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The Magnesium Content of The Rocks of The Upper Cretaceous System of Ellis and Osborne Counties, Kansas

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THE MAGNESIUM CONTENT
OF
ROCKS OF THE UPPER CRETACEOUS SYSTEM
OF ELLIS AND OSBORNE COUNTIES, KANSAS

being

A thesis presented to the Graduate Faculty
of the Fort Hays Kansas State College in
partial fulfillment of the requirements for
the Degree of Master of Science

by

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July 24, 1941

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I. INTRODUCTION

The recent impetus given industry by the national defense emergency has made everyone more or less conscious of the great importance of minerals. During the past few years some of the industrial leaders of Kansas have been attempting to promote the natural resources of the state. Some minerals once considered of little or no value are now being developed.

For many years the limestone rocks of Western Kansas have been used for building purposes, for fence posts, for surfacing roads, and for many other purposes. Until recently little work has been done on the chemical composition of these rocks.

^{1*}
Lawrence Rarick has determined the calcium content of the rocks of the upper Cretaceous system of Ellis County, Kansas.

A similar study for Osborne County, Kansas, was carried on by

²
Herman Search. The author decided to continue these studies by analyzing these same rocks for their magnesium content.

Since an analysis of magnesium in rocks necessitates the removal of the insoluble matter and of the iron and aluminum oxides, it was believed that the determination of these components would be of some interest. The determination of these

* Foot-note numbers correspond to bibliography.

1. Rarick, Lawrence, Theses F.H.K.S.C., (1935). Transactions Kansas Academy of Science, 39, 121-126, (1936).
2. Search, Herman, Thesis F.H.K.S.C., (1939). Transactions Kansas Academy of Science, 42, 233-236, (1939).

components of the rocks of Ellis and Osborne counties could be of considerable value; first, in ascertaining whether enough magnesium was present to be of commercial value, and second, in determining the amount of impurities, such as magnesium or silica, which might interfere with the use of the rocks for purposes requiring a high percentage of calcium carbonate.

Little emphasis has been placed on the geology of the rock formations, except as it might affect the quantities of certain constituents of the rocks.

II. Geography of Ellis and Osborne Counties

A. Ellis County

Ellis county is located in the third tier of counties south of the Nebraska line and in the fifth row east from the Colorado border. It is approximately thirty miles square and contains about 576,000 acres. Hays is the county seat with a population of 6,381.

The county is served by the main line of the Union Pacific railroad between Kansas City and Denver. United States Highway 40 crosses the county east and west while United States 183 serves north and south traffic.

The northern part of the county is drained by the Saline River, the central portion by Big Creek, and the southern part by the Smoky Hill River. The elevation at Hays is 1990 feet.

Farming is the chief occupation, but few crops have been raised in the last ten years because of drought. The production of oil, however, is gradually supplementing agriculture.

B. Osborne County

Osborne county is located in the second tier of counties south of the Nebraska line and in the sixth row, counting east from the Colorado border. It is square, being about thirty miles on each side. It contains approximately 573,000 acres.

It is served by the Missouri Pacific, Union Pacific, and Atchison, Topeka, and Santa Fe railroads. U.S. Highway 24 crosses Osborne county from east to west.

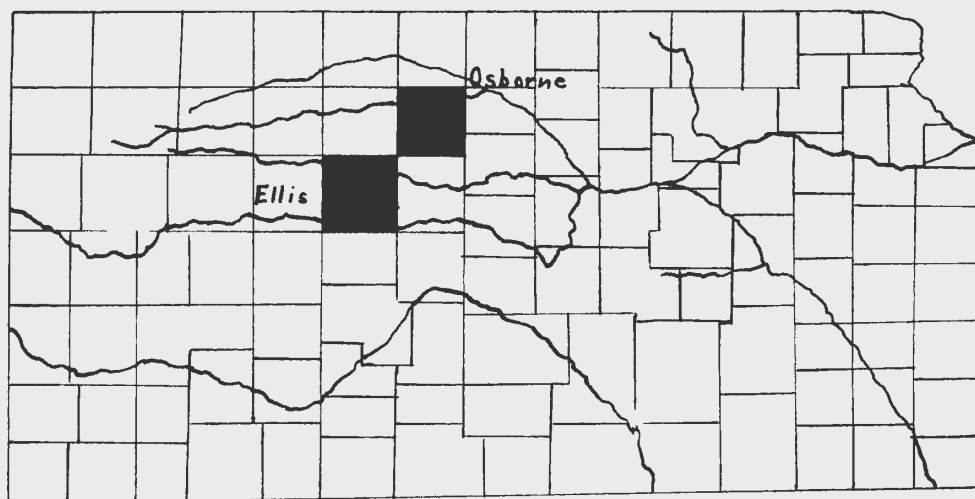
Agriculture is the main occupation, with wheat as the

principal crop. In some sections there is considerable emphasis on grazing of cattle and sheep.

The map on the following page shows the relative location of the two counties, as well as their location in the state.



Map of Kansas
(Showing the location of Ellis and Osborne Counties)



III. Geology of the Upper Cretaceous System

The outcropping rocks in both Ellis and Osborne counties are of the same ages; that is, Quaternary, Tertiary, and Cretaceous. This report is concerned only with those rocks which make up the Cretaceous system. A brief discussion of each formation and its members follows. The geology of Ellis and Osborne Counties is treated more fully by Bass³ and by Landes.⁴ The counties will be treated separately so that the most prominent outcroppings may be mentioned and located.

A. Ellis County³

1. Niobrara Formation

The Niobrara formation is the highest part of the Cretaceous system exposed in Ellis county. This formation is divided into the Smoky Hill chalk, above, and the Fort Hays Limestone below.

a. Smoky Hill Chalk Member.

This member is rather extensive in the western part of the county. In most places it forms smooth slopes, but in some places it is eroded into very rough badlands. It is made up of marl beds, alternating with chalk and thin beds of clay. The chalk beds range in thickness from one inch to $1\frac{1}{2}$ feet.

-
- 3. Bass, N. W., Kansas State Geological Survey Bulletin 11, Lawrence, Kansas, p. 11-36.
 - 4. Landes, Kenneth K., Kansas State Geological Survey Bulletin 16, Lawrence, Kansas, p. 7-30.

The total thickness exposed amounts to 100 feet.

b. Fort Hays Limestone Member.

This member is made up of chalky limestone averaging $2\frac{1}{2}$ to 3 feet, separated by shale 1 to 4 inches thick. The aggregate thickness is 55 feet. It occurs mainly along the valley of the Saline river and its tributaries.

2. Carlile Shale

The Carlile shale in Ellis county is divided into the Blue Hill shale member above and the Fairport Chalky shale member below.

a. Blue Hill Shale Member.

This member is found in Ellis county in the southern and eastern section and, to a certain extent, along the Saline river in the northern part. The Blue Hill shale ranges from 215 feet in thickness in the northeast part of the county to 175 feet in the southwest corner. It is made up of gray-black fissile clay shale with a bed of sandstone at the top.

b. Fairport Chalky Shale Member.

This member ranges from 115 feet in thickness in the southwest corner to 85 feet in the northeastern part of the county. It is made up of chalky shale alternated with thin layers of chalky limestone.

3. Greenhorn Limestone

The Greenhorn limestone is composed of four members. These are; Pfeifer shale member, Jetmore chalk member, Hartland shale member, and the Lincoln limestone member. No

data is available from which to ascertain which member or members are represented by the samples which were run. It is fairly safe to assume that at least part of them came from the Pfeifer member, since the sample locations correspond with an outcropping of this shale. The Greenhorn limestone makes up only a small part of the exposed rock of Ellis county, perhaps 15 per cent.

4. Graneros Shale

The Graneros shale is found in a narrow strip in the southeastern part of the county along the Smoky Hill river. It is made up of dark bluish-black shale approximately 35 feet thick.

5. Dakota Sandstone

Only a few acres of the Dakota sandstone are exposed in Ellis county. These are along the Smoky Hill river in the southeastern section of the county. The Dakota sandstone is made up of fine-grained white sandstone with various colored clay and a sandy shale.

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B. Osborne County

1. Niobrara Formation

The Niobrara formation is the highest part of the Cretaceous exposed in Osborne county. It is divided into the Smoky Hill chalk above and the Fort Hays limestone below.

a. Smoky Hill Chalk.

The thickest section of the Smoky Hill member in Osborne

county is 115 feet. Except for protection furnished by "mortar beds", the chalk is badly eroded.

b. Fort Hays Limestone.

This member occupies much more territory than does the Smoky Hill. Since it is much harder than the Smoky Hill it is present in steep slopes and cliffs. It is found in beds 60 feet thick along both sides of the south fork of the Solomon river.

2. Carlile Shale

The Carlile shale is divided into two members, the Blue Hill shale above and the Fairport shale below. The Blue Hill shale is characterized by the lack of noncalcareous material.

a. Blue Hill Shale member.

This member covers a large area in Osborne county. It is about 200 feet thick with a sandstone or sandy shale on top. The Blue Hill shale is a gray or gray-black fissile clay shale.

b. Fairport Chalky Shale Member.

The Fairport may be found in a narrow belt along the south boundary of Osborne county and, to a certain extent, along the two forks of the Solomon. It is composed of chalky shale, with thin beds of limestone intervening. The total thickness is about 100 feet.

3. Greenhorn Limestone

The Greenhorn Limestone is found in only a very small

part of Osborne county. It is divided into four members named in order, beginning at the top; Pfeiffer, Jetmore, Hartland, and Lincoln. The samples used were taken from the southern part of the county and probably belong to the Pfeiffer member.

IV. Selection of Samples

The samples used were those collected by Rarick and¹
²Search in their study of the calcium content of Ellis and
Osborne counties. The portions remaining after they had de-
termined the calcium content have been kept in labeled glass
bottles. For the method used in collecting these samples^{1,2}
see their works listed below.

Various factors were considered in selecting the samples
to be used in this study. An effort was made to select samples
that varied in calcium content. If only two samples were
run on a certain formation or member for this investigation,
one sample reasonably high in calcium content and one rather
low in calcium were chosen. If only one sample had been
collected on a formation, that formation was sometimes
omitted. The variation in calcium content of samples from
the same formation indicated that one sample would hardly
give an accurate indication of the percentage of the various
constituents present.

The location of the sample was noted, and selection made
so that the samples were well scattered over the county.

1. Rarick, op. cit., p. 18.

2. Search, op. cit., p. 15.

5,6,7.

V. Laboratory Procedure

A. Preparation of Samples for Analysis

The Ellis County samples were already pulverized by Rarick. These were dried in an oven at 110°C . for at least an hour.

The Osborne County samples were still in rock fragment form. A number of these fragments were pulverized in an iron mortar until approximately 200 grams of the sample had been reduced to a fine powder. This was thoroughly mixed, and fifteen grams were then placed in a labeled bottle. The sample was later placed in a weighing bottle and dried in the oven for one hour at a temperature of 110°C .

B. Determination of Insoluble Matter

Two portions of the same dried sample, of approximately one gram each, were weighed out and placed in 250 c.c. beakers. The samples were then treated with twenty-five c.c. of water and fifty c.c. of hydrochloric acid (Sp. Gr. 1.12), added in small portions.

After addition of the acid, the beakers were covered with watch glasses, placed on a hot plate, and allowed to evaporate to dryness. When evaporation was complete, each sample was treated with ten c.c. of hydrochloric acid (Sp. Gr. 1.12) and evaporated to dryness as before. The residue was then heated in an oven for an hour at a temperature

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5. Talbot, The Macmillan Company, New York, (1937) p. 184-200.
6. Washington, Henry S., John Wiley and Sons, New York, (1930), p. 1-208.
7. Fales and Kenny, D. Appleton-Century, New York, (1939).

of 110°C . It was next treated with fifty c.c. of dilute hydrochloric acid (one volume Sp. Gr. 1.12 to five volumes water) and boiled for five minutes. The solution was then filtered and the filter and precipitate washed with hot water until free from chlorides. The moist filters were placed in porcelain crucibles, ignited over a Bunsen burner, and then heated for thirty minutes with a Meker burner. The crucibles were then cooled in a desiccator. Later they were weighed and reheated to a constant weight.

C. Determination of Iron and Aluminum Oxides

The filtrate from the preceding operation was heated almost to boiling, and ammonium hydroxide was added until the smell of ammonia was distinct. Five c.c. of bromine water were added, and the solution was kept warm until the smell of ammonia was only faint. It was then filtered while hot, and the filtrate was washed with hot water. The beaker containing the filtrate was replaced by the beaker in which the precipitation had been made. The precipitate was dissolved by pouring twenty-five c.c. of hot hydrochloric acid (one volume Sp. Gr. 1.12 to five volumes of water) through the funnel and by washing the filter with hot water. The hydroxides were then reprecipitated as above. The filtrate was again washed with hot water, and the moist filter paper and filtrate were placed in a porcelain crucible. This was dried and ignited slowly over a Bunsen burner and then heated at

the full heat of the burner for one half hour. It was then cooled, placed in a dessicator, weighed, and reheated to a constant weight.

D. Removal of Calcium as Calcium Oxalate

Methyl red was added to the combined filtrates from the previous precipitation and five c.c. of concentrated hydrochloric acid (Sp. Gr. 1.18) added in excess. The solution was heated to 70° - 80° C., and 100 c.c. of ammonium oxalate solution (35 gms. ammonium oxalate in 1000 c.c. of water) were added. Ammonium hydroxide was then added dropwise until the solution was alkaline. The solution was then set aside for one hour to settle. At the end of this time, the liquid was decanted through a filter. The beaker containing the precipitate was then placed under the funnel and dilute hydrochloric acid (Sp. Gr. 1.12) was poured through the filter until the precipitate was dissolved. The filter was then washed with water and finally with dilute ammonium hydroxide.

The solution was diluted to 250 c.c., a few drops of ammonium oxalate solution were added, and the calcium was reprecipitated as above. It was allowed to settle for at least an hour, and then filtered through the original filter. The precipitate was washed with water and was then discarded.

E. Determination of Magnesium

The combined filtrates from the calcium precipitation were made slightly acidic and were evaporated to a volume of about 200 c.c. Five c.c. of concentrated hydrochloric acid were added in excess. Ten c.c. of diammonium phosphate (25 gm. in 100 c.c. of water) were then added. The solution was then cooled in ice water, and ammonium hydroxide was added drop by drop with constant stirring. When the solution was alkaline, as indicated by the methyl red, no more ammonia was added but the stirring was continued until precipitation took place. At this point, five c.c. of ammonium hydroxide were added and the solutions were set aside for at least four hours--generally over night.

After standing, the solution was filtered and washed with dilute ammonia (1 part ammonia to 20 parts water). The precipitate was dissolved in fifty c.c. of hydrochloric acid (1 volume Sp. Gr. 1.12 to 5 volumes water) and the filter was washed in very dilute hydrochloric acid. The filtrate was then diluted to 150 c.c.; five c.c. of diammonium phosphate solution were added and the magnesium was reprecipitated as above. After standing at least four hours, the solution was filtered and the precipitate washed with cold, one to twenty, ammonium hydroxide.

The filter paper was placed in a porcelain crucible and ignited slowly over a Bunsen burner. When the paper was

thoroughly burned, the crucible was placed in an electric oven and heated at 1050°C. for one hour.

VI. Results

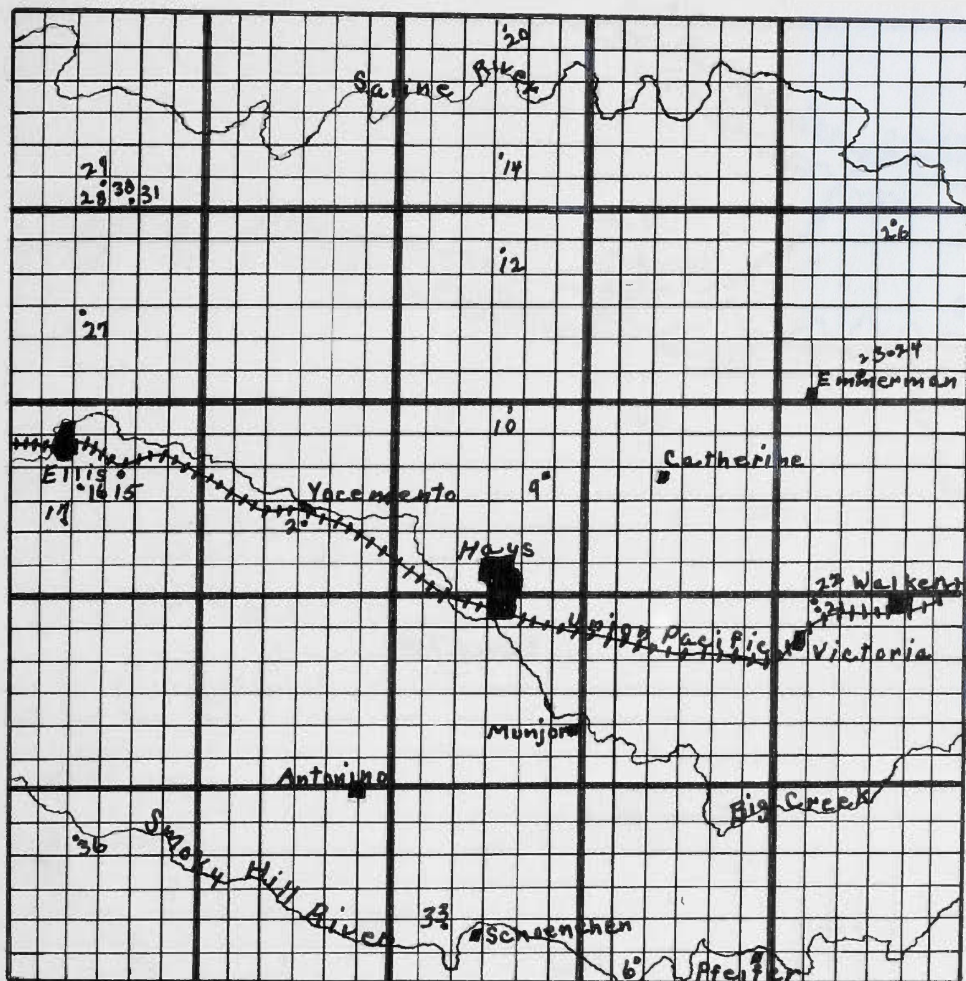
The following tables show the results obtained. The sample numbers used correspond to the numbering of Rarick and Search. A map follows which gives the location in the counties for the various samples.

Table I and Table II show the percentage of the four components which have been determined. The tables following give the percentages when the samples are listed according to the formations from which they were taken.

Check samples were run on all determinations. The results reported are the averages of at least two concordant results in each determination.

Map of Ellis County

(Location of each sample represented by dot adjacent to sample number. Sample numbers correspond to those of Table I.)



Map of Osborne County

(Location of each sample represented by dot adjacent to sample number. Sample numbers correspond to those of Table II.)

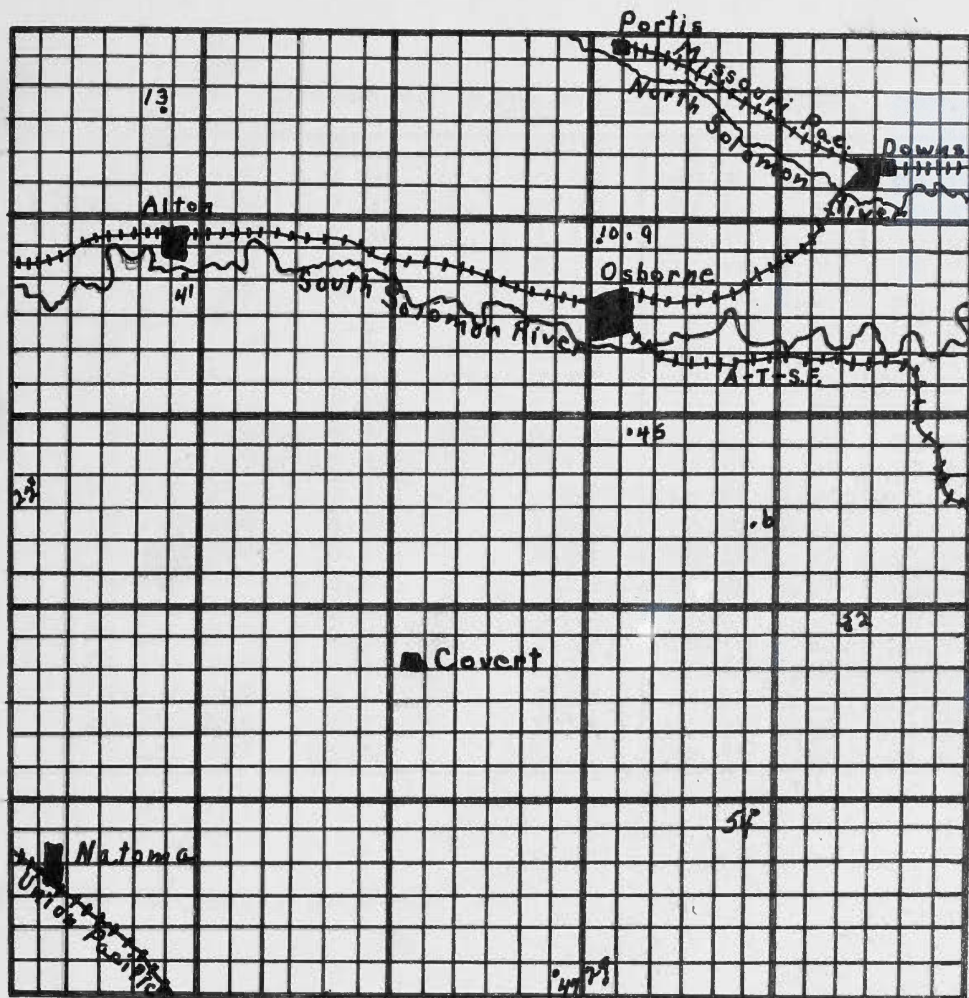


Table I

Ellis County

(Indicating sample number, location of sample, percentage of insoluble matter, percentage iron and aluminum oxides, percentage of calcium carbonate, percentage magnesium carbonate and a summation.)

Sample Number	Location S. T. R.	Insolubles	Al_2O_3 & Fe_2O_3	$CaCO_3$ ⁽¹⁾	$MgCO_3$	Sum.
2	22-13S-19W	68.59	17.76	0.57	0.94	87.86
6	32-15S-17W	4.82	0.58	92.88	0.90	99.18
9	22-13S-18W	1.92	3.72	95.80	1.07	102.51
10	4-13S-18W	3.32	1.19	92.70	1.23	98.44
12	9-12S-18W	12.72	3.12	81.86	2.09	99.79
14	27-11S-18W	75.03	16.60	0.80	2.47	94.90
15	15-13S-20W	3.08	1.90	93.50	0.69	98.28
16	16-13S-20W	8.10	2.32	87.00	0.75	98.17
17	20-13S-20W	15.22	3.67	83.88	0.93	103.70
20	3-11S-18W	6.17	1.82	90.22	0.73	98.94
21	5-14S-16W	9.59	1.82	86.01	1.17	98.59
22	5-14S-16W	11.53	1.01	83.56	1.02	97.12
23	33-12S-16W	2.17	0.87	96.37	0.96	100.37
24	27-12S-16W	3.66	1.53	93.85	0.65	99.69
26	3-12S-16W	34.36	8.23	48.16	1.19	91.94
27	21-12S-20W	9.32	3.03	80.60	0.87	93.82
28	33-11S-20W	21.48	3.33	64.60	0.21	89.62
29	33-11S-20W	7.68	1.19	88.40	0.46	97.73
30	33-11S-20W	9.58	2.05	86.46	0.59	98.68
31	34-11S-20W	8.15	2.07	88.93	1.18	100.33
33	29-15S-18W	6.47	1.17	91.93	0.96	100.53
36	9-15S-20W	36.45	5.23	47.71	1.61	91.21

1. Rarick, op. cit., p. 37-38

Table II
Osborne County

Sample Number	Location S. T. R.	Insolubles	$\text{Al}_2\text{O}_3\&\text{Fe}_2\text{O}_3$	CaCO_3 ⁽²⁾	MgCO_3	Sum.
6	24- 8S-12W	27.78	6.06	66.09	.90	100.83
9	5- 7S-12W	4.09	2.76	90.18	.23	97.26
10	6- 7S-12W	4.59	2.72	92.39	.71	100.41
22	18- 8S-15W	2.70	1.37	97.16	.79	102.02
29	31-10S-12W	4.97	.75	94.95	1.02	101.69
41	12- 7S-15W	77.55	5.26	9.03	.92	92.76
45	5- 8S-12W	84.71	7.53	.45	1.82	94.51
47	36-10S-13W	11.12	1.54	82.90	1.09	97.05
52	4- 9S-11W	24.01	3.11	68.14	0.46	95.72
54	1-10S-12W	2.17	1.34	94.68	0.65	98.84
Average Percentage						

2. Search, op. cit., p. 30,31.

Table III
Ellis County

(Indicating percentage magnesium carbonate in various members.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Percentage $MgCO_3$	Sample Number	Percentage $MgCO_3$
10	1.23	9	1.07
12	2.09	15	.69
16	0.75	20	1.17
17	0.93	23	0.96
27	0.87	24	0.65
28	0.21		
29	0.46		
30	0.59		
31	1.18		
Average Percent- age 0.92		Average Percent- age 1.11	

Table III (cont.)

Carlile Shale

BLUE HILL SHALE		FAIRPORT CHALK	
Sample Number	Percentage MgCO_3	Sample Number	Percentage MgCO_3
2	.94	21	1.17
14	2.47	22	1.02
		26	1.19
		36	1.61
Average Percentage 1.75		Percentage 1.25	

Greenhorn

Sample Number	Percentage MgCO_3
6	0.90
33	0.96
Average Percentage 0.93	

Table IV

Ellis County

(Indicating percentage of iron and aluminum oxide
in various members.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Percentage Al_2O_3 & Fe_2O_3	Sample Number	Percentage Al_2O_3 & Fe_2O_3
10	1.19	9	3.72
12	3.12	15	1.90
16	2.32	20	2.32
17	3.67	23	0.87
27	3.07	24	1.53
28	3.33		
29	1.19		
30	2.05		
31	2.07		
Average Percentage			
2.45		2.07	

Table IV (cont.)

Carlile Shale

BLUE HILL SHALE		FAIRPORT CHALK	
Sample Number	Percentage Al_2O_3 & Fe_2O_3	Sample Number	Percentage Al_2O_3 & Fe_2O_3
2	17.76	21	1.82
14	16.60	22	1.01
		26	8.23
		36	5.23
Average Percentage			
17.18		4.07	

Greenhorn

Sample Number	Percentage Al_2O_3 & Fe_2O_3
6	0.58
33	1.17
Average Percentage	
0.87	

Table V

Ellis County

(Indicating percentages of insoluble matter in various members.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Percentage Insolubles	Sample Number	Percentage Insolubles
10	3.32	9	1.92
12	12.72	15	3.08
16	8.10	20	6.17
17	15.22	23	2.17
27	9.32	24	3.66
28	21.48		
29	7.68		
30	9.58		
31	8.15		
Average Percentage			
10.62		3.40	

Table V (cont.)

Carlile Shale

BLUE HILL SHALE		FAIRPORT CHALK	
Sample Number	Percentage Insolubles	Sample Number	Percentage Insolubles
2	68.59	21	9.59
14	75.03	22	11.53
		26	34.36
		36	36.45
Average Percentage		Average Percentage	
71.89		22.98	

Greenhorn

Sample Number	Percentage Insolubles
6	4.82
33	8.15
Average	
6.48	

Table VI

Osborne County

(Indicating percentage of magnesium carbonate in the various members.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Percentage $MgCO_3$	Sample Number	Percentage $MgCO_3$
10	0.71	9	0.23
52	0.46	22	0.79
Average Percentage .58		Average Percentage .51	

Carlile Shale

Blue Hill Shale		Concretions of Blue Hill Shale		Fairport Chalk	
Sample Number	Percentage $MgCO_3$	Sample Number	Percentage $MgCO_3$	Sample Number	Percentage $MgCO_3$
41	.92	6	0.90	54	0.65
45	1.82				
Average Percentage 1.37		Average Percentage 0.90		Average Percentage 0.65	

Greenhorn

Sample Number	Percentage $MgCO_3$
29	1.02
47	1.09
Average 1.05	

Table VII

Osborne

(Indicating percentage of iron and aluminum oxide in the various members.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Percentage Al_2O_3 & Fe_2O_3	Sample Number	Percentage Al_2O_3 & Fe_2O_3
10	2.72	9	2.76
52	3.11	22	1.37
2.91		Average Percentage 2.06	

Carlile Shale

Blue Hill Shale		Concretions of Blue Hill Shale		Fairport Chalk	
Sample Number	Percentage Al_2O_3 & Fe_2O_3	Sample Number	Percentage Al_2O_3 & Fe_2O_3	Sample Number	Percentage Al_2O_3 & Fe_2O_3
41	5.26	6	6.06	54	1.34
45	7.53				
6.39		Average Percentage 6.06		1.34	

Greenhorn

Sample Number	Percentage Al_2O_3 & Fe_2O_3
29	0.75
47	1.94
Average 1.34	

Table VIII

Osborne

(Indicating percentage of insoluble matter in the various members of Osborne county.)

Niobrara Formation

S M O K Y H I L L		F O R T H A Y S	
Sample Number	Insolubles	Sample Number	Insolubles
10	4.59	9	4.09
52	24.01	22	2.70
14.30		3.39	

Carlile Shale

Blue Hill Shale		Concretions of Blue Hill Shale		Fairport Chalk	
Sample Number	Insolubles	Sample Number	Insolubles	Sample Number	Insolubles
41	77.55	6	27.78	54	2.17
45	84.71				
81.13		27.78		2.17	

Greenhorn

Sample Number	Insolubles
29	4.97
47	11.12
Average 8.04	

Table IX

(Showing the ranking of the various members for the different constituents.)

Ellis

	Insolubles	$Al_2O_3 \& Fe_2O_3$	$CaCO_3$	$MgCO_3$
HIGH TO LOW	Blue Hill	Blue Hill	Fort Hays	Blue Hill
	Fairport	Fairport	Greenhorn	Fairport
	Smoky Hill	Smoky Hill	Smoky Hill	Fort Hays
	Greenhorn	Fort Hays	Fairport	Greenhorn
	Fort Hays	Greenhorn	Blue Hill	Smoky Hill

Osborne

	Insolubles	$Al_2O_3 \& Fe_2O_3$	$CaCO_3$	$MgCO_3$
High To Low	Blue Hill	Blue Hill	Fairport	Blue Hill
	Smoky Hill	Smoky Hill	Fort Hays	Greenhorn
	Greenhorn	Fort Hays	Greenhorn	Fairport
	Fort Hays	Fairport	Smoky Hill	Smoky Hill
	Fairport	Greenhorn	Blue Hill	Fort Hays

B. Discussion and Summary

Probably the most important fact revealed by this study is the low amount of magnesium present in nearly all of the rocks tested. The sample having the largest percentage was No. 14 of Ellis county with 2.47% magnesium carbonate. In Osborne county, No. 45 contained the most magnesium with 1.82% magnesium carbonate. Both of these samples were taken from the Blue Hill shale. It is rather interesting to note that sample No. 2 of Ellis county was taken from the same formation, yet it contained only 0.94% magnesium carbonate.

The Fort Hays Limestone and the Greenhorn Limestone show the least variation in magnesium content for Ellis county, while the Smoky Hill ranges all the way from 2.09% magnesium carbonate to 0.21% magnesium carbonate.

In Osborne county the Blue Hill shale is highest in insoluble matter, in iron and aluminum oxide, and in magnesium carbonate.

A comparison of the two counties is an interesting feature of the study. If we eliminate the Fairport chalk (which is so unimportant in Osborne county that only one sample was collected) we find that the same members in each county rank in much the same order for all components except magnesium. The Blue Hill shale is highest in magnesium in both cases with the Smoky Hill being rather low.

A survey of the tables would indicate that it is almost

impossible to forecast how much magnesium is present by the calcium content. Sample No. 2 of Ellis county contains only 0.57% calcium carbonate and 0.94% magnesium carbonate. Sample No. 23 of the same county has almost the same percentage magnesium carbonate, (0.96%) but is 96.37% calcium carbonate.

The component listed as insoluble residue consists of silica and of silicates insoluble in acid. The iron and aluminum oxides also contain traces of manganese oxide, titanium oxide, and some of the rare earths.

Some samples were first fused with sodium carbonate at 1100°C . and then dissolved in hydrochloric acid. This fusion and subsequent addition of acid dissolves silicates which otherwise are insoluble in acid. The silica content on these samples was slightly lower than when the alkaline flux was not used. The percentage of iron and aluminum oxides was somewhat higher. This would indicate that some iron and aluminum silicates (insoluble in acids) were changed to soluble compounds by the fusion. There was no change in the magnesium content of the fused samples. The amount of magnesium compounds insoluble in acid are believed to be negligible.

As further study it would be interesting to dissolve the samples of limestone by using sodium carbonate flux and redetermine the silica and the iron and aluminum oxides. This would give an indication of the amounts of insoluble silicates (as distinguished from silica) that were present. We intend to do this before publication.

In this proximate analysis of limestone, a summation of 97% to 100% for the four components determined was considered satisfactory. The experimental errors in the determination would account for some discrepancies. These errors, however, should not be large. Sodium and potassium compounds were not determined, nor was water of combination. In samples containing considerable clay, the water of combination might be present to the extent of three or four per cent. The determination of sodium and potassium and the water of combination would of course increase the summation. In nearly all cases where the summation is quite low, a large percentage of insolubles was found.

Rarick¹ and Search² have pointed out the uses or possible uses of these limestones. If the present industrial development continues, it is quite possible that they might be of commercial importance. Some of the uses mentioned were the use of these rocks for building purposes; for manufacturing quicklime; for manufacturing cement; for cattle feed.

For any use requiring a high content of calcium and a low content of magnesium, these rocks, as a whole, would be quite satisfactory. For example, a high content of magnesium is objectionable if the rock is to be used in the manufacture of cement. These rocks have low content of magnesium as desired for cement manufacture.

1. Rarick, op. cit., p. 46-48.

2. Search, op. cit., p. 40-43.

All of these rocks contain too much silica to permit their use in manufacturing blackboard crayon. However, a few of the rocks with very high lime content might be purified sufficiently by water flotation to be used as a source of crayon.

Most of the rocks studied contain too small a percentage of shale or of silicates to permit their use in manufacturing rock wool by direct calcination. These rocks, however, could be used for this purpose if they were mixed with shale or with silicate rocks before calcination.

These rocks, of course, could never be utilized as a source of magnesium metal; the magnesium content is much too low.

VII. Bibliography

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