 to 2 ft from mine floor.
B and BB. Lab #50-36. From 2 to 4 ft from mine floor.
C and CC. Lab #50-37. From 4 to 6 ft from mine floor.

	A ^{a/}	AA	B ^{a/}	BB	C ^{a/}	CC
Fe ₂ O ₃	tr		0.01		0.01	
MgO		0.04		0.05		0.06
MgSO ₄	0.01		0.51		0.11	
MgCl ₂	0.13				0.13	
CaO		1.79 ^{c/}		1.28 ^{c/}		1.47 ^{c/}
CaSO ₄	3.02		2.28		3.58	
Na ₂ SO ₄			0.15			
NaCl	98.84	96.06 ^{a/}	96.98	96.63 ^{a/}	96.15	96.56 ^{a/}
SO ₃		2.07		1.89		1.81
H ₂ O -	0.05	0.05 ^{a,e/}	0.07	0.07 ^{a,e/}	0.06	0.06 ^{a,e/}
Insol in acid ^{b/}	(0.01)		(0.07)		(0.03)	
Insol in water ^{b/}	(1.68)		(0.93)		(2.12)	
Total	102.05	99.99	100.00	99.92	100.04	99.96

^{a/} Figures rounded off to two decimal places
^{b/} Not included in total
^{c/} Includes SrO

^{a/} Calculated
^{e/} Below 105° to 110°C

Qualitative spectrographic analyses with graphite electrodes. Key to symbols, p. 193.
(Higher numbers indicate greater abundance)

	A ^{1/}	A ^{2/}	A ^{3/}	B ^{1/}	B ^{2/}	B ^{3/}	C ^{1/}	C ^{2/}	C ^{3/}
B	-	-	-	-	-	-	4	-	3
Na	-	9	9	1	8	9	2	10	8
Mg	6	4	6	5	5	8	6	6	6
Al	5	2	-	6	1/2	-	6	2	2
Si	5	4	4	6	3	4	4	4	-
K	-	-	-	-	-	5	-	-	-
Ca	12	10	9	12	9	8	10	10	7
Ti	3	4	4	2	3	1/2	6	3	2
V	4	5	4	3	4	1/2	3	5	6
Cr	2	1/2	-	1	-	-	1	-	-
Mn	4	-	-	4	-	-	3	-	-
Fe	5	1	3	6	1/2	1	8	1	4
Cu	5	2	5	6	2	5	5	3	5
Zn	-	-	-	-	-	-	-	-	-
Sr	6	5	4	7	5	5	6	5	5
Ag	-	-	-	-	-	-	-	-	2
Sa	2	-	-	3	-	-	4	-	-
Pb	-	-	-	-	-	-	3	-	-

^{1/} Insoluble fraction ^{2/} Least soluble fraction ^{3/} Most soluble fraction

II Salines

Kansas

A-B: Reno Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 23 S, R 6 W, town of Hutchinson. Analyst, C. Jobs, Carey Salt Co. Runnels, R. T., Reed, A. C., and Schleicher, J. A., 1952, Kans GS B 96, pt 4, p. 189, 197.

Rock salt, Carey Salt Co.

AA-BB: Analyses of samples A-B in lab of Kans GS

A and AA. Lab #50-38. From 6 to 8 ft from mine floor.

B and BB. Lab #50-39. From 8 to 10 ft from mine floor.

	A	AA	B	BB
Fe ₂ O ₃	0.03		0.03	
MgO		0.13		0.06
MgCl ₂	0.38		0.29	
CaO		1.11 ^{b/}		0.72 ^{b/}
CaSO ₄	3.05		2.08	
CaCl ₂	0.42		0.02	
NaCl	95.85	97.08 ^{e/}	94.25	98.06 ^{e/}
SO ₃		1.34		0.74
H ₂ O -	0.09	0.05 ^{d/}	0.09	0.07 ^{d/}
Insol in acid ^{e/}	(0.26)		(0.32)	
Insol in water ^{e/}	(2.03)		(1.51)	
Total	99.82	99.71	96.76	99.65

^{e/} Not included in total

^{e/} Calculated

^{b/} Includes SrO

^{d/} Rounded off to two decimal places; below 105° to 110°C

Qualitative spectrographic analyses with graphite electrodes. Key to symbols, p. 193.
(Higher numbers indicate greater abundance)

	A ^{1/}	A ^{2/}	A ^{3/}	B ^{1/}	B ^{2/}	B ^{3/}
B	3	-	3	7	-	2
Na	4	7	8	5	10	9
Mg	8	5	7	9	4	7
Al	6	4	3	7	1	4
Si	3	3	6	7	3	4
K	-	-	-	-	-	-
Ca	10	10	10	9	10	9
Ti	7	4	3	8	4	6
V	3	4	7	4	3	8
Cr	3	-	-	3	-	-
Mn	7	-	-	7	-	-
Fe	10	2	3	12	1	4
Cu	4	3	6	6	2	5
Zn	-	-	-	-	-	-
Sr	3	5	5	5	5	5
Ag	-	-	3	-	-	4
Sn	1	-	-	-	-	-
Pb	2	-	-	3	-	-

^{1/} Insoluble fraction

^{2/} Least soluble fraction

^{3/} Most soluble fraction

II Salines

Kansas

A-E: Reno Co. **BERNIAH, WELLINGTON** fm, Hutchinson salt mem. T 23 S, R 6 W, Carey Salt Co., town of Hutchinson. Runnels, R. T., Reed, A. C., and Schleicher, J. A., 1952, Kans GS B 96, pt 4, p. 185, 197.

A. Analyst, C. Jobes.
No. 2 rock salt, colorless particles only.

B. Analyst, C. Jobes.
No. 2 rock salt, red particles only. Partial analysis of red and opaque particles in lab of Kans GS: Fe_2O_3 , 0.024; MgO, 0.53; CaO, 4.10; K_2O , 1.77; SO_3 , 6.42; SrO, 0.76; insol in acid, 0.06.

C. Analyst, C. Jobes.
No. 2 rock salt, opaque particles only.

D. Analyst, C. Jobes. Lab #50-29.
No. 2 rock salt, average sample. Mixture of white, red or pink, and shaly (black) particles; white predominant, p. 198. Analyses of red and opaque pieces show about 11.3% polyhalite; white sample shows 2.6%, p. 195.
Partial analysis in lab of Kans GS: Fe_2O_3 , 0.02; MgO, 0.21; CaO, 2.76; K_2O , 0.40; SO_3 , 4.31; SrO, 0.49; insol in acid, 0.28.

E. Lab #50-459.

Polyhalite. Selected under microscope from No. 2 salt and salt 2 to 4 ft from mine floor. No. 2 salt contains about 2.6% polyhalite; red and opaque pieces from Carey's No. 2 salt show about 11.3% polyhalite. A Hutchinson salt member core shows two 4 ft zones containing 5.8 and 8.7% polyhalite; occurs about 100 ft above beds mined for salt.

	A ^{b/} g/	B ^{b/} g/	C ^{b/} g/	D g/	E
Fe_2O_3	tr	0.03	0.08	0.01	
$MgSO_4$	0.02			0.21	
$MgCl_2$	0.04		0.88	0.18	
CaO					7.67 ^{h/}
$CaSO_4$	8.14 ^{d/}	9.67	4.94	5.61	
$CaCl_2$		1.93	0.09		
Na_2SO_4		1.45			
$PbCl$	99.79 ^{d/}	86.92	92.69	92.67	47.10 ^{1/}
SO_3					27.11
H_2O	0.02	0.03	0.16	0.07	} 3.26 ^{1/}
H_2O+					
Insol in acid ^{a/}	(0.01)	(0.03)	(1.31)	(1.32)	
Insol in water ^{a/}	(0.02)	(4.64)	(5.96)	(4.24)	
Total	108.01	100.03	98.84	98.75	85.14

^{a/} Not included in total

^{b/} Figures rounded off to two decimal places

^{c/} H_2O -soluble 0.00070%, p. 199, and 0.00010, p. 196

^{d/} (sic text)

^{e/} H_2O -soluble 0.000085%, p. 196, 199

^{f/} H_2O -soluble 0.000074%, p. 199

^{g/} H_2O -soluble 0.00025%

^{h/} Includes SrO

^{1/} Determined by titration with standard $AgNO_3$

^{2/} Loss of wgt recorded after heating to 400°C

II Salines

Kansas

A. Republic Co. Recent. Tuthill marsh. Bailey, E. H. S., 1902, Kans GS v 7, p. 70, 72. Clarke, F. W., 1924, USGS B 770, p. 231.
Salt, incrustation. Deposit covers 1000 acres.

B. Republic Co. Recent. Tuthill marsh. Analyst, C. Chandler. Mudge, B. F., 1866, First Ann Rept on Geology of Kans, p. 47.
Salt. Presumably an incrustation.

	A	B <u>b/</u>
Al ₂ O ₃	} 0.13	
Fe ₂ O ₃		
MgSO ₄	1.29	
MgCl ₂		0.30
CaSO ₄	0.99	0.22
Na ₂ CO ₃ <u>a/</u>	3.56	
Na ₂ SO ₄	21.98	1.96
NaCl	71.82	96.69
H ₂ O.		} 0.79
H ₂ O+		
Insol in acid	0.23	
Insol in water		0.05
Total	100.00	100.01

a/ Includes organic matter

b/ Figures rounded off to two decimal places

II Salines

Kansas

A-C: Rice Co. PERMIAN, WELLINGTON fm, Hutchinson salt mem. T 20 S, R 8 W, Carey Salt Co., town of Lyons. Analyst, R. Thompson. Runnels, R. T., Reed, A. C., and Schleicher, J. A., 1952, Kans GS B 96, pt 4, p. 188, 196.

Rock salt.

- A. Lab #RES-2. Shaly salt, 1,027 ft below top of shaft.
- B. Lab #RES-3. Shaly salt, 1024 ft below top of shaft.
- C. Lab #RES-4. Shaly salt, 1,021 ft below top of shaft.

	A	B	C
MgCl ₂	0.21		0.21
CaSO ₄	2.18	1.84	0.95
CaCl ₂			0.20
Na ₂ SO ₄	0.01	0.64	
NaCl	96.63	95.82	97.08
H ₂ O -	0.09	0.20	1.40
Insol in water ^{a/}	(0.84)	(1.48)	(0.18)
Total	99.12	98.50	99.82

^{a/} Not included in total

Qualitative spectrographic analyses with graphite electrodes. Key to symbols, p. 193.
(Higher numbers indicate greater abundance)

	A ^{1/}	A ^{2/}	A ^{3/}	B ^{1/}	B ^{2/}	B ^{3/}	C ^{1/}	C ^{2/}	C ^{3/}
B	4	-	-	7	-	-	2	1/2	-
Na	6	11	12	7	8	11	11	10	9
Mg	8	8	8	9	6	8	9	8	7
Al	7	5	2	7	3	4	8	4	1
Si	7	3	2	7	3	3	7	4	2
K	3	-	1/2	4	-	1/2	9	-	-
Ca	13	9	9	12	6	10	10	7	7
Ti	6	-	2	5	2	1/2	6	-	1/2
V	8	3	3	5	6	2	7	1/2	1
Cr	-	-	-	-	-	-	1	-	-
Mn	5	-	-	7	-	-	8	-	-
Fe	7	3	1	9	3	2	6	3	1/2
Cu	8	5	4	8	3	4	8	4	4
Zn	1	-	-	1/2	-	-	<1/2	-	-
Br	8	6	5	8	5	7	2	5	4
Ag	2	1/2	-	6	-	-	2	-	-
Sn	8	-	-	9	-	-	10	-	-
Pb	7	-	-	7	-	-	7	-	-

- ^{1/} Insoluble fraction
- ^{2/} Least soluble fraction
- ^{3/} Most soluble fraction

II Salinas

Kansas

A-C: Rice Co. PERMIAN, WELLINGTON fm, Hutchinson salt man, S 20 E, R 8 W, Carey Salt Co., town of Lyons. Analyst, R. Thompson. Runnels, R. T., Reed, A. C., and Schleicher, J. A., 1952, Kans GS B 96, pt 4, p. 188, 196

Rock salt.

- A. Lab #RES-5. Shaly salt, 1,020.25 ft below top of shaft.
- B. Lab #RES-7. Shaly salt, 1,017 ft below top of shaft.
- C. Lab #RES-8. Shaly salt, 1,015 ft below top of shaft.

	A	B	C
MgCl ₂		0.05	
CaSO ₄	2.16	2.41	2.07
CaCl ₂	0.02		
MgSO ₄		0.05	
NaCl	96.00	95.71	95.85
H ₂ O-	0.18	0.27	0.07
Insol in water ^{a/}	(1.63)	(1.55)	(2.02)
Total	98.36	98.49	97.97

^{a/} Not included in total

Qualitative spectrographic analyses with graphite electrodes. Key to symbols, p. 193.
(Higher numbers indicate greater abundance)

	A ^{1/}	A ^{2/}	A ^{3/}	B ^{1/}	B ^{2/}	B ^{3/}	C ^{1/}	C ^{2/}	C ^{3/}
B	-	-	-	2	-	-	11	-	-
Na	4	9	12	7	8	11	11	9	10
Mg	7	7	9	10	7	8	9	7	7
Al	6	3	1	8	3	1	8	5	1
Si	7	2	2	8	3	1	8	2	1
K	-	-	-	4	-	1/2	10	-	-
Ca	13	6	9	13	7	9	10	7	7
Ti	6	-	1	7	-	2	6	1	1/2
V	6	-	4	7	1	3	8	3	1
Cr	-	-	-	2	-	-	8	-	-
Mn	3	-	-	9	-	-	8	-	-
Fe	3	4	2	10	5	1	5	2	1
Cu	7	3	5	9	3	3	9	5	6
Zn	2	-	-	-	-	-	1/2	5	-
Br	6	3	4	7	3	4	9	3	4
Ag	3	-	-	8	-	-	1	-	-
Sr	3	-	-	7	-	-	10	-	-
Pb	6	-	-	7	-	-	8	-	-

- ^{1/} Insoluble fraction
- ^{2/} Least soluble fraction
- ^{3/} Most soluble fraction

II Salines

Kansas

A-G: Rice Co. T 20 S, R 8 W, town of Lyons.
Rock salt.

A. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} Analysts, E. Bailey and E. Case. Bailey, E. H. S., 1902, Kans GS v 7, p. 73.
Bed more than 8 ft thick. Shaft about 1000 ft deep sunk in 1890. Other salt beds separated by soft clay or shale lie above that sampled.

B. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} Analysts, E. Bailey and E. Case. Idem.

C. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} Analysts, E. Bailey and E. Case. Idem.

D. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} Analysts, E. Bailey and E. Case. Idem.

E. PERMIAN, WELLINGTON fm, Hutchinson salt mem. ^{1/} Analysts, E. Bailey and E. Case. Idem.

F. Presumably PERMIAN, WELLINGTON fm, Hutchinson salt mem. Analysts, R. Gardiner. Phalen, W. C., 1919, USGS B 669, p. 216.
Composite sample from bottom to top of 16 ft bed at Bevis Rock Salt Co. Collected by company in 1911.

G. Presumably PERMIAN, WELLINGTON fm, Hutchinson salt mem. Analyst, R. Gardiner. Idem.
Fine salt screened from coarse. Collected by Bevis Rock Salt Co. in 1911.

^{1/} Letter from Kans GS, 7/16/53

	A	B	C	D	E	F	G
Fe ₂ O ₃	0.03	0.02		0.55	0.07	tr	0.3
Mg							
MgCl ₂	0.07	0.02	0.02	0.03	0.14	0.8	0.4
Ca							
CaSO ₄	0.97	2.02	1.25	0.08	1.70		
CaCl ₂			0.51			38.3	38.3
Na							
Na ₂ SO ₄	2.00	0.46		0.10	tr		
NaCl	96.85	97.39	98.20	99.78	97.95	tr	tr
K						0.8	0.6
SO ₄						60.0	60.2
Cl							
Insol in acid	0.08 _{a/}	0.09 _{a/}	0.02 _{a/}	0.01 _{a/}	0.14 _{a/}	99.9 _{b/}	99.8 _{b/}
Total	100.00	100.00	100.00	100.55	100.00		

_{a/} Analysis after all moisture driven off

_{b/} Analysis of H₂O- soluble material

Miscellaneous Sedimentary Rocks
 [Predominant constituents other than SiO₂, R₂O₃·H₂O, and (Ca,Mg) CO₃]

III Phosphatic Nodules in Shale

Kansas

A-E: PENNSYLVANIAN. Analyst, R. Runnels. Runnels, R. T., Schleicher, J. A., and Von Hertwick, H. S., 1953, Kans GS B 102, pt 3, p. 97, 99.

Phosphate nodule. Minerals present, p. 100, 101. Graphs showing relationship of certain chemical constituents, p. 102, 103.

A. Crawford Co. CHEROKEE sh, shale above Mulky coal. SW 1/4 SE 1/4 sec 16, T 31 S, R 23 E. Lab #50545.

Black fissile shale contains abundant round to oval nodules, p. 96.
 3 ft thick.

B. Crawford Co. ALFAMONT ls, Lake Neosho sh mem. SW 1/4 NW 1/4 sec 30, T 29 S, R 21 E. Lab #50548.

Nodule from weathered remnant of shale, p. 96. 4 ft thick.

C. Douglas Co. OREAD ls, HEBBNER sh mem. SW 1/4 sec 25, T 12 S, R 19 E. Lab #52263.

Nodule from fresh outcrop. Nodules generally well formed and numerous, p. 101. 3 ft thick.

D. Labette Co. CHEROKEE sh, shale above Mulky coal. NE 1/4 NW 1/4 sec 2, T 35 S, R 20 E. Lab #50546.

Black fissile shale contains abundant round to oval nodules, p. 96.
 3 ft thick.

E. Labette Co. CHEROKEE sh, shale above Mulky coal. SE 1/4 NE 1/4 sec 16, T 33 S, R 21 E. Lab #5022.

Black fissile shale contains abundant round to oval nodules, p. 96.
 3 ft thick.

	A	B	C	D	E
SiO ₂	18.94	8.86	6.73	10.37	12.29
Al ₂ O ₃	6.12	2.59	5.08	6.03	6.75
Fe ₂ O ₃ ^{a/}	3.42	2.38	0.48	1.04	1.26
MgO	0.05	0.20	0.35	0.08	0.77
CaO	35.02	43.74	46.38	42.12	39.78
Na ₂ O	0.22	0.04	0.36	0.05	0.05
K ₂ O	0.29	0.05	0.26	0.03	0.08
TiO ₂ ^{b/}	0.57	0.43	0.36	0.37	0.24
P ₂ O ₅	24.72	30.44	31.95	29.01	28.62
U ₂ O ₃	0.01	0.021	0.017	0.01	0.024
F	2.45	3.43	3.24	2.99	2.76
SO ₃	0.17	0.12	0.44	0.13	0.11
S	0.96	0.70	0.05	0.09	0.15
Ignit Loss ^{c/}	9.68	10.39	6.29	9.71	8.97
Total	102.62	103.37	101.99	102.03	101.85

^{a/} Total iron as ferric oxide

^{b/} Precipitated gravimetrically with cupferron

^{c/} Between 105° and 1000°C

III Phosphatic Nodules in Shale

Kansas

A-F: PENNSYLVANIAN. Analyst, R. Runnels. Runnels, R. T., Schleicher, J. A., and Van Hertzwick, K. S., 1953, Kans GS B 102, pt 3, p. 97, 99.

Phosphate nodule. Minerals present, p. 100, 101. Graphs showing relationship of certain chemical constituents, p. 102, 103.

A. Labette Co. FORT SCOTT ls, Little Osage sh mem. NW 1/4 SW 1/4 sec 9, T 34 S, R 20 E. Lab #50547.
4 ft thick.

B. Labette Co. PANNEE ls, Anna sh mem. NW 1/4 SW 1/4 sec 3, T 33 S, R 20 E. Lab #50549.
4 ft thick.

C. Labette Co. PLEASANTON group. SE 1/4 SE 1/4 sec 17, T 32 S, R 19 E. Lab #5021.

Nodule from black fissile bituminous shale in county quarry 6 mi S and 4 mi W of town of Parsons. Many nodules have core of FeS. Tonnage estimate p. 96, 97. 6 ft thick; possibly 10 ft more.

D. Linn Co. ALBANY ls, Lake Neosho sh mem. NE 1/4 NE 1/4 sec 8, T 22 S, R 24 E. Lab #5023.
Nodule from weathered remnant of shale, p. 96.

E. Wilson Co. IOLA ls, Muncie Creek sh mem. NE 1/4 SW 1/4 sec 29, T 29 S, R 17 E. Lab #52531.
3 ft thick.

F. Wyandotte Co. IOLA ls, Muncie Creek sh mem. Sec 12, T 11 S, R 24 E. Lab #5020.
3 ft thick.

	A	B	C	D	E	F
SiO ₂	6.95	4.07	6.95	11.55	7.10	0.93
Al ₂ O ₃	2.64	1.25	2.57	6.18	3.94	2.99
Fe ₂ O ₃ ^{a/}	1.77	2.47	6.65	1.72 ^{a/}	4.02	0.30
MgO	0.32	0.11	0.11	0.81	0.37	0.64
CaO	44.71	47.77	42.32	44.27	42.11	52.46
H ₂ O	0.21	0.05	0.25		0.30	0.07
K ₂ O	0.31	0.05	0.24		0.45	0.09
TiO ₂ ^{b/}	0.54	0.37	0.21			0.21
P ₂ O ₅	30.88	34.10	27.22	28.25	29.93	37.34
U ₃ O ₈	0.029	0.02	0.011	0.007	0.007	0.03
F	3.40	3.62	2.84	3.51	2.94	4.05
SO ₃	0.15	nil	0.94	nil	1.05	nil
S	0.63		2.53	0.21	0.03	0.30
Ignit Loss ^{c/}	11.14	6.81	11.71	7.19	9.51	4.55
Total	103.66	100.67	104.53	103.46	101.76	103.94

^{a/} Total iron as ferric oxide

^{b/} Precipitated gravimetrically with cupferron

^{c/} Between 105° and 1000°C

^{d/} Includes TiO₂

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