SOURCE of SOIL MINERALS in LABETTE COUNTY, KANSAS

by

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INTRODUCTION

The purpose of this study is to determine the Source of Soil Minerals in Labette county by the examination of mantle rock samples. The composition of light and heavy mineral fractions has been quite valuable in the identification of some rock formations in Kansas. The soils of Labette county in general are made up of residual material from the Pennsylvanian rocks according to Moore (11). There are a few transported soils but they are found in the flood plain of the Neosho river.

The techniques involved during this study were standard methods for petrographic work. Preliminary field study was made to determine the number of samples necessary and the approximate amount of material to be taken to the laboratory for detailed study.

PROCEDURE

The field survey conducted for the preliminary investigation began with the location of a few stations. Sample locations were based in part on the presumed stratigraphic horizon of the source rock.

Soil samples were collected with the aide of shovel and soil auger. The latter was used to obtain material from the lower portion of sample holes. Material from all zones of the soil profile at each location was gathered for the purpose of study. Five to ten pounds of soil were used initially for each collection, and after a preliminary study of the physical appearance, the Jones sample splitter was used to separate the amount necessary for laboratory work. The sample splitter reduces the amount of error that may result if improper methods are used in dividing a given sample to be used in laboratory analysis.

In preparing the samples for petrographic study the soil samples were dried, crushed and then placed in dispersion bottles, with 20 percent normal sodium silicate as a dispersing agent and shaken until all particles were believed to be adequately separated. From the dispersion bottles the collodial material was decanted off and the remaining material was washed and screened into two size groups. The particles less than number 120 mesh screen and greater than number 230 mesh screen were in one groups; the particles greater than number 120 screen in the other group. The residue left on the number 120 screen was used for further study uner the binocular microscope.

The portion of the soil samples retained on the number 230 screen was further divided into the heavy and light mineral fractions. Bromoform with a specific gravity of 2.66 was used thus the lighter fraction contains quartz and other minerals with specific gravity below 2.65. Heavy mineral fractions contained muscovite and other minerals with specific gravity over 2.66.

Heavy liquid mineral separation requires a set of funnels, filter paper, rubber tubing($\frac{1}{4}$ inch), pinchcock, funnel-holder stand with two tiers of adjustable funnel-holders (2 batteries), and a glass stirring rod. An adequate supply of Bromoform (25 - 40 cc for every 1 - 3 cc of sample), alcohol, containers to receive the washings of bromoform and alcohol, are also needed.

After completing the mineral separation, slides were prepared for petrographic study. In this preparation the heavy and light mineral fractions were mounted on separate slides by taking a small amount, approximately one-hundredth of a cubic centimeter, and sprinkling it on glass slides (1 inch by 3 inches) which were later covered with canada balsam. To retain the grains in their original position a drop or two of de-ionized water was placed over the mineral grains and then allowed to evaporate. The grain were then held on the slide firmly enough so that canada balsam placed over them did not displace them. The slide was completed by adding a glass cover slip and a label for identification. The slides were cooked at 105 to 120 degrees C for several minutes (3 to 15). The time depended on air temperature and amount of solvent in the balsam.

The petrographic findings that are stated herein furnish a more precise explanation of the origin of the mantle rock in Labette county Kansas. Heavy and light minerals slides have been prepared for all the stations listed.

REVIEW of LITERATURE

The sources for soil minerals may be grouped uner two gmneral headings (1) Residual and (2) Transported. The weathering and maturity of soils aides in the more exact designation of horizons by soil scientists. Soil maturity is thought generally to be determined by the amount of weathering involved, Pettijohn (12). The geologists and the agronomists have agreed that mature soil consists of four definite zones "A", "B", "C", and "D" (12) and (18). The most weathered material which has undergon oxidation, leaching, and decomposition will be found in the top or "A" zone. Those materials which have been subjected only to oxidation are grouped in the "C" zone. The original bedrock material is identified as the D zone. All variations from original unweathered bedrock to completely weathered soil may be encountered on the surface in different places due to erosion. A quotation from Krumbein and Pettijohn (7), on weathering is as follows:

> The first change that occurs is oxidation, which affects mainly the ironbearing minerals. The net result is a change in color incling toward brown. Following the oxidation comes a leaching of the more soluble minerals, such as the carbonates, notably calcite. The third stage is the decomposition of the silicates, during which feldspars and similar minerals are decomposed. Finally, near the surface, the soil zone

> proper is evolved, with only the more resistant minerals remaining, notably quartz. The chemical changes are accompanied by changes, in size distribution and other physical attributes of the sediment. Thus a calcareous sediment, which includes primary grains of calcite, has a different size distribution after it has been subjected to leaching. Similarly the breakdown of the feldspars into clays and colloids involves significant changes in the physical properties. The drainage conditions at the site of weathering also influence the process of decomposition, so that different end-products result from well and poorly drained situations.

Pettijohn (12), in his writing on minor accessory minerals describes the complex character of soils and is quoted in part below:

> That the heavy minerals assemblage recovered from certain strata is distinct and unlike that of overlying and underlying strata has been confirmed many times. This observation is the basis for "Petrographic correlation". Such correlation depends for its success, not only on the recognition of distinctive association of minerals, but also upon peculiar varieties and on changing proportions of the constituent minerals with time. Such differences are secured by progressive denudation of a varied terran. Each new rock mass unroofed contributes new species or varieties to the accumulating sediment or changes the proportions of the several species already being deposited. Correlation is complicated, however, by reworking of earlier-formed sediments and incorporation of such reworking necessarily has many species in common with the deposit from which it was derived.

The analysis and interpretation of clay minerals encountered in soil profile was explained by Jefferies (5) in his work on composition of clay minerals. The application of differential thermal analysis to clay minerals was presented in such papers and bulletins as (2), (5) and (19).

Tye (17), in his unpublished masters thesis sets forth four criteria to be used which are quoted as follows:

> The following criteria are suggested as a means of showing the genetic connection between parent material and the overlying mantle rock:
>
> 1. The stable heavy minerals present in the mantle rock must also be present in the assigned parent material.
> 2. The light minerals present in the mantle rock must be such that they could be derived from the minerals of the assigned parent material by known or suspected processes of weathering.

3. If the parent material is thought to be fluvial, lacustrin, aeolian or glacial in origin, it should show on mechanical analysis the characteristics of such sediments. The mantle rock derived from such parent material should show the same mechanical analysis data as the parent material except for the effect of weathering.

4. The mechanical analysis of mantle residual on consolidated sedimentary rocks may not resemble that of the parent material very closely.

LOCATION OF COLLECTED SAMPLES

The locations of sample stations are shown on Plate I, which is the latest soil map of the county published by the Bureau of Chemistry and Soils, U. S. Dpartment of Agriculture (20). The samples are numbered and located as follows:

Sample LB-1 A thru D zones.	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 8	T 33 s	R 18 e.
Sample LB-2 A thru D zones.	SE$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 4	T 33 s	R 18 e.
Sample LB-3 A thru D zones.	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 8	T33 s	R 18 e.
Sample LB-4 A,B, and D zones.	SW$\frac{1}{4}$ of SE$\frac{1}{4}$	Sec 5	T 31 s	R 18 e.
Sample LB-5 A thru D zones.	SW$\frac{1}{4}$ of SE$\frac{1}{4}$	Sec 5	T 31 s	R 18 e.
Sample LB-6 D zone only.	SE$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 5	T 31 s	R 18 e.
Sample LB-7 A thru D zones.	SE$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 5	T 31 s	R 18 e.
Sample LB-21 A thru D zones.	SE$\frac{1}{4}$ of SE$\frac{1}{4}$	Sec 26	T 32 s	R 19 e.
Sample LB-24 A thru D zones.	SW$\frac{1}{4}$ of SW$\frac{1}{4}$	Sec 32	T 32 s	R 18 e.
Sample LB-25 A thru D zones.	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 32	T 34 s	R 18 e.
Sample LB-26 A thru C zones.	NE$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 35	T 34 s	R 19 e.
Sample LB-28 A thru D zones.	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 5	T 35 s	R 21 e.
Sandbar sample;Neosho river.	SE$\frac{1}{4}$ of NE$\frac{1}{4}$	Sec 17	T 31 s	R 21 e.
Sample LB-17 A and B zones.	NW$\frac{1}{4}$ of SE$\frac{1}{4}$	Sec 17	T 31 s	R 21 e.
Sample LB-18 A and B zones.	NW$\frac{1}{4}$ of NW$\frac{1}{4}$	Sec 27	T 32 s	R 21 e.

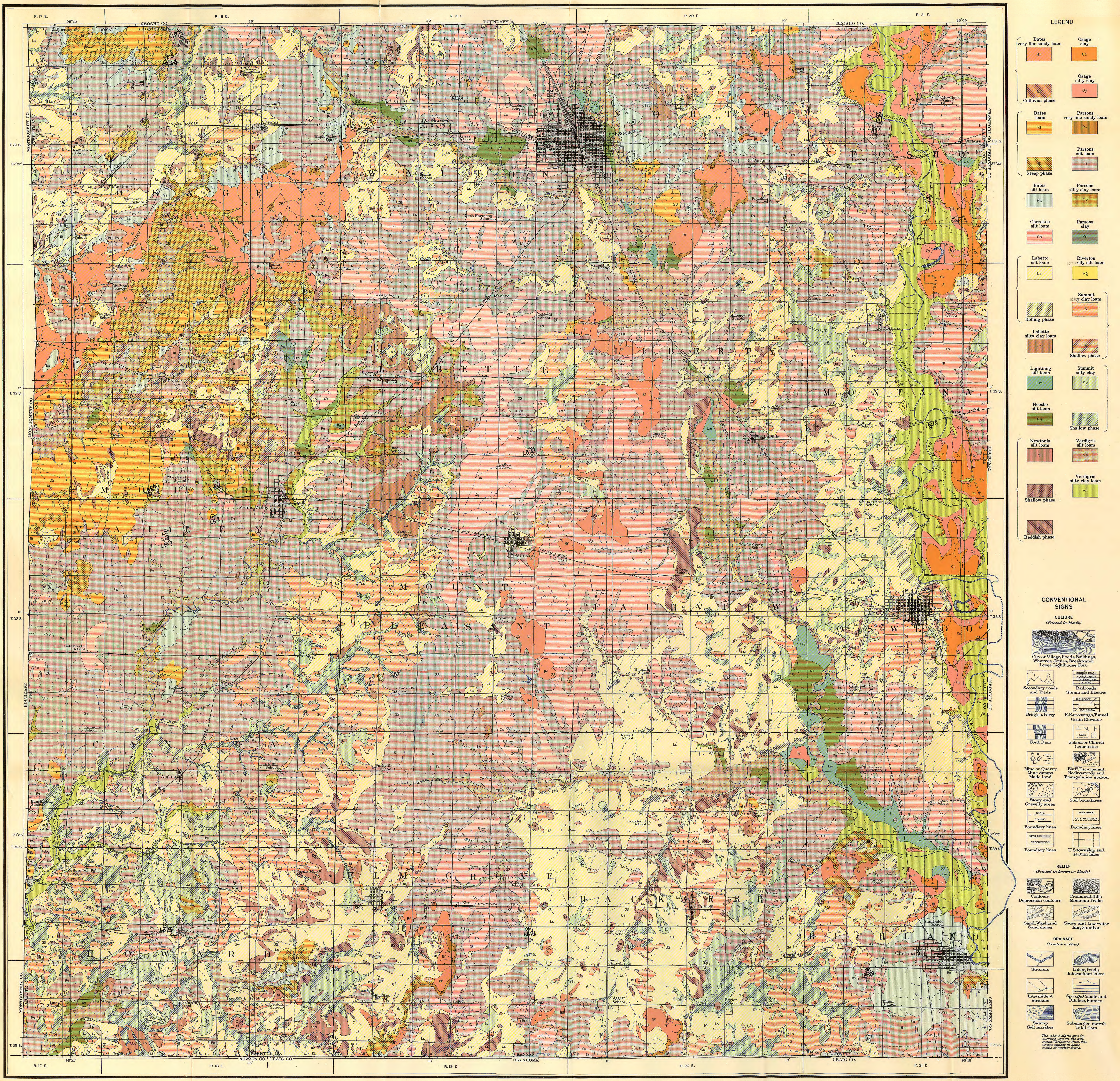
EXPLANATION OF PLATE I

Soils map of Labette county showing locations of sample stations

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
LABETTE COUNTY
KANSAS

KANSAS AGRICULTURAL EXPERIMENT STATION
L. E. CALL, DIRECTOR
R. I. THROCKMORTON, HEAD, DEPARTMENT OF AGRONOMY



Hugh H. Bennett, Inspector, District 4.
Soils surveyed by E. W. Knobel, U. S. Department of Agriculture, in charge, and R. L. von Trebra, and H. W. Higbee, Kansas Agricultural Experiment Station.

Scale 1 inch=1 mile

LITHO EASTERN OFFSET INC. BALTO.

Field Operations
Bureau of Soils
1926

DESCRIPTION AND EXPLANATION of SAMPLES

The soil sample stations were selected on the basis of their location in the county for wide distribution and of their position with reference to the stratigraphic column.

The subsurface strata has a regional dip to the west of approximately 23 feet to the mile, Plate III. The outcropping shales and limestones gave an indication of complex depositional features in the Pennsylvanian system of the Desmoinesian and Missori series. The Kansas City, Marmaton, Pleasanton, and Cherokee groups had contrasting features and the exact separation of the members and formations entailed considerable study.

The Kansas City group was characterized by thick beds of alternating shales and sandstones. There were several thin and lenticular beds of limestone one, the Watersville, posessed numerous chert nodules.

The Pleasanton group is best explained by this quotation from Moore (11) as follows:

> Pleasanton group.— Rocks lying between the base of the Hertha limestone and the disconformity that separates Missourian from Desmoinesian beds are mainly clastic sediments that mostly represent mechanically weathered detritus derived from land and deposited in shallow seas which advanced over Kansas after a time of more or less prolonged emergence. Gray, yellow, and dark-gray to black clay shale predominates, but there is much sandstone and some limestone and coal. The thickness ranges from about 70 feet to 130 feet.
>
> The disconformity below the Hepler sandstone brings deposits classified as lowermost Missourian into contact with rocks ranging from the Memorial shale downward to the upper part of the Bandera shale. Paleontological evidence and indication of widespread interruption in sedimentation, accompanied by some erosion, support placement of the Desmoinesian-Missourian boundary at this position.

Marmaton group consisted of strata which were more calcareous and more dominately marine than those of the underlying Cherokee. Thick limestones help produce erosional benches in the southern part of the county.

The Cherokee group consisted mainly of clastic rocks with light and dark colored rock predominating. Depositional cyclothems were encountered in the bedrock in the southeast portion of the county.

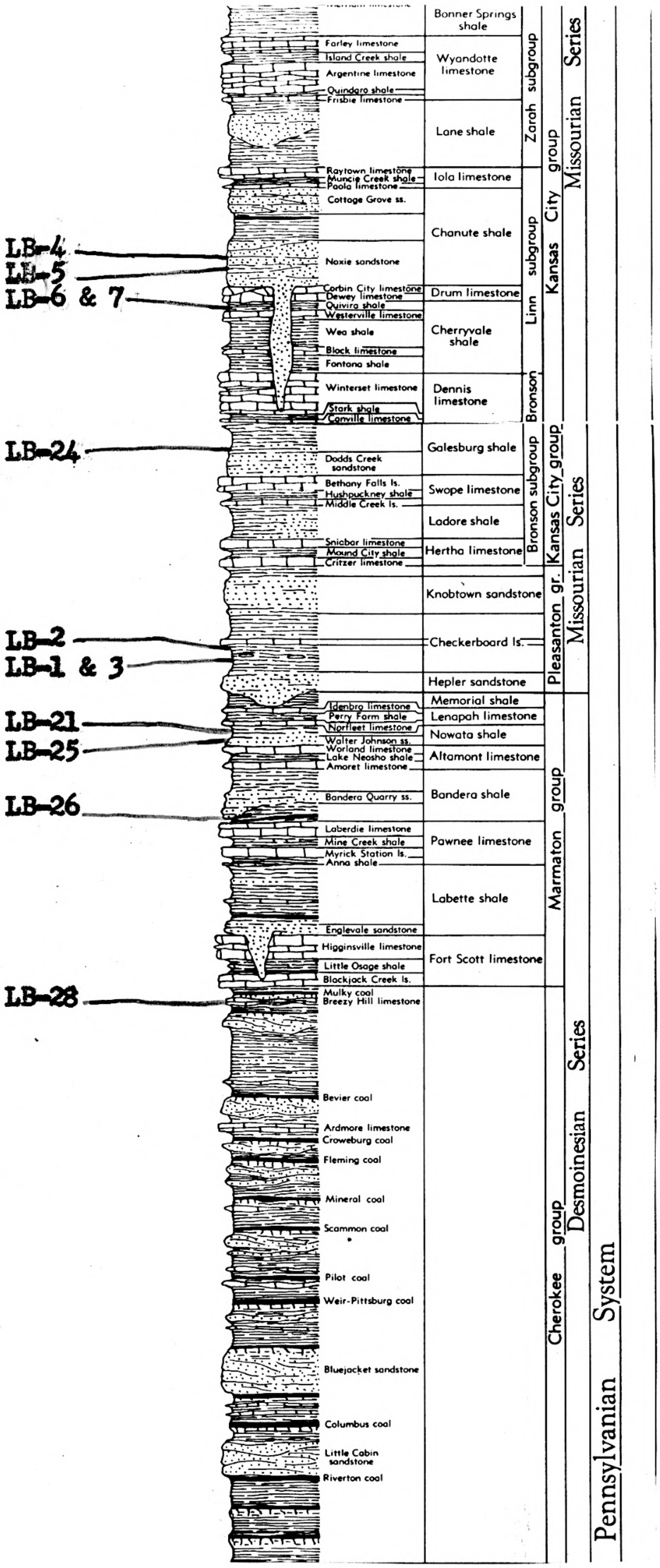
Sample LB-1 consisted of mantle rock material which rested on a shale of the Pleasanton group and is labeled LB-1 or 1 in the references that follow. The samples collected consisted of all of the four soil horizons. "A" zone was 0 to 10 inches in depth, dark brown to black in color, loose when cultivated regularly but with a tendency to become tight and moderately heavy when wet. "B" zone was 10 to 34 inches deep of a light brown color. "B" zone contained some organic material which decreased rapidly with depth. "C" horizon was 34 to 48 inches deep colored yellowish brown but mottled with rust and white areas. It posessed very little if any organic matter. The subsoil was tighter and caked readily on the auger sides. "D" zone, below 48 inches, was a shale of buff-gray mottled color. The D horizon consisted of firm, coarse and calcareous shale indicating the possibility that a thin limestone which out cropped to the east, was probably present in shaly-lime bedrock. From a rock outcrop area near the northeast corner of the experiment station site the following facts were established. The sample station is underlain by a thin fossiliferous limestone or a very calcareous shale. Below this calcareous zone is a dark blue to black shale.

The mineral analysis of this sample is given in Table 1. In addition to the minerals listed in the table the following were present: orthoclase, microcline and plagioclase, all in small amounts. The heavy minerals, in addition to those listed, were actinolite, biotite, chlorite, garnet, sillimanite and wollastonite, all in minute quanity. The light and heavy fraction both contained a minute amount of unknown minerals or minerals coated with opaque weathered material so positive identification with use of the

EXPLANATION OF PLATE II

Stratigraphic column of outcrop rocks of Labette county showing vertical position of sample stations.

PLATE II

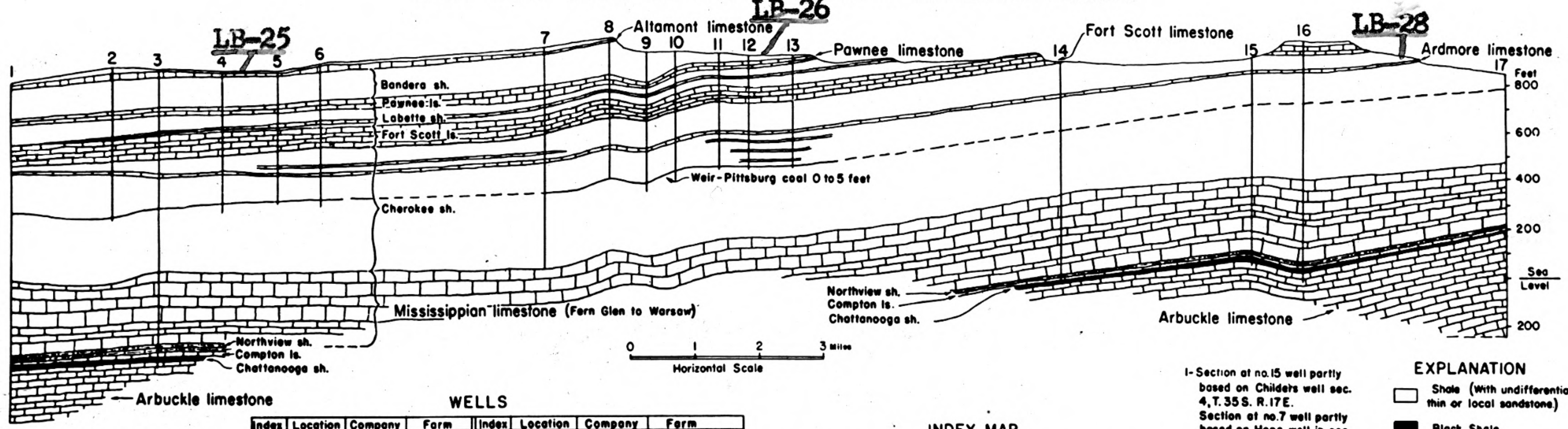

LB-4
LB-5
LB-6 & 7
LB-24
LB-2
LB-1 & 3
LB-21
LB-25
LB-26
LB-28
Farley limestone
Island Creek shale
Argentine limestone
Quindaro shale
Frisbie limestone
Bonner Springs shale
Wyandotte limestone
Lane shale
Raytown limestone
Muncie Creek shale
Paola limestone
Iola limestone
Cottage Grove ss.
Chanute shale
Noxie sandstone
Corbin City limestone
Dewey limestone
Drum limestone
Quivira shale
Westerville limestone
Wea shale
Block limestone
Fontana shale
Cherryvale shale
Winterset limestone
Stark shale
Canville limestone
Dennis limestone
Zarah subgroup
Linn subgroup
Bronson
Kansas City group
Missourian Series
Galesburg shale
Dodds Creek sandstone
Bethany Falls ls.
Hushpuckney shale
Middle Creek ls.
Swope limestone
Ladore shale
Sniabar limestone
Mound City shale
Critzer limestone
Hertha limestone
Bronson subgroup
Kansas City group
Knobtown sandstone
Checkerboard ls.
Hepler sandstone
Pleasanton gr.
Missourian Series
Memorial shale
Idenbro limestone
Perry Farm shale
Norfleet limestone
Lenapah limestone
Nowata shale
Walter Johnson ss.
Worland limestone
Lake Neosho shale
Amoret limestone
Altamont limestone
Bandera Quarry ss.
Bandera shale
Laberdie limestone
Mine Creek shale
Myrick Station ls.
Anna shale
Pawnee limestone
Labette shale
Englevale sandstone
Higginsville limestone
Little Osage shale
Blackjack Creek ls.
Fort Scott limestone
Marmaton group
Mulky coal
Breezy Hill limestone
Bevier coal
Ardmore limestone
Croweburg coal
Fleming coal
Mineral coal
Scammon coal
Pilot coal
Weir-Pittsburg coal
Bluejacket sandstone
Columbus coal
Little Cabin sandstone
Riverton coal
Cherokee group
Desmoinesian Series
Pennsylvanian System

EXPLANATION OF PLATE III

East west geologic section across Labette county showing the regional dip of bedrock, (approximately 23 feet to the mile).

PLATE III

EAST-WEST GEOLOGIC SECTION ACROSS LABETTE COUNTY

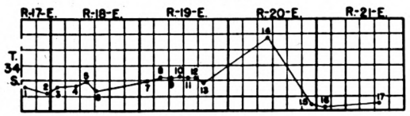


Wells drilled by Pittsburg and Midway Coal Co., indicated by PMC: Central Coal and Coke Co. indicated by CCC; Kansas Oil and Gas Co., indicated by KOGC: Chetopa Oil and Gas Co., indicated by COGC: Seepy and Braught indicated by CB

WELLS

Index	Location	Company	Farm	Index	Location	Company	Farm
1	26-34-17	PMC no 23	Downing	10	21-34-19	CCC 63	Blair
2	25-34-17	PMC no 5	Roberts	11	22-34-19	CCC 321	Davis
3	30-34-18	PMC no 29	Byrum	12	22-34-19	CCC 323	Sammelinger
4	29-34-18	PMC no 14	Bowman	13	26-34-19	CCC 322	Stafford
5	28-34-18	PMC no 16	Mason	14	9-34-20	KOGC no. 1	Ruttgen no 1
6	27-34-18	PMC no 17	Wingfield	15	36-34-20	COGC no 8	Remmington no 3
7	30-34-19	CCC no 314	Morgan	16	31-34-21	COGC no 1	Hagner no 1
8	20-34-19	CCC no 62	Hossinger	17	35-34-21	CB	Condy no 1
9	21-34-19	CCC no 69	Blair				

INDEX MAP



1- Section at no. 15 well partly based on Childers well sec. 4, T. 35 S. R. 17 E.
Section at no. 7 well partly based on Hope well in sec. 31, T. 34 S., R. 19 E.

2- Well no. 15 is producing oil from the Arbuckle limestone.

3- The Northview and Compton are identified on basis of study by H. S. McQueen, Missouri Geological Survey, of samples from well no 15.

EXPLANATION

Shale (With undifferentiated thin or local sandstone)

Black Shale.

Limestone (including dolomite)

Limestone and shale or shaly limestone.

Coal bed.

petrographic microscope was hindered. Because of the variation in the separate zones of LB-1 a second mineral analysis was run. The second of the two samples collected from LB-1 site was 12 feet west of the first collection point and is labeled LB-3. The main difference in the two analyses was the abnormal abundance of pyrite present in the heavy minerals in the first run or LB 1-D, Tables 1 and 3.

The D horizon actually responsible for the A, B, and C of LB-1 is probably similar to the average of LB 3-D and LB 2-D, Table 2. The accumulation of zircon and tourmaline in the upper zones is a natural weathering result. Muscovite increases percentage-wise, from LB 2-D and LB 3-D average, up to the B zone and then decreases. Alteration of muscovite to clay is the reason for the low percentage in the A zone.

Station LB-1 and LB-3 were situated midway between two creeks that drain from north to south; the stations were approximately three-eithths of a mile from either creek on a nearly flat to slightly sloping surface. A mile to the north is the base of the sharp incline to the uplands of this area. Considerable slope wash was evident near this location.

Sample LB-2 was situated stratigraphically several feet above positions of LB-1 and LB-3. The mantle rock rests on a shale member of the Pleasanton group. Station LB-2 was situated on gently rising round near the base of a hill, and material from levels above station LB-2 could easily be mixed with the mantle zones. The "A" zone was 0 to 14 inches deep. The soil was dark gray to black in color, and contained an abundance of grass and weedroots. Zone "B" was 14 to 36 inches deep. The soil was dark gray to reddish brown in color. As the depth of zone B increased less organic matter was present

Table 1. Mineral analysis of the mantle zones of sample LB-1. The D horizon is a calcareous shale of the Pleasanton group, and is not the source of A, B, and C.

Minerals	LB 1-A	LB 1-B	LB 1-C	LB 1-D
Chalcedony	41.6	78.6	77.3	98.9
Quartz	57.8	21.2	22.5	1.0
All others	0.6	0.2	0.2	0.1
Hematite	15.9	0.0	14.3	0.0
Hornblende	2.2	3.3	1.6	0.0
Limonite and coated minerals	53.4	31.9	1.6	0.4
Magnetite	0.0	0.0	25.4	0.0
Muscovite	6.3	54.8	33.3	0.1
Opaques	3.4	0.4	9.5	0.0
Tourmaline	5.9	3.7	4.8	0.1
Zircon	4.9	3.3	7.9	0.1
Pyrite*	0.0	0.0	0.0	98.2
All others	8.0	2.6	1.6	1.1

*The pyrite was abnormally high in the heavy fraction of the D horizon therefore it mask the true representation of the other minerals.

Table 2. Mineral anslysis average of sample LB 2-D and LB 3-D. This average is probably similar to that of the D source of LB 1-A, B, and C of Table 1.

Minerals	Average of LB 2-D and LB 3-D
Chalcedony	57.5
Quartz	39.5
All others	3.0
Hematite	18.3
Hornblende	1.3
Limonite and coated minerals	46.8
Magnetite	1.6
Muscovite	8.2
Opaques	14.8
Tourmaline	6.3
Zircon	1.3
All others	1.4

Table 3. Mineral analysis of the mantle rock zones of sample LB-3. The D horizon is a shale of the Pleasanton group and is not the source of A, B, and C.

Minerals	LB 3-A	LB 3-B	LB 3-C	LB 3-D
Chalcedony	41.6	78.6	48.3	15.2
Quartz	57.8	21.3	50.8	78.8
All others	0.6	0.1	0.9	6.0
Hematite	15.9	0.0	3.1	1.6
Hornblende	2.3	3.3	10.8	1.6
Limonite and coated minerals	53.4	32.2	8.2	43.0
Magnetite	0.0	0.0	3.6	3.1
Muscovite	6.3	54.8	17.0	10.9
Opaques	3.4	0.0	19.1	29.5
Tourmaline	5.8	3.7	7.2	9.3
Zircon	4.9	3.3	14.4	0.5
All others	8.0	2.7	16.6	0.5

Table 4. Mineral analysis average of bedrock material that lies stratigraphically above the Nowata formation. This bedrock is probably the source material of A,B,and C of LB-3, Table 3 and of A,B,and C of LB-25, Table 13.

Minerals	Average of LB 2-D and LB 24-D
Chalcedony	66.0
Quartz	26.6
All others	7.4
Hematite	17.5
Hornblende	1.0
Limonite and coated minerals	26.5
Magnetite	0.0
Muscovite	40.9
Opaques	8.3
Tourmaline	2.8
Zircon	1.1
All others	1.9

Table 5. Mineral analysis of the mantle rock zones of sample LB-2. The D horizon is a Pleasanton shale and is the source material of A, B, and C zones.

Minerals	LB 2-A	LB 2-B	LB 2-C	LB 2-D
Chalcedony	50.8	59.1	73.2	99.8
Quartz	47.4	34.3	26.7	0.2
All others	1.8	6.6	0.1	0.0
Hematite	1.3	2.0	10.1	34.9
Hornblende	2.2	1.8	8.4	1.0
Limonite and coated minerals	20.2	5.4	17.3	35.2
Magnetite	0.0	0.7	5.9	0.0
Muscovite	61.6	81.6	38.7	5.1
Opaques	0.4	1.1	5.4	15.3
Tourmaline	3.1	3.4	2.5	3.3
Zircon	8.1	1.8	10.1	2.0
All others	3.1	2.2	1.6	3.2

in the zone. "C" zone was 36 to 45 inches deep. The material was reddish to gray-green in color; plant roots were almost entirely absent. The "D" bedrock zone, was below 45 inches in depth and it consisted of gray-green shale mottled orange and rust. The damp shale material was tight and caked on the sides of the auger. C and D zones were calcareous with LB 2-D effervescing violently in cold hydrochloric acid. Hard calcareous shale particles of large size were still present after two and one-half hours of dispersion and shaking. These pieces were dark green to almost black in color and after being repulverized were mixed back in the original sample. The mineral analysis of LB-2 is shown in Table 5. Additional minerals identified were feldspars which included orthoclase and plagioclase in the light fraction. Actinolite, biotite, chlorite, garnet, staurolite, topaz and wollastonite were identified in the heavy fraction.

The percentages of minerals, in the light and heavy fractions, from the A, B, C, and D zones of sample LB-2 suggest the source as LB 2-D. The gradual increase of quartz from D to A zone and the gradual decrease of chalcedony favors LB 2-D as the source. Muscovite was unusually abundant in the A zone. This is partially explained by the large amount in the B zone. The percentage of muscovite in A is lower than in B due to weathering. The grade of the surface at site of LB-2 would increase the amount of slope wash over that from more level ground. Muscovite with a specific gravity of 2.76 is lighter than numerous other minerals in the heavy fraction. The platy habit of muscovite together with the specific would favor its movement over the movement of some of the other heavy minerals thus increasing its percentage relative to them in the top zone. The small amount of muscovite in the heavy fraction of the D zone is due to mineralogical variations of the bedrock vertically.

Table 6. Mineral analysis of the mantle zones of sample LB-4. The D horizon is a sandstone of the Chanute formation and is the source of A and B.

Minerals	LB 4-A & B	LB 4-D
Chalcedony	7.0	12.4
Quartz	91.9	87.3
All others	1.1	0.3
Hematite	0.3	2.1
Hornblende	1.4	2.4
Limonite and coated minerals	33.8	29.6
Magnetite	0.0	0.4
Muscovite	3.2	36.9
Opaques	44.8	20.5
Tourmaline	7.7	4.7
Zircon	4.4	1.6
All others	4.4	1.8

Sample LB-4 was resting on a sandstone member of the Chanute formation and is the highest stratigraphic sample obtained for this study. The A and B horizons, 0 to 4 inches, were grouped together because of their appearance and the shallow depth to bedrock. A and B were of dark gray to dark brown color and of rather silty texture. They have probably weathered from a sandstone or arenaceous shale. The D zone from 4 inches on down to hard bedrock was a sandstone which capped most of the broad hill tops in this vicinity. The topography underlain by this sandstone is hilly.

The minerals shown by A and B could be derived from D. Minerals such as hornblende and muscovite are low in the A and B zones. This is as expected because its topographic position on the hilltop has exposed it to considerable weathering thus altering the minerals to more stable products. Slope wash had not affected the mineral composition because of the station's topmost position. The most stable minerals such as tourmaline and zircon have accumulated in the upper zones as expected due to long periods of weathering.

Sample LB-5 was situated near the high escarpment prominate in the area. LB-5 lies a few feet stratigraphically below LB-4. The A and B zones of LB-5, 0 to 2 feet, were grouped together for the lack of adequate separation marks. The C zone was 24 to 38 inches below the surface and was a buff mottled arenaceous shale. The mineral analysis is presented in Table 7. Minerals present in small amounts included orthoclase, plagioclase, biotite, chlorite, sillimanite, and wollastonite. These minerals were also present LB-4 above.

The D source for LB-5 is suggested by LB 4-D and LB 5-D average mineral analysis Table 8. The gradual increase of quartz from D to A zone and the gradual decrease of chalcedony suggest the average of LB 4-D and LB 5-D as

Table 7. Mineral analysis of the mantle zones of sample LB-5. The D horizon is an arenaceous shale of the Chanute formation and not the source of A, B, and C zones.

Minerals	LB 5-A&B	LB 5-C	LB 5-D
Chalcedony	3.5	1.7	66.3
Quartz	86.9	93.8	28.3
All others	9.6	4.5	5.4
Hematite	0.0	1.7	0.7
Hornblende	3.3	3.4	0.3
Limonite and coated minerals	36.0	44.1	12.5
Magnetite	0.0	0.4	0.0
Muscovite	2.9	12.7	79.3
Opaques	42.7	22.4	3.7
Tourmaline	8.8	11.0	2.7
Zircon	3.3	1.7	0.3
All others	3.0	2.6	0.5

Table 8. The average mineral analysis of LB 4-D and LB 5-D. This average is probably similar to the source rock of LB5, Table 7.

Minerals	Average LB 4-D and LB 5-D
Chalcedony	39.4
Quartz	57.8
All others	2.8
Hematite	1.4
Hornblende	1.4
Limonite and coated minerals	21.1
Magnetite	0.2
Muscovite	58.1
Opaques	12.1
Tourmaline	3.7
Zircon	1.0
All others	1.0

the source. The accumulation of tourmaline and zircon from the D to A zone also favors the average as the probably source. The high percent of muscovite in the heavy mineral fraction of LB 5-D zone is due probably to the environmental condition at time of deposition. A silty texture is commonly associated with rocks high in mica minerals. The material from C, B, and A horizons could have moved from higher levels to their present position by such action as gravity, colluvial effects, and weathering processes associated with the formation of mantle rock.

Sample LB-6 was the D zone of a silty shale member of the Cherryvale formation. It was stratigraphically a few feet above sample LB-7. The mineral analysis is given in Table 10, and most of the additional light and heavy minerals are similar to data of LB-7 below (Table 9).

Sample LB-7 was mantle rock resting on a shale of the Cherryvale formation. The site of the station was on a long smooth slope beyond the base of the local escarpment. The A zone was from 0 down to 9 inches deep. The soil was a dark gray to brownish-black loose material. B and C zones were from 9 to 15 inches in depth. The samples were brown to gray in color. These zones consisted of fine silt and clay material. The intermediate weathered material graded rapidly into the oxidized zone of the bedrock strata. The line of demarkation was so indeterminate that the B and C zones were grouped together. The unweathered bedrock "D" zone was a shale of mottled color. Mineral analysis of LB-7 is shown in Table 9. Minerals present in small amounts were orthoclase, actinolite, biotite, chlorite, garnet, sillimanite, and beryl.

The bedrock from which LB-7 weathered was similar to the average mineral composition of LB 6-D and LB 7-D, Table 10. Source rock for LB-7 had weathered, settled and moved down the slope while disintergrating. In the process

Table 9. Mineral analysis of the mantle zones of sample LB-7. The D horizon is a shale of the Cherryale formation and is not the source of A,B,and C.

Minerals	LB 7-A&B	LB 7-B&C	LB 7-D
Chalcedony	27.7	48.2	97.6
Quartz	70.3	51.3	2.0
All others	2.0	0.5	0.4
Hematite	1.6	1.7	83.3
Hornblende	1.2	0.4	3.9
Limonite and coated minerals	74.7	91.5	5.7
Magnetite	0.0	0.0	0.0
Muscovite	0.4	0.2	0.9
Opaques	6.7	0.0	0.0
Tourmaline	11.4	4.2	0.9
Zircon	1.6	0.8	3.5
All others	2.4	1.2	1.8

Table 10. Mineral analysis of LB 6-D a shale of the Cherryvale formation, stratigraphically above LB 7. The column on the right is an average of LB 6-D and LB 7-D and is similar to the source material of LB 7, Table 9.

Minerals	LB 6-D	Average LB 6-D &LB 7-D
Chalcedony	28.3	65.0
Quartz	67.6	34.8
All others	4.1	0.2
Hematite	0.3	41.8
Hornblende	1.1	2.5
Limonite and coated minerals	61.4	33.6
Magnetite	0.3	0.2
Muscovite	21.3	11.1
Opaques	0.0	0.0
Tourmaline	12.6	6.8
Zircon	1.1	2.3
All others	1.9	1.7

of weathering, mantle rock may come to rest on bedrock stratigraphically lower than the D horizon that produced it. LB 6-D and LB 7-D are different in mineral percentages probably due to depositional variation in the original sediments. The abnormal amount of hematite in the heavy fraction of LB-7 D was probably due to a placer type accumulation. The high percent of hematite present in the sample would tend to mask the true proportions of the other heavy minerals. The quartz increased in percent in zones C to B to A, where as the chalcedony decreased in the same order.

Sample LB-21 was on a broad flat area with very little slope. The soil zones were obtained from a mantle that rests on a shale of the Nowata formation. LB-21 is higher in the stratigraphic column than LB-25, but near the same stratigraphic level. Sample 21 was collected at a time when the ground was well saturated following a prolonged rain. The leached zone was sticky silty clay material, dark gray to blackish brown in color, and ranged from 0 to 9 inches in depth with abundant vegetation on the surface. B and C zones were 9 to 20 inches in depth and contained some roots of plants. B and C zones were light brown to buff in color. The shale was mottled, light gray, orange, blue-gray and green in color and it contained numerous black spots. Relatively dry material persisted even though the top soil had been saturated for several days. The mineral analysis of LB-21 is shown in Table 11. Additional minerals identified were orthoclase, microcline, plagioclase, actinolite, beryl, biotite, chlorite, diopside, garnet, staurolite and wollastonite,

The mantle rock of LB-21 had weathered from material similar to that found in LB 21-D. The quartz percentage in the light fraction increased toward the upper zones whereas chalcedony decreased. The total opaque minerals such as limonite, hematite, and magnetite show nearly the same

Table 11. Mineral analysis of A thru D zones of sample LB-21. The D horizon is a shale of the Nowata formation and is the source of A,B, and C.

Minerals	LB 21-A	LB 21-B	LB 21-C	LB 21-D
Chalcedony	9.6	8.2	32.3	42.5
Quartz	85.5	81.3	62.4	41.1
All others	4.9	10.5	5.3	16.4
Hematite	1.3	1.3	4.0	0.4
Hornblende	1.7	4.1	4.7	4.3
Limonite and coated minerals	59.4	58.5	52.1	63.1
Magnetite	3.0	3.1	4.4	3.9
Muscovite	0.4	1.3	6.2	0.8
Opaques	3.8	1.6	0.0	0.0
Tourmaline	17.1	15.1	17.9	16.0
Zircon	9.4	10.1	6.2	9.2
All others	3.9	4.9	4.5	2.3

Table 12. Mineral analysis of the mantle zones of sample LB-24. The D horizon is a sandy shale of the Galesburg formation and similar to the source rock of A, B, and C.

Minerals	LB 24-A&B	LB 24-C	LB 24-D
Chalcedony	5.7	22.8	32.2
Quartz	78.5	66.3	53.0
All others	15.8	10.9	14.8
Hematite	0.4	0.0	0.0
Hornblende	1.7	0.1	1.0
Limonite and coated minerals	64.3	20.7	17.7
Magnetite	2.5	1.1	0.0
Muscovite	7.1	73.7	76.7
Opaques	7.1	1.1	1.2
Tourmaline	12.6	2.5	2.2
Zircon	2.5	0.3	0.2
All others	1.7	0.5	1.0

percentages in the A and D zone, (Table 11). Tourmaline and zircon show nearly the same percentage in all four zones. Muscovite and hornblende are lower in A then in B or C zones.

Sample station LB-24 was situated on the top of a hill that rises abruptly from the lowland that extends to the east and south of it. The mantle rock lies on a sand-shale member of the Galesburg formation. The A and B zones were 0 to 6 inches deep. The sample had a silty loam texture and was dark gray to buff in color. The C horizon was 6 to 11 inches in depth. This sample was whitish-gray in color. The D zone, 11 inches thick was a reddish-buff to white-gray sandy-shale or siltstone. Some similar outcropping rock material on the same level was obtained 100 yards to the west along the road cut. It had weathered to a material similar to the C horizon of LB-24. The mineral analysis is given in Table 12. Other minerals present in small amounts are orthoclase, plagioclase, actinolite, biotite, garnet, staurolite, rutile and wollastonite.

The D formation from which the mantle rock of LB-24 weathered was probably similar to LB-24 D. All zones show a similar mineral composition. The increase of quartz percentage-wise in the light fraction and the loss of chalcedony from D thru to the A zone suggest that the source rock was similar to that of LB 24-D. The variation in percentage between zones may be explained by normal weathering processes. The unusually high abundance of muscovite in D is due in large part to the type of bedrock, an arenaceous silty-shale. Such a high percentage of muscovite would tend to mask the proportion of other heavy minerals of the sample. The weathering of muscovite to clay minerals in A and B zone is normal.

Sample station LB-25 was located on a broad flat area. This area is south of the promient erosional remant which dominates the northern two-thirds of the

Table 13. Mineral analysis of the mantle zones of sample LB-25. The D horizon is the Altamont limestone and not the source of A,B, and C.

Minerals	LB 25-A	LB 25-B	LB 25-C	LB 25-D
Chalcedony	66.1	68.7	77.3	98.1
Quartz	29.6	26.4	21.2	0.2
All others	4.2	4.9	1.5	1.7
Hematite	1.8	13.4	4.4	2.0
Hornblende	12.2	12.6	6.4	0.1
Limonite and coated minerals	28.2	31.9	22.2	2.4
Magnetite	0.0	0.8	4.4	0.0
Muscovite	0.2	3.3	3.6	3.2
Opaques	28.2	14.3	10.0	0.0
Tourmaline	11.1	7.6	27.0	0.0
Zircon	14.5	13.4	12.9	0.0
Barite	0.0	0.0	0.0	62.6
Chlorite	0.0	0.0	0.0	28.1
All others	3.8	2.7	4.1	1.3

Table 14. (Table 4 repeated) Mineral analysis average of bedrock material that lies stratigraphically above the Nowata formation. This bedrock average is probably the source material of A,B, and C of LB 25- Table 13.

Minerals	Average of LB 2-D and LB 24-D
Chalcedony	66.0
Quartz	26.6
All others	7.4
Hematite	17.5
Hornblende	1.0
Limonite and coated minerals	26.5
Magnetite	0.0
Muscovite	40.9
Opaques	8.3
Tourmaline	3.8
Zircon	1.1
All others	0.9

west part of the county. The mantle is resting on the Altamont formation. The A zone, 0 to 18 inches in depth, is a loose loam of dark gray to blackish brown color. The B zone was 18 to 38 inches deep. This sample was a tight clay, brown to buff in color with a very little organic material. The C zone was 38 to 66 inches in depth. This weathered shale material was brown to buff in color, with some black specks scattered through it. The D horizon was at a depth of 5½ feet. LB 25-D was a limestone of light buff to white color. The mineral analyses of A, B, C, and D zones are presented in Table 13. The following minerals were also identified, microcline, orthoclase, plagioclase, actinolite, biotite, garnet, chlorite, topaz, andulusite, rutile and wollastonite. Barite is a rather common authigenic mineral in limestone. The chlorite is apparently authigenic in the limestone, Pettijohn (12).

The D formation from which the mantle rock of LB-25 weathered is probably represented by an average of LB 2-D and LB 24-D. The bedrock of the Pleasanton group and the Galesburg formation lie stratigraphically above LB-25, Plate II. The A, B, and C zones of LB-25 could not have weathered from LB 25-D. The barite and chlorite found in D was not present in any of the zones above it. The tourmaline and zircon present quite abundantly in A, B and C were not present in the limestone. Three opaques rather abundant in A, B and C were scarce in LB 25-D. Hornblende, present in A, B and C, was also scarce in the D. For the above reasons the mantle rock is not a product of the weathering of LB 25-D, but was weathered from a source rock similar to the average of LB 2-D and LB 24-D, Table 14.

Sample LB-26 was located on the top of a low hill in southern Labette county. The mantle rock rests on a limestone of the Bandera formation. The A horizon, 0 to 13 inches deep, consisted of soil with a silty clay texture, reddish gray in color. The B horizon was 13 to 27 inches deep. The

Table 15. Mineral analysis of A thru C zones of sample LB-26. Under C was a limestone. The A,B, and C zones probably derived from the Bandera formation.

Minerals	LB 26-A	LB 26-B	LB 26-C
Chalcedony	44.3	70.9	85.4
Quartz	52.3	28.3	14.6
All others	3.4	0.8	0.0
Hematite	2.8	7.1	3.8
Hornblende	6.1	1.2	6.5
Limonite and coated minerals	44.5	48.7	45.5
Magnetite	1.8	1.6	2.3
Muscovite	3.1	0.0	0.0
Opaques	1.0	4.6	8.1
Tourmaline	27.2	22.5	19.7
Zircon	11.8	11.6	12.1
All others	1.7	2.7	2.0

Table 16. Mineral analysis of the mantle zones of sample LB-28. The D horizon is an arenaceous shale near top of the Cherokee group and is the source of A, B, and C.

Minerals	LB 28-A	LB 28-B	LB 28-C	LB 28-D
Chalcedony	8.3	11.9	16.8	17.9
Quartz	86.6	86.8	77.5	70.6
All others	5.1	1.3	6.7	11.5
Hematite	0.6	0.3	1.2	0.3
Hornblende	4.3	8.0	4.2	2.7
Limonite and coated minerals	72.4	67.5	61.0	41.5
Magnetite	0.0	0.0	0.0	0.0
Muscovite	0.6	1.3	13.0	46.5
Opaques	0.0	0.0	0.0	0.0
Tourmaline	13.5	15.1	13.9	6.5
Zircon	6.4	7.4	4.8	1.3
All others	2.2	0.4	1.9	1.2

sample was a clay, buff to dark gray in color. The C zone, was from 27 inches to 48 inches in depth. This sample, a weathered shale was buff-green to brown in color with white spots in some layers. The mineral analysis of A, B, and C zones are shown in Table 15. Additional minerals identified were microcline, orthoclase, plagioclase, garnet, sillimanite and wollastonite.

Since there was no D horizon collected for this sample no definite bed-rock can be correlated with the mantle of LB-26, in this study. The D for LB-26 is probably part of the Bandera formation and stratigraphically above the limestone. The analysis as shown in Table 15 suggest that A could have weathered from B and B in turn could have weathered from C.

The mantle rock of LB-28 rests on an arenaceous shale of the Cherokee group. A complete profile of the mantle is given in Table 16. The A horizon was 0 to 11 inches deep. This sample was a silty sand, gray in color and contained roots and other organic material. B zone was from 11 to 18 inches deep. This zone contained material which had a silty texture; mottled buff-gray in color. The C zone was 18 to 40 inches deep. This sample was weathered silty sand or arenaceous shale. White, gray to buff, were the dominate colors in the C horizon. The C zone was fairly dry even though top layers were saturated with water due to recent rains. The D zone was below 40 inches in depth. A sample was obtained from the D horizon which extended down from 40 inches to 5 feet. The white, gray to buff arenaceous shale was firm and possessed a laminated structure. The mineral analysis for this sample is presented in Table 16. Additional minerals identified in this sample were microcline, orthoclase, plagioclase, actinolite, beryl, biotite, chlorite, topaz, sillimanite and staurolite.

The D formation from which LB-28 weathered was similar to LB 28-D, an

Table 17. Mineral analysis of an excavated Sandbar in the Neosho river flood plain.

Minerals	Top	Middle	Bottom	Average
Chalcedony	12.9	12.3	10.9	11.9
Feldspars	5.6	2.5	14.5	8.7
Quartz	81.4	85.1	74.6	79.4
All others	0.1	0.1	0.0	0.0
Actinolite	0.0	0.8	0.0	0.2
Epidote	0.0	5.9	5.3	3.9
Garnet	1.6	4.8	2.3	2.8
Hematite	0.0	5.9	2.9	2.9
Hornblende	6.1	3.5	4.2	4.5
Limonite and coated minerals	11.5	23.8	23.6	19.9
Magnetite	4.9	11.7	7.2	7.9
Muscovite	1.2	1.2	5.3	2.7
Opaques	41.2	16.0	21.6	25.8
Tourmaline	7.3	8.2	12.5	9.5
Zircon	25.3	15.2	14.1	17.8
All others	0.9	3.4	2.0	2.1

arenaceous shale near the top of the Cherokee group. Factors suggesting that the D horizon is the source material of LB-28 are stated below. More quartz and less chalcedony were present in the zones from D up to A. There was less muscovite in the A and B zones then in the C and D zones. Sandy soil texture would tend to favor deeper weathering action. Tourmaline and zircon being quite stable accumulated up to the B horizon and were present in nearly the same amounts in A as in B.

The Sandbar sample together with the samples LB-7 and LB-18 were taken from the Neosho river flood plain at the locations indicated on Plate I.

The Sandbar is situated on the present flood plain approximatly 150 yards from the river channel. The sandbar had from 1 to 5 feet of over burden above the gravel and sand. At the surface the over burden was a gray to black soil and graded rapidly down to a buff to reddish clay which rested on top of the gravel. A channel sample was taken from a face of the gravel pit, which is being worked for road material. The channel sample was separated into the top, middle and bottom parts. The mineral analysis is presented in Table 17. Additional minerals noted were the feldspars which included microcline, orthoclase, and plagioclase in the light fraction and barite, rutile, staurolite and wollastonite in the heavy fraction.

Sample LB-17 was located on the first terrace above the flood plain of the Neosho river. LB-17 was situated several feet above the sandbar site and one-fourth mile to the south west of it. The terrace was flooded in the summer of 1951 during the unusally high water stage. Table 18 shows the mineral analysis of LB-17. The total depth was 11½ feet. The mantle material had a loose, silty clay texture and was gray to brownish-black in color. It was collected with the use of a long soil auger. The A zone was from the surface to 4½ feet. The B zone extended on down to 11½ feet with no reason-

Table 18. Mineral anlysis of Alluvium from the Neosho river flood plain Sample LB-17.

Minerals	LB 17-A	LB 17-B	Average LB 17-A&B
Chalcedony	11.2	26.5	18.8
Feldspars	4.3	2.4	3.3
Quartz	82.3	64.5	73.4
All others	2.2	6.6	4.5
Actinolite	1.6	1.6	1.6
Epidote	1.8	0.8	1.3
Garnet	0.9	0.8	0.8
Hematite	0.9	1.0	0.9
Hornblende	1.6	1.3	1.4
Limonite and coated minerals	24.9	21.4	23.1
Magnetite	13.1	9.7	11.4
Muscovite	0.5	0.8	0.7
Opaques	18.4	17.4	17.9
Tourmaline	16.1	22.8	19.5
Zircon	18.4	22.2	20.3
All others	2.7	1.0	1.1

Table 19. Mineral analysis of Alluvium from the Neosho river flood plain Sample LB-18.

Minerals	LB 18-A	LB 18-B	Average LB-A & B
Chalcedony	38.1	37.9	38.0
Feldspars	7.5	3.1	5.3
Quartz	46.5	57.4	52.0
All others	7.9	1.6	4.7
Actinolite	0.5	0.2	0.4
Epidote	3.8	1.7	2.8
Garnet	4.1	37.0	20.6
Hematite	2.7	2.7	2.7
Hornblende	1.5	1.3	1.4
Limonite and coated minerals	25.8	9.3	17.6
Magnetite	4.3	4.5	4.4
Muscovite	3.5	0.6	2.6
Opaques	22.7	13.2	18.0
Tourmaline	13.9	10.5	12.2
Zircon	16.3	13.1	14.7
All others	1.7	5.8	2.6

able indication of approaching the shale or limestone that under lies this area.

Sample LB-18 was situated on the Neosho flood plain. LB-18 was located several miles down the river from LB-17. The A and B horizon showed practically the same texture and analysis as did LB-17 above. The Neosho river channel is approximately 250 yards from the sample station site. The mineral analysis is given in Table 19. The source of material for the mantle on the flood plain is the bedrock and mantle found on the water-shed plus some contamination with glacial materials. The percentage of some of the minerals found in the heavy and light fractions of the alluvium material is higher then that found in local mantle and bedrock. The most stable minerals, tourmaline and zircon, were at least as abundant in alluvium as in the upland samples. All minerals identified in the upland samples were present in the alluvium. The similarity of the minerals identified in the alluvium samples to those of the upland suggest that the local sediments furnished most of the material. In other words, for the most part, the alluvium was locally derived. Epidote found in the alluvium and not in local mantle or bedrock indicated contamination from glacial sources. Glacial sediments exsist at the surface in the north east part of Kansas but are not found (or have not been identified) in Labette county.

While differential thermal analyses tests were run on only four sets of samples LB-1, LB-2, LB-7 and LB-21 they all show the presence of Illite in all four horizons. This indicates that under the climatic conditions present in Labette county , the original illite of the bedrock is stable and accumulates in the upper horizons. Some of the illite in the A horizons could also be due to the weathering of the less stable minerals, that is, feldspars and muscovite present in the bed rock.

Table 20. Average mineral analysis of the Kaw river Alluvium and of the Glacial Till, as given by Harned (3).

Minerals	Kaw river	Glacial Till
Chalcedony	16.9	17.6
Feldspars	13.2	5.2
Quartz	64.5	70.4
All others	5.4	6.8
Epidote	12.7	17.3
Garnet	4.5	7.6
Hornblende	29.0	14.2
Magnetite	30.0	23.8
Tourmaline	1.4	4.2
Zircon	6.1	4.5
All others	16.3	28.4

Table 21. The percentage of Quartz and of Chalcedony found in the A zone as compared to the amount present in the D zone.

Sample number	Quartz Zone A	Quartz Zone D	Chalcedony Zone A	Chalcedony Zone D
LB-1	57.8	39.9	41.6	57.1
LB-2	47.4	0.2	50.8	99.8
LB-4	91.9 (A&B)	87.3	7.0 (A&B)	12.4
LB-5	86.9 "	28.3	3.5 "	66.3
LB-7	70.3 "	2.0	27.7 "	97.6
LB-21	85.5	41.1	9.6	42.5
LB-24	78.5 "	53.0	5.7 "	32.2
LB-25	29.6	0.2	66.1	98.1
LB-26	86.6	14.6 (C)	44.3	85.4 (C)
LB-28	86.6	70.6	8.3	17.9
Alluvium	64.4	61.0 (B)	24.7	32.2 (B)

Table 22. Muscovite comparison in A, B, C and D zones of each respective sample.

Sample number	Muscovite Zone A	Zone B	Zone C	Zone D
LB-1	6.3	54.8	25.2	5.5
LB-2	61.6*	81.6	38.7	5.1
LB-4	3.2 (A&B)			36.9
LB-5	2.9 "		12.9	79.3
LB-7	0.4 "		0.2	0.9
LB-21	0.4	1.3	6.2	0.8
LB-24	7.1 "		73.7	76.7
LB-25	0.2	3.3	3.6	3.2
LB-26	3.1*	0.0	0.0	——
LB-28	0.6	1.3	13.0	46.5
Alluvium	2.2	1.2	——	——

* Partially due to slope wash.

Table 23. The percent of total Opaques in zone A as compared to zone D of each respective sample.

Sample number	Zone A		Zone D
LB-1	72.7*		87.9
LB-2	21.9**		85.4
LB-4	78.9 (A&B)		52.6
LB-5	81.6 "		16.9
LB-7	83.0 "		75.6
LB-21	67.5		67.4
LB-24	74.3 "		18.9
LB-25	58.2		4.4 (ls)
LB-28	73.0		41.8
Alluvium	56.4	39.6 (B)	

* D zone abnormally high in pyrite of heavy fraction.

** Unusually high muscovite there fore low in total opaques.

Table 24. Tourmaline percentage relationship in zone A as compared to zone D of each respective sample.

Sample number	Tourmaline Zone A		Zone D
LB-1	5.9		4.7
LB-2	3.1		3.3
LB-4	7.7 (A&B)		4.7
LB-5	8.8 "		2.7
LB-7	11.4 "		0.9**
LB-21	17.1		16.0
LB-24	12.6 "		2.2***
LB-25	11.1	7.6 (B)	
LB-26	27.2	19.7 (C)	
LB-28	13.5		1.3
Alluvium	15.0	16.7 (B)	

** unusually high in hematite.
*** unusually high in muscovite.

Table 25. Zircon distribution in the A and D horizons.

Sample number	Zircon Zone A	Zircon Zone D
LB-1	4.9	0.3
LB-2	8.1	2.0
LB-4	4.4 (A&B)	1.6
LB-5	3.3 "	0.3*
LB-7	1.6 "	3.5
LB-21	9.4	9.2
LB-24	2.5 "	0.2
LB-25	14.5	12.9 (C)
LB-26	11.8	12.1 (C)
LB-28	6.4	1.3
Alluvium	17.4 18.0 (B)	

* Unusually high in muscovite.

DIFFERENTIAL THERMAL ANALYSIS EXPLANATION AND DESCRIPTION

The Differential Thermal Analysis (D.T.A.) was run on the following mantle and bedrock samples LB-1, LB-2, LB-7 and LB-21. The procedure followed similar to that followed by Grim (2). A heating rate of approximately 40 degrees Centigrade (C) per minute was used.

The specimen holder was a nickel block 1 inch square and 5/8 inch deep with two holes each ¼ inch in diameter and 3/8 inch deep, mounted on an alundum cylinder that fitted inside the furnace tube. The sample was placed in one of the holes of the specimen holder, and calcined aluminum oxide (which undergoes no thermal reaction up to 1000 degrees centigrade) was placed in the other hole. A platinum-platinum 10 percent rhodium thermocouple with the junction centered below the two masses was attached to a reflecting galvanometer, and the furnace temperature was recorded on a Leeds-Northrup Micromax recorder.

A double-junction differential thermocouple, consisting of two alumnel leads joined by chromel wire, was placed with one junction in the sample and the other in the remaining mass of aluminum oxide. When the temperature of the sample was greater or less than that of the aluminum oxide because of a thermal reaction, a potential difference was set up in the thermocouple. The differential thermocouple was attached to a second reflecting galvanometer and the temperature differences were recorded on a second Leeds-Northrup Micromax recorder.

In Plates IV to VII, the differential curves are presented so that the endothermic effects (heat taken up) are represented by deflections downward and exothermic effects (heat given off) by deflection upward.

Illite clay minerals (Figures 1 thru 11) show endothermic reactions between about 50 degrees and 250 degrees centigrade, 500 degrees and 650 degrees centigrade, and 850 degrees and 925 degrees centigrade. They show also an exothermic reaction between about 925 degrees and 980 degrees centigrade. The final endothermic and exothermic reactions are often so slight that they are not detected.

Kaolin was not found in the samples investigated. Kaolinite show an intense endothermic reaction between about 550 degrees and 650 degrees centigrade, and a very sharp exothermic reaction between 960 degrees and 990 degrees centigrade.

The endothermic reaction indicates the loss of crystal lattice water and a simultaneous breakdown of the crystal structure. Exothermic reaction indicates the transformation amorphous alumina to gamma alumina.

Montmorillonite was not found in the samples investigated. Montmorillonite like the illites, show three endothermic reactions and a final exothermic reaction. Most montmorillonites provide curves differing from those of illites only by showing the second endothermic reaction to be more intense and taking place at a temperature about 100 degrees higher, that is, approximately 700 degrees centigrade, and by more intense final endothermic and exothermic reactions.

The initial endothermic peak in both illite and montmorillonite indicates the loss of adsorbed water. The second or middle endothermic peak show the loss of crystal lattice water but the final breakdown of the crystal structure does not occur until the third endothermic peak. The first exothermic peak is caused by the formation of spinel, Grim (2).

EXPLANATION of PLATE IV

Fig. 1. Differential thermal analysis (D.T.A.) graph showing the presence of the clay mineral Illite in zone A of the mantle in LB-1.

Fig. 2. D. T. A. graph showing the presence of the clay mineral illite in zone B of the mantle in LB-1.

Fig. 3. D.T.A. graph showing the presence of the clay mineral illite in zone C of the mantle in LB-1.

Fig. 4. D. T. A. graph showing the presence of the clay mineral illite in zone D of the bedrock in LB-1.

PLATE IV

LB 1-A

Figure 1.

LB 1-B

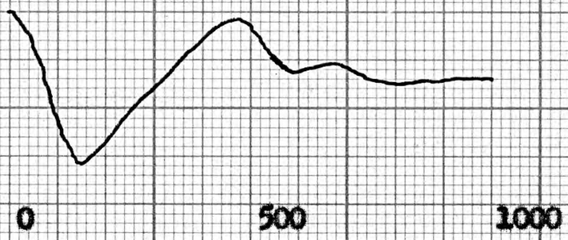


Figure 2.

LB 1-C

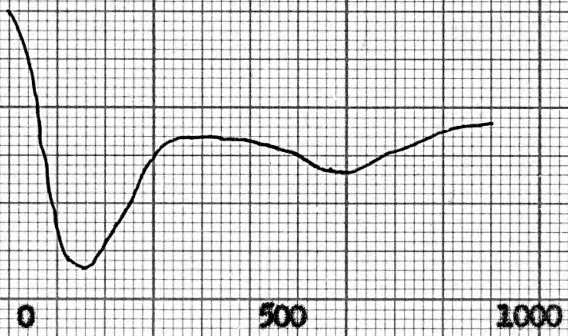


Figure 3.

LB 1-D

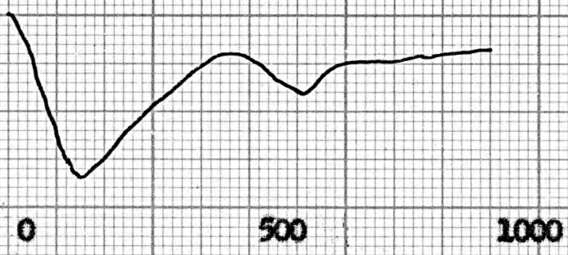


Figure 4.

EXPLANATION of PLATE V

Fig. 5. Differential thermal analysis (D.T.A.) graph showing the presence of the mineral illite in zone A of the mantle in LB-21.

Fig. 6. D. T. A. graph showing the presences of the clay mineral illite in zone B and C of the mantle in LB-21.

Fig. 7. D. T. A. graph showing the presence of the clay mineral illite in zone D of the bedrock in LB-21.

PLATE V

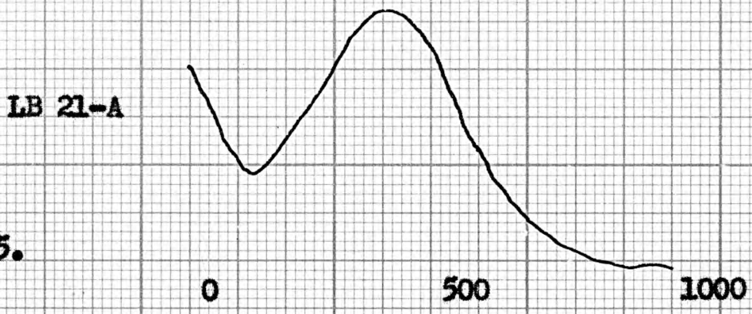


Figure 5.

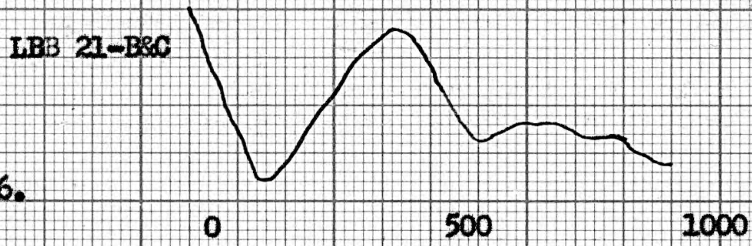


Figure 6.

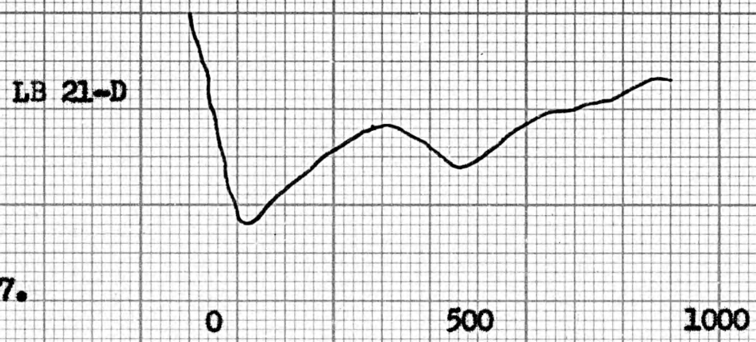


Figure 7.

EXPLANATION of PLATE VI

Fig. 8. Differential thermal analysis (D.T.A.) graph showing the presence of the clay mineral illite in zone A and B of the mantle in LB-7.

Fig. 9. D. T. A. graph showing the presence of the clay mineral illite in zone D of the bedrock in LB-7.

PLATE VI

LB 7-A&B

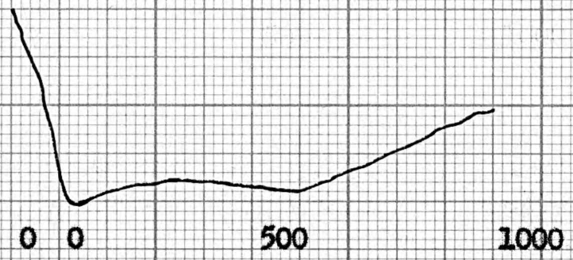


Figure 8.

LB 7-D

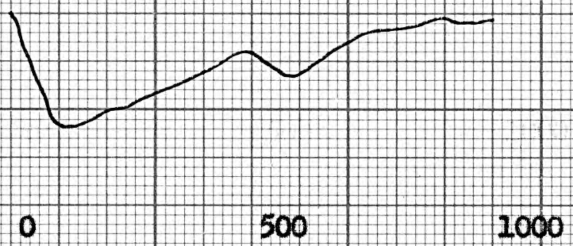


Figure 9.

EXPLANATION of PLATE VII

Fig. 10. Differential thermal analysis (D.T.A.) graph showing the presence of the clay mineral illite in zone A of the mantle in LB-2.

Fig. 11. D. T. A. graph showing the presence of the clay mineral illite in zone D of the bedrock in LB-2.

PLATE VII

LB 2-A

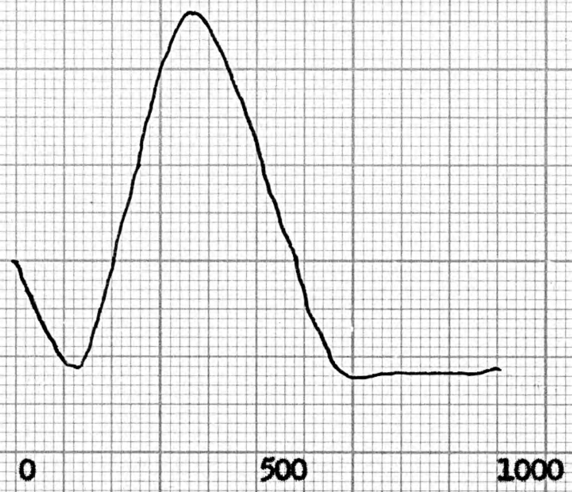


Figure 10.

LB 2-D

Figure 11.

CONCLUSIONS

I. Most of the mantle rock sampled in Labette county can be assigned to a residual origin as indicated by:

A. Consistent relationship shown by mineral composition of the A, B, C and D horizons.

B. In almost all cases A can be shown to be derived from B, and B from C.

C. A definite D horizon has not been identified for some samples but these situations can be explained either by mineralogical variations of the bedrock vertically, or by the effects of slope wash (colluvial effects).

II. Some criteria for residual origin are:

A. Less quartz and more chalcedony progressively from A to B to C to D.

B. Relatively high abundance of tourmaline and zircon in all horizons.

C. Less muscovite in A than B or C or D. Muscovite may increase percentage-wise up to B.

III. The best criterion for some admixture of glacial materials with the mantle rocks of the area is the presence of Epidote in the heavy minerals.

The mantle rock in Labette county is for the most-part residual in origin. The analysis of the heavy and light minerals indicated that the weathering of the C zones produced the B, and that the B zones weather to form the A zones, Tables 1 thru 17. The A zone could have weathered in every case from B zone, the B zone could have weathered from C zone, and the C could have weathered from a D horizon either actually present or postulated as explained for the respective mantle rock samples.

Weathering of chalcedony tends to change it toward other products. It has been suggested that there are two ways in which chalcedony weathers: first it either partially or wholly dissolves and goes into solution, second it recrystallizes as quartz. Since the time interval associated in bedrock and mantle weathering seems adequate to allow for extensive alteration of chalcedony, the smaller percentage of it is found in the A and B zones then in the parent material is readily explained, Table 21.

Quartz being one of the most stable and ubiquious detrital minerals is usually more abundant than any other of the other detrital minerals. Because the end product of many weathering processes results in some released quartz, and because of its wide distribution originally; quartz makes up the largest percentage of the detrital minerals of most mature soils. The mantle material analized shows accumulation of quartz in every case in the A zone, Table 21.

The feldspars were found to be of minor importance in this investigation.

The accumulation of iron oxides in the A and B horizons is a result of the weathering action of oxidation on iron bearing minerals. When examined under the microscope hematite, magnetite and other opaques such as limonite and ilmenite all show the effects of weathering. Weathered iron oxides could also have been deposited in the original sediments and this accounts for their presence in the D level.

Tourmaline and zircon are the most stable heavy minerals and are present in all samples as shown in Tables 24 and 25. Their increased abundance in the upper mantle is the result of their stability.

The mantle of the Labette county is largely residual, except for the alluvium on the flood plain. Alluvium from the main river of the county shows a little contamination with glacial material. It contains more garnet than the local rocks and some epidote which is lacking in all local rocks examined.

The presence of Barite and Chlorite in the D horizon of sample LB-25 and their absence in the A, B, and C zones proves that the D zone is not the source of the mantle that overlies it. Barite is a common authigenic mineral in limestone and chlorite may be present in limestone according to Pettijohn(12).

A study of the mineral analyses shows the more arenaceous a bedrock tends to be, the greater the loss of muscovite in the B zone. Table 22, shows the consistent loss of muscovite during weathering from B to A levels. The lack of muscovite accumulation in the B horizon in samples LB-5 and LB-28 suggests that in sandy materials weathering may penetrate to greater depths. Muscovite is altered to clay when subjected to periods of weathering. This explains the loss of this mineral in the A zone.

Illite is the dominant clay mineral in the clay mineral fraction. It is present in the local bedrock and may also result from the weathering of muscovite and other minerals. The presence of illite in all zones tested, Plates IV and thru to VII suggests that it is stable under the weathering conditions in Labette county. There may be a close relationship between muscovite and the illite as inferred by the following quotation from Pettijohn (12). "Illite is similar structurally to mica except that in muscovite the aluminum replacement effects $\frac{1}{4}$ of the silicon position and the number of potassium ions is proportionaltely greater".

Mantle rock showed a genetic relation to the D horizon identified for each sample. The proof that the mantle in some cases can not be derived from the bedrock on which it rest is shown by Table 13. If derived from the bedrock, the C, B and A horizons should show the same mineral composition as the bedrock. LB 25-C shows neither barite nor chlorite which are abundant in the limestone immediate below.

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SOURCE of SOIL MINERALS in LABETTE COUNTY

by

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B. S., Kansas State College
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ABSTRACT
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ABSTRACT

The purpose of this study was to determine the Source of Soil Minerals in Labette County, Kansas by the examination of mantle rock samples.

The techniques involved during this study were standard methods for petrographic work. The field survey conducted for the preliminary investigation began with the location of a few sample stations. Material from all zones of the soil profile at each location was gathered for the purpose of study.

The mantle rock of Labette county has been classified as residual on the Pennsylvanian shales and sandstones by Moore (11). The A, B, C, and D horizons at several locations have been examined to determine from the mineral composition whether the overlying horizon could be derived by weathering from the underlying horizon.

In every case (except for the alluvium) the C horizons can be shown to have produced their respective B horizons and the B horizons are the source for the A horizons. In five cases the D horizons were not the parent materials for the C horizons. These apparent exceptions are explained on the basis of slope wash and variations in the mineral composition of bedrock.

The alluvium of the Neosho river was shown to be similar mineralogically to the residual mantle rock of Labette county but the presence of the mineral epidote indicated some contamination by glacial material from north eastern Kansas.