OKLAHOMA GEOLOGICAL SURVEY

Robert H. Dott, Director

MINERAL REPORT No. 5

LIMESTONE ANALYSES

Compiled by

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NORMAN

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FOREWORD

The chief object of this report is to make available the chemical analyses of better grades of Oklahoma limestones, together with a brief discussion of their general distribution.

Most of the samples for these analyses were collected by the State Mineral Survey, a WPA Project, (65-65-538) sponsored by the Oklahoma Geological Survey in 1936-1937. Thicknesses of the limestones given in Tables II and III are from data sheets of the Mineral Survey field crews, and may often represent the thickness of an outcrop from which only a small portion was sampled. The reported thicknesses are included with the analyses as an aid in locating sites that suggest possibilities which justify more detailed sampling and prospecting by those interested in development work.

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MINERAL REPORTS:

No. 1, Volcanic Ash and Tripoli

No. 2, Phosphate

No. 3, Glass Sand

No. 4, Iron Ores

No. 5, Limestone analyses

IN PREPARATION:

Asphalt

Dolomite

OKLAHOMA LIMESTONE

Previous publications of the Oklahoma Geological Survey dealing with various phases of the geology of Oklahoma and containing information on the distribution of limestones are:

Bulletin 12, The Arbuckle and Wichita Mountains, originally published as Professional Paper 31 by the U. S. Geological Survey.

Bulletin 23, The Geology and Economic Value of the Wapanucka Limestone (out of print).

Bulletin 26, Lime Resources and Industry in Oklahoma.

Bulletin 33, Geology of Love County.

Bulletin 35, Index to the Stratigraphy of Oklahoma.

Bulletin 39, Geology of Marshall County.

Bulletin 55, Stratigraphy and Physical Characteristics of the Simpson Group, (contains detailed geologic map of Arbuckle Mountains).

Bulletin 2 of the Bureau of Geology, available at Oklahoma Geological Survey, deals with the geology of the Stonewall Quadrangle, chiefly Pontotoc County.

Circular 15, Physical Characteristics of the Arbuckle Limestone, Arbuckle Mountains.

Circular 22, Progress Report on the Classification of the Timbered Hills and Arbuckle Groups of Rocks, Arbuckle and Wichita Mountains.

Bulletin 40, Oil and Gas in Oklahoma. The chapters of some of the counties contain discussions of distribution of outcrops of the various formations, and several contain maps showing distribution of outcrops.

The main limestone areas of Oklahoma may be grouped as follows: northeastern; north-central; southern; Wapanucka ls.; Arbuckle Mountain area in south-central; and Wichita Mountain area in southwestern part of the state.

Northeast Area

This area embraces the Oklahoma portion of the Ozark Plateau, roughly the area north of Arkansas River and east of the main line of M. K. & T. Railroad. The area is characterized by a rather thick cherty limestone known as the Boone formation, cropping out over most of the area, with younger formations, including some limestones, around the edges. Some older formations are exposed as a result of folding and erosion within the area of the main Boone limestone outcrops. At the base of the Boone is the St. Joe limestone member, usually 15 to 20 feet thick, and generally showing a high content of calcium carbonate. Near the top in some areas is another high calcium limestone member known as the Short Creek oolite. The major portion of the Boone is too cherty for a good limestone. The Pitkin and Morrow formations which crop out around the Boone contain good limestones.

North-central Area

The north-central area includes the area from central Kay County to eastern Craig County, and extending approximately as far south as northern Payne and central Tulsa Counties. This area is not so dominantly limestone as the northeastern area, but contains numerous limestone beds alternating with sandstones and shales. The different limestones show considerable variations in quality and thickness, but in all the counties included in the area there are some beds of high calcium limestone.

Southeastern Area

This area includes the limestones of Cretaceous age, south of the Arbuckle and Ouachita Mountains from Love County east to Arkansas. The most prominent limestone in this group is the Goodland which crops out in a narrow band across the entire area. Other less prominent limestones are present. The Goodland limestone is usually high in calcium carbonate and has been used for the manufacture of lime to some extent, especially at Fort Towson.

Wapanucka Area

The Wapanucka limestone is present around the eastern part of the Arbuckle Mountains, and to the northeast as a long narrow outcrop in Atoka, Pittsburg, and Latimer Counties, where it is not associated with other limestones of importance. The Wapanucka is quite variable in character, locally near Bromide it is extremely pure, and in general contains less impurities in and near the Arbuckle Mountains, but becomes cherty to the northeast.

Arbuckle and Wichita Mountain Areas

If the dolomites of the Arbuckle group are included, the thickest limestone in Oklahoma is to be found in the Arbuckle Mountains. The limestones and dolomites of the Arbuckle group total some 7,000 feet. In addition, in this area, there are limestone members in the Simpson group, the Viola limestone, and the limestones of the Hunton group. Several of the formations of the Arbuckle group, and older formations of the Timbered Hills group, are present in the Wichita Mountains, particularly on the north side. These rocks are of the same age and similar in character to much of the limestone of the Arbuckle Mountains.

IMPORTANCE OF LIMESTONE IN THE CHEMICAL INDUSTRY

Limestone and its chief basic products, lime and carbon dioxide, are intimately connected with the production of many of the important chemicals and are used in numerous industrial and chemical processes. With the increasing importance of industrial chemistry, the basic raw materials from which chemicals may be derived are also becoming of more value as potential mineral resources.

Most of the important chemicals are derived from a

relatively small number of raw materials. In a study of the sources of 150 important chemicals produced in this country, it was found that only 34 mineral raw materials are used.(1) Listed in the order of frequency in which they are used, the first ten are: water, air, coal, sulphur, mineral salt, limestone, sulphide ores, brines, petroleum, and natural gas. Omitting water and air, limestone becomes fourth on the list. In the listing of frequency of use as a basic raw material in the manufacture of the 150 chemical products, water, coming first, was listed 99 times, and natural gas 23 times in tenth place. Limestone was listed 75 times. Thus, on the basis of the number of chemical processes in which they find a use, the ten basic materials listed above appear to be of dominant importance to industrial chemistry.

In addition to limestone, Oklahoma has an abundance of most of the other ten leading chemical raw materials and especially coal, sulphide ores, petroleum, and natural gas. Availability of these additional minerals increases the potential value of the limestones, should attempts be made to develop chemical industries in Oklahoma.

Limestone and its products are used in so many industrial and technical applications that a list of these uses would be too lengthy for a report of this nature. In Table I some of the general uses of limestone are given, together with brief remarks on the quality of limestone required. Rock wool manufacturing, a comparatively new and growing industry, utilizes impure siliceous limestones, or limestone mixed with silica or clay, as a raw material.(2)

In Tables II and III, analyses of a number of samples of high grade limestones are given. Table II includes limestones containing 95 per cent or more calcium carbonate and Table III includes analyses containing more than 90 percent calcium carbonate plus magnesium carbonate, but with not over 10 percent magnesium carbonate. Magnesian limestones with more than 10 percent magnesium carbonate are to be included in a Mineral Report on dolomites of Oklahoma.

The field data given, location of samples, thickness, and overburden, are taken from field sheets compiled during the State Mineral Survey. The field work was of a reconnaissance nature. In many, perhaps most, instances, the thickness given represent the estimated thickness of an outcrop from which only one or few samples were taken. Hence, the analysis given may not be representative of the entire thickness reported. For some of the deposits, several analyses are available showing variations of the limestone, but only those above 90 percent can be given here. The tables are given for the purpose of making analyses of the better limestones so far sampled available for distribution, and are intended only as a guide to deposits which may appear to justify further investigation.

Additional information on many specific deposits is available, and may be obtained by visiting or writing the Oklahoma Geological Survey, Norman.

Chemical analyses by S. G. English, chief chemist, Herschel Sudduth, L. W. Workman, R. George Mihram, staff chemists of Oklahoma Geological Survey; and chemists of State Mineral Survey; calculations by S. G. English. Geological data by Robert H. Dott and J. O. Beach.

1. Keller, R.N., and Quirke, T.T., Mineral Resources of the Chemical Industries, Economic Geology, vol. XXXIV, No. 3, May, 1939, pp. 287-296.

2. Wood, F. C., Rock Wool Possibilities in Oklahoma, Oklahoma Geological Survey Bulletin 60, 1939.

TABLE I. Uses of Limestone, Depending on Chemical Composition

Use	Minimum percent $CaCO_3$	$MgCO_3$	CaO	MgO	Remarks
Agricultural	95				10-mesh and finer. 100-mesh desired by some users. Some $MgCO_3$ permissable, required on some soils.
Alkali	93	5			Maximum of 3% SiO_2 [a]. Calcined, both CaO and CO_2 required.
Baking soda	95?				
Calcium carbide	97	2			Maximum of .5% Al_2O_3, 3% SiO_2, .01% P_2O_5, trace sulphur.
Carbon dioxide (CO_2)	high	high			$MgCO_3$ contains more CO_2.
Calcium nitrate	high				
Dye works	high				Finely ground. Used as base.
Explosives	high	[b]			Average of 1.5% blasting explosive is limestone.
Fertilizers	high	[b]			Mfg. nitrogenous fertilizer, and as filler in some other types.
Filter, sewage	high	[b]			Pyrite and clay not tolerated.
Flux, blast furnace	90-95	[c]			Maximum of 2% Al_2O_3, 3% SiO_2, .1% phosphorous and sulphur.
Bessemer, acid					Not over .01% phosphorous.
Open hearth, basic		10			Maximum 1.5% Al_2O_3, 3% SiO_2, low sulphur and phosphorous.
Food, animal	high				Finely ground, often mixed with feed to furnish calcium to livestock.
Glass manufacture					
Class 1			96	[b]	Max. 3% Al_2O_3, .2% Fe_2O_3, 4% SiO_2.
Class 2			91	[b]	Max. 5% do., .4% do., 9% do.
Class 3			83	[b]	Max. 5% do., .8% do., 17% do.
Lime	97				Magnesium may or may not be used.
Paint manufacture	high	[b]			Inert filler in many paints.
Paper manufacture					
Tower system			53.0	1.5	Max. organic matter .5% Al_2O_3, Fe_2O_3, and SiO_2 1.5%.
Tank system			29.8	17.9	do., magnesian limestone usually preferred in tank or milk of lime system.
Portland cement	75				20% clay; 5% $MgCO_3$; sulphur, and alkali permitted.
Poultry grit	high	low			Must have less than .1% flourine, size less than 4-mesh, greater than 10-mesh.
Rock wool	45-65	[c]			Remainder mainly SiO_2 and Al_2O_3, very little Fe_2O_3.
Sugar refining	97	1			Maximum of 1% SiO_2. Used in 2 to 8 inch blocks.
Whiting substitute	95-97	2-8[c]			Must be finely ground.
Precipitated chalk	high				Made by precipitation of $CaCO_3$ from high calcium limestone.

NOTE: See footnotes next page.

a/ Maximum percentages of alumina, iron and silica are those indicated as standard limits for purpose, and are approximate averages of several authorities. Some users permit higher percentages of impurities, others demand higher carbonate content.

b/ Indicates magnesian limestone is satisfactory for purpose.

c/ Part of the percentage indicated for $CaCO_3$ may be $MgCO_3$. Some users prefer limestone, others magnesian limestone.

In general, if no notation is given relative to percentage of impurities, impurities are not obnoxious, but increase the amount of material necessary to obtain the required carbonate.

Table I compiled chiefly from information obtained from the following publications:

Lamar, J. E., and Willman, H. B., A summary of the uses of limestone and dolomite, Illinois Geological Survey, Report of Investigations, No. 49, 1938.

Miller, Benjamin Leroy, Limestones of Pennsylvania, Pennsylvania Geological Survey, Bulletin M 20, 1934.

Whitlatch, George I., Limestone, Tennessee Geological Survey, Markets Circular No. 3, 1937.

Publications of the National Lime Association.

U. S. Bureau of Mines, Information Circulars 6723, 6830, 7088, 6984.

Rock Products, chiefly vols. 41 and 42, 1938 and 1939.

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TABLE II. LIMESTONE ANALYSES, with Calcium Carbonate Greater than 95%

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	ADAIR COUNTY									
138	9-14N-24E	0.90	0.30	55.20[1]	0.40[2]	44.00	100.80	20	1-30	St. Clair[q]
791*	12-14N-24E	1.74	0.94	54.34	none	42.65	99.66			Morrow ?
119	15-14N-24E	2.20	0.80	53.78	0.40	42.64	99.82	4-30	?	Boone ?
148	21-14N-24E	1.40	0.80	54.30	0.64	42.10	99.24	20	10	Pitkin
161	1-15N-25E	2.44	1.86	53.52	none	42.94	100.76			Hale
764*	34-15N-25E	3.16	1.18	54.14	none	42.48	100.96	23	75	Pitkin
	ATOKA COUNTY									
4464	25-26-35-36 4S-10E	1.40	1.34	54.40	none	42.68	99.82	25	2	Goodland

Ins.: Insoluble Residue, chiefly silica. Th.: Thickness in feet. q Old quarry site.
R_2O_3: Al_2O_3, Fe_2O_3, and MnO_2, combined. Ovb.: Overburden in feet. Q Quarry.
* Phosphate (P_2O_5), less than 0.5%.

1. To obtain percent of calcium carbonate ($CaCO_3$), multiply CaO by 1.7846
2. To obtain percent of magnesium carbonate ($MgCO_3$), multiply MgO by 2.0913.

TABLE II. (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	CHEROKEE COUNTY									
4580*	36-14N-23E	1.82	0.94	57.19	none	43.12	103.07	16	20	St. Clair Q
4532*	25-16N-22E	2.96	1.28	55.83	none	41.97	102.04	25	2	Boone ?
	CHOCTAW COUNTY									
515	17-5S-16E	0.56	0.94	55.38	none	43.45	100.75	25	0	Goodland
432	4-6S-17E	1.70	0.73	54.08	0.34	42.80	99.65	25	0	Goodland
	CRAIG COUNTY									
507*	12-24N-20E	2.40	1.10	53.40	0.10	42.01	99.31	6	3	Mayes ?
508*	12-24N-20E	2.58	1.33	54.00	none	42.37	100.50	6	3	Mayes
	DELAWARE COUNTY									
7987*	1-20N-23E	1.44	0.54	54.18	none	42.57	98.73	20	16	Boone Q
8019	17-20N-23E	0.90	0.60	54.94	none	43.16	99.60	4	6	Boone
7989*	9-20N-25E	2.62	0.66	54.32	none	42.68	100.28	13	35	St. Joe ?
7986	18-21N-22E	3.32	0.75	53.76	none	42.24	100.06	5-25	65	Boone
7990*	26-22N-22E	2.84	0.86	53.76	none	42.18	99.64	6	3	St. Joe ?
2064*	13-22N-23E	3.02	0.76	54.15	none	42.59	100.52	10-25		St. Joe ?
2071	13-22N-23E	1.18	0.50	55.13	none	43.91	100.72	10-25		St. Joe Q
2124*	21-22N-23E	1.98	0.40	54.44	none	42.71	99.53	14	10	St. Joe ?
2073	24-22N-23E	3.92	0.60	54.01	none	42.77	101.30	10	6-10	St. Joe ?
2076	24-22N-23E	3.62	0.64	53.87	none	42.42	100.55	10	6-10	St. Joe
2132*	30-22N-23E	4.04	0.70	53.66	none	42.10	100.50	40	10	St. Joe
2114	34-22N-23E	2.28	0.78	54.71	none	43.74	101.51	60?	15	St. Joe
2116	34-22N-23E	1.46	0.68	55.55	none	44.00	101.69	60?	15	St. Joe
2113*	36-22N-23E	1.34	0.74	55.55	none	43.30	100.93	80?	45	St. Joe
1858*	5-23N-24E	2.06	0.34	54.66	none	42.89	99.95	7-12	12	Boone
1860	5-23N-24E	3.48	0.46	54.00	none	42.37	100.31	7-12	12	Boone
1861*	5-23N-24E	2.62	0.58	54.28	none	42.59	100.07	7-12	12	Boone
1862*	9-23N-24E	3.68	0.66	53.50	trace	41.98	99.82	120	6	Boone
1871	7-23N-25E	2.10	0.82	54.18	none	42.51	99.61	20-30	8	Boone
1872	7-23N-25E	1.54	0.66	54.62	none	42.85	99.67	20-30	8	Boone
1874	17-23N-25E	3.46	0.50	53.60	none	42.05	99.61	5-15	1-5	St. Joe
1875	17-23N-25E	3.28	0.90	53.58	none	42.05	99.81	5-15	1-5	St. Joe
1877	17-23N-25E	3.18	0.46	54.34	none	42.64	100.62	5-15	1-5	St. Joe
1879*	17-23N-25E	4.42	0.62	53.44	none	41.93	100.41	5-15	1-5	St. Joe
1885*	17-23N-25E	2.44	0.64	54.46	none	42.73	100.27	5-15	1-5	St. Joe
1887*	17-23N-25E	2.70	0.64	54.14	trace	42.48	99.96	5-15	1-5	St. Joe

TABLE II. (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	CHEROKEE COUNTY									
4580*	36-14N-23E	1.82	0.94	57.19	none	43.12	103.07	16	20	St. Clair Q
4532*	25-16N-22E	2.96	1.28	55.83	none	41.97	102.04	25	2	Boone ?
	CHOCTAW COUNTY									
515	17-5S-16E	0.56	0.94	55.38	none	43.45	100.75	25	0	Goodland
432	4-6S-17E	1.70	0.73	54.08	0.34	42.80	99.65	25	0	Goodland
	CRAIG COUNTY									
507*	12-24N-20E	2.40	1.10	53.40	0.10	42.01	99.31	6	3	Mayes ?
508*	12-24N-20E	2.58	1.33	54.00	none	42.37	100.50	6	3	Mayes
	DELAWARE COUNTY									
7987*	1-20N-23E	1.44	0.54	54.18	none	42.57	98.73	20	16	Boone Q
8019	17-20N-23E	0.90	0.60	54.94	none	43.16	99.60	4	6	Boone
7989*	9-20N-25E	2.62	0.66	54.32	none	42.68	100.28	13	35	St. Joe ?
7986	18-21N-22E	3.32	0.75	53.76	none	42.24	100.06	5-25	65	Boone
7990*	26-22N-22E	2.84	0.86	53.76	none	42.18	99.64	6	3	St. Joe ?
2064*	13-22N-23E	3.02	0.76	54.15	none	42.59	100.52	10-25		St. Joe ?
2071	13-22N-23E	1.18	0.50	55.13	none	43.91	100.72	10-25		St. Joe Q
2124*	21-22N-23E	1.98	0.40	54.44	none	42.71	99.53	14	10	St. Joe ?
2073	24-22N-23E	3.92	0.60	54.01	none	42.77	101.30	10	6-10	St. Joe ?
2076	24-22N-23E	3.62	0.64	53.87	none	42.42	100.55	10	6-10	St. Joe
2132*	30-22N-23E	4.04	0.70	53.66	none	42.10	100.50	40	10	St. Joe
2114	34-22N-23E	2.28	0.78	54.71	none	43.74	101.51	60?	15	St. Joe
2116	34-22N-23E	1.46	0.68	55.55	none	44.00	101.69	60?	15	St. Joe
2113*	36-22N-23E	1.34	0.74	55.55	none	43.30	100.93	80?	45	St. Joe
1858*	5-23N-24E	2.06	0.34	54.66	none	42.89	99.95	7-12	12	Boone
1860	5-23N-24E	3.48	0.46	54.00	none	42.37	100.31	7-12	12	Boone
1861*	5-23N-24E	2.62	0.58	54.28	none	42.59	100.07	7-12	12	Boone
1862*	9-23N-24E	3.68	0.66	53.50	trace	41.98	99.82	120	6	Boone
1871	7-23N-25E	2.10	0.82	54.18	none	42.51	99.61	20-30	8	Boone
1872	7-23N-25E	1.54	0.66	54.62	none	42.85	99.67	20-30	8	Boone
1874	17-23N-25E	3.46	0.50	53.60	none	42.05	99.61	5-15	1-5	St. Joe
1875	17-23N-25E	3.28	0.90	53.58	none	42.05	99.81	5-15	1-5	St. Joe
1877	17-23N-25E	3.18	0.46	54.34	none	42.64	100.62	5-15	1-5	St. Joe
1879*	17-23N-25E	4.42	0.62	53.44	none	41.93	100.41	5-15	1-5	St. Joe
1885*	17-23N-25E	2.44	0.64	54.46	none	42.73	100.27	5-15	1-5	St. Joe
1887*	17-23N-25E	2.70	0.64	54.14	trace	42.48	99.96	5-15	1-5	St. Joe

Table II (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	Delaware Co.									
1888	17-23N-25E	1.72	0.48	55.02	none	43.17	100.39	5-15	1-5	St. Joe
1890	17-23N-25E	1.38	2.24	53.82	none	42.23	99.67	5-15	1-5	St. Joe
1891	17-23N-25E	1.40	0.54	55.32	none	43.40	100.66	5-15	1-5	St. Joe
1892	17-23N-25E	2.82	0.44	54.68	none	42.90	100.84	5-15	1-5	St. Joe
4926	19-23N-25E	0.50	2.00	54.85	none	43.03	100.38	6	8	Boone
2029*	24-24N-22E	1.76	0.64	54.85	none	43.56	100.81	30-40	15-30	Boone
2028	24-24N-22E	1.86	0.32	54.57	none	43.12	99.87	30-40	15-30	Boone
2034	26-24N-22E	1.50	1.56	54.71	none	43.56	101.33	80?	10	Boone
2023	7-24N-23E	0.66	0.60	55.58	none	43.61	100.45	170?	15	Boone
1328*	12-24N-23E	0.72	0.60	55.62	trace	43.64	100.53	20	15	Boone q
1329	12-24N-23E	1.12	0.52	55.04	trace	43.18	99.86	20	15	Boone q
1771	12-24N-23E	0.84	0.44	55.50	none	43.55	100.33	10-20	1-5	Boone
1773	12-24N-23E	1.22	0.34	55.14	none	43.26	99.98	10-20	1-5	Boone
1776	12-24N-23E	1.92	0.46	54.50	none	42.76	99.64	10-20	1-5	Boone
1986*	21-24N-23E	2.36	0.90	54.15	none	43.12	100.53	12-20	15-50	St. Joe
1987*	21-24N-23E	2.34	1.00	54.01	none	43.21	100.56	12-20	15-50	St. Joe
1988*	21-24N-23E	2.06	0.82	54.29	none	44.00	101.17	12-20	15-50	St. Joe
1989	21-24N-23E	1.26	0.44	54.85	none	43.91	100.46	12-20	15-50	St. Joe
1992	21-24N-23E	3.46	0.94	53.45	none	42.59	100.44	12-20	15-50	St. Joe
1898	23-24N-23E	0.64	1.04	55.40	none	43.47	100.55	10-18	1-5	Boone
1902	23-24N-23E	0.50	0.34	55.70	none	43.70	100.24	10-18	1-5	Boone
1904	23-24N-23E	0.50	0.46	55.80	none	43.78	100.54	10-18	1-5	Boone
1327	24-24N-23E	0.68	0.68	55.02	none	43.17	99.55			Boone
1940*	27-24N-23E	3.22	0.40	57.03	none	43.30	103.95	5-17	5	St. Joe ?
1945	27-24N-23E	2.62	0.74	55.55	none	42.33	101.24	5-17	5	St. Joe ?
1790	16-24N-24E	2.48	0.36	54.24	none	42.56	99.64	10	2-5	Boone
1792*	16-24N-24E	3.14	0.74	53.58	none	42.04	99.50	10	2-5	Boone
1777	17-24N-24E	1.26	0.56	54.88	none	43.06	99.76	10	6	Boone
760*	20-24N-24E	2.40	2.26	53.48	0.40	42.40	100.94	7-10	5	Boone
1782	20-24N-24E	1.48	0.42	54.76	none	42.96	99.62	7-10	5	Boone
1785*	20-24N-24E	1.26	0.50	54.74	none	42.95	99.45	7-10	5	Boone
1786	20-24N-24E	1.56	0.20	54.98	none	43.14	99.88	10-20	3-10	Boone
1794	22-24N-24E	0.82	0.42	55.32	none	43.40	99.96	10-20	3-10	Boone
1795*	22-24N-24E	0.84	0.46	55.56	none	43.59	100.45	10-20	3-10	Boone
1797	22-24N-24E	0.48	0.36	55.46	none	43.51	99.98	10-20	3-10	Boone
1799*	22-24N-24E	0.86	0.70	55.10	none	43.23	99.89	10-20	3-10	Boone
1800*	22-24N-24E	0.44	0.68	55.62	none	43.64	100.38	10-20	3-10	Boone
1801*	23-24N-24E	0.64	0.50	55.58	none	43.61	100.33	15-30	5	Boone
1803	23-24N-24E	0.52	0.58	55.22	none	43.33	99.65	15-30	5	Boone

Table II (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	Delaware Co.									
1810	24-24N-24E	0.78	0.58	55.36	none	43.44	100.16	20	8	Boone
1855*	32-24N-24E	1.24	0.50	54.92	none	43.09	99.75	125	5	Boone
1856	32-24N-24E	0.50	0.30	55.46	none	43.51	99.77	125	5	Boone
1857	32-24N-24E	0.66	0.32	55.48	none	43.53	99.99	125	5	Boone
2054	34-25N-23E	0.84	0.24	55.41	none	43.82	100.31	75?	10	Boone
2146	12-25N-24E	1.22	0.50	54.82	none	43.01	99.55	25	45	Boone
2148	12-25N-24E	1.46	0.44	55.16	none	43.28	100.34	25	45	Boone
2151*	12-25N-24E	1.12	0.40	55.00	none	43.15	99.67	25	45	Boone
	JOHNSTON COUNTY									
1444*	4-2S-8E	1.30	0.69	55.42	trace	43.48	100.89			Wapanucka
1445*	4-2S-8E	1.56	0.59	53.68	trace	42.12	99.95			Wapanucka
1446*	4-2S-8E	1.16	0.56	54.92	none	43.09	99.73			Wapanucka
1447*	4-2S-8E	0.42	0.46	54.40	none	42.68	97.96			Wapanucka
1448*	4-2S-8E	0.98	0.57	55.16	none	43.28	99.99			Wapanucka
1449*	4-2S-8E	1.84	0.64	54.94	none	43.11	100.53			Wapanucka
1450*	4-2S-8E	0.84	0.67	55.30	none	43.39	100.20			Wapanucka
1451	4-2S-8E	0.88	0.47	54.84	trace	43.03	99.22			Wapanucka
1454*	9-2S-8E	0.80	0.49	54.80	none	43.00	99.09			Wapanucka
1455*	9-2S-8E	0.48	0.37	55.00	none	43.15	99.00			Wapanucka
1457*	9-2S-8E	0.74	0.54	55.46	trace	43.51	100.25			Wapanucka
1458*	9-2S-8E	0.60	0.50	55.56	trace	43.59	100.25			Wapanucka
1459*	9-2S-8E	0.90	0.58	55.68	trace	43.69	100.85			Wapanucka
1460*	9-2S-8E	1.10	1.14	53.74	none	42.16	98.14			Wapanucka
1461*	9-2S-8E	0.86	1.63	53.66	none	42.10	98.25			Wapanucka
1462*	9-2S-8E	0.94	0.85	54.14	none	42.48	98.41			Wapanucka
	LATIMER COUNTY									
4419*	20-5N-19E	1.66	0.90	53.95	none	42.33	98.84	20	30	Wapanucka
	MAYES COUNTY									
1620*	22-21N-19E	2.40	1.48	53.90	none	42.29	100.07			Mayes ?
1621*	22-21N-19E	1.88	0.90	54.44	none	42.71	99.93			Mayes ?
	McCURTAIN COUNTY									
1072	24-7S-25E	2.40	1.30	54.28	none	42.59	100.57	25		Goodland

Table II (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	OTTAWA COUNTY									
2858	1-26N-23E	0.38	0.34	55.63	none	43.65	100.00	10	15	Boone Q
217	19-26N-24E	0.40	0.40	55.80	none	43.78	100.38	90?	4	Boone
218	19-26N-24E	0.60	0.72	55.21	none	43.31	99.84	90?	4	Boone
1085	6-26N-25E	1.36	0.82	55.28	none	43.37	100.83	8	8	Boone
	PAWNEE COUNTY									
5452*	18-21N-6E	2.00	1.60	54.19	none	42.68	100.47	15	1-15	Brownville
	PITTSBURG COUNTY									
1547*	31-3N-14E	2.44	0.90	54.06	none	42.42	99.82			Wapanucka
1537*	15-4N-16E	1.36	0.86	54.74	none	42.95	99.91			Wapanucka
1536	31-4N-16E	1.04	0.80	54.78	none	42.98	99.60			Wapanucka
3743*	17-4N-17E	1.94	0.96	53.28	none	42.50	98.68			Wapanucka Q
	PONTOTOC COUNTY									
1320	29-2N-6E	1.08	0.69	55.08	none	43.22	100.07	10		L. Chimneyhill
	SEQUOYAH COUNTY									
1202	11-13N-23E	0.82	0.32	55.36	none	43.44	99.94			St. Clair?
771	13-13N-23E	0.84	0.37	55.66	none	43.67	100.54			St. Clair Q
772	13-13N-23E	0.80	0.31	55.50	none	43.55	100.16			St. Clair Q
775	13-13N-23E	3.00	0.32	53.80	none	42.21	99.38			St. Clair Q
776	13-13N-23E	0.86	0.71	55.88	none	43.84	101.29			St. Clair Q
	TEXAS COUNTY									
5005	20-2N-19E	4.16	0.54	53.39	none	41.89	99.98	5	1	Caliche
	TULSA COUNTY									
307	22-19N-10E	3.20	1.46	53.76	0.10	42.29	100.81	1	2	Avant ?
315*	24-19N-10E	2.32	1.32	53.24	0.30	42.10	99.28	5	4	Avant ?
291*	24-19N-11E	3.70	1.60	53.40	none	41.90	100.92	12	1-14	Lost City Q
296*	24-19N-11E	2.30	2.03	53.30	none	41.82	99.45	12	1-14	Lost City Q
328*	6-19N-12E	2.20	3.27	53.70	0.40	42.57	102.14	2	10	Lost City?
325*	6-19N-12E	2.60	2.00	53.80	none	42.21	101.01	1	4	Lost City?
324*	6-19N-12E	3.00	2.12	53.60	none	42.05	101.57	1	0	Lost City?
1725*	3-19N-14E	1.94	0.64	54.37	none	43.16	100.11	25	5	Oologah
1602	17-19N-14E	3.24	1.14	54.10	trace	42.45	100.93	35	5-10	U.Oologah?
1099*	28-19N-14E	1.50	0.59	53.62	1.10	43.27	100.08	15		Oologah
346*	34-19N-14E	3.46	1.30	53.72	none	42.15	100.63	12		Oologah
1701*	19-20N-14E	1.02	1.00	55.44	none	43.50	100.96	20	1	U.Oologah

TABLE III. LIMESTONE ANALYSES, with Calcium Carbonate plus Magnesium Carbonate greater than 90%. Magnesium Carbonate less than 10%.

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	ADAIR COUNTY									
789*	12-14N-24E	5.70	2.07	51.06[1]	1.10[2]	41.26	101.19			Morrow ?
134*	1-15N-25E	3.20	1.56	52.33	none	41.97	99.06			Morrow ?
159*	1-15N-25E	3.96	1.30	52.89	none	41.53	99.68			Morrow ?
	ATOKA COUNTY									
4465	36-4S-10E	8.50	1.90	51.59	none	38.81	100.80	10	3	Goodland
	CADDO COUNTY									
6133*	18-5N-12W	4.60	1.38	52.24	none	42.06	100.08			Arbuckle

Ins.: Insoluble Residue, chiefly silica. Th.: Thickness in feet. q Old quarry site.
R_2O_3: Al_2O_3, Fe_2O_3, and MnO_2, combined. Ovb.: Overburden in feet. Q Quarry
*Phosphate (P_2O_5), less than 0.5%.

1. To obtain percent of calcium carbonate ($CaCO_3$), multiply CaO by 1.7846
2. To obtain percent of magnesium carbonate ($MgCO_3$), multiply MgO by 2.0913.

	CHEROKEE COUNTY									
4572*	7-15N-21E	4.50	1.56	55.62	none	41.27	102.95	7-20	3-35	Pitkin ?
7297	8-15N-21E	2.94	1.70	51.90	0.68	43.12	100.34			Pitkin ?
7298	8-15N-21E	3.42	1.94	51.62	0.90	41.71	99.59	8		Pitkin ?
4570*	32-15N-22E	4.34	2.06	52.47	none	41.36	100.23	6	40	Boone or Mayes ?
4561*	7-15N-23E	3.60	1.26	53.41	none	41.53	99.80	10	14	do
4547*	18-16N-21E	3.78	1.40	54.98	none	41.53	101.69	2-5		Morrow
4526*	4-16N-22E	6.96	1.97	51.63	none	39.86	100.42			Boone or Mayes
4527*	4-16N-22E	4.52	1.60	52.85	none	40.39	99.36			
4529[a]	6-16N-22E	5.92	1.93	52.30	none	40.39	101.23	5		Fayetteville-Pitkin?
4539[b]	29-16N-22E	8.54	1.41	49.41	none	39.07	99.70			Pitkin?
4517[c]	7-16N-23E	10.74	4.77	45.51	0.34	35.82	99.81			Boone ?
4494*	12-17N-22E	3.20	1.81	52.96	none	41.36	99.33	8	30	Fernvale
2751	12-17N-22E	2.64	1.01	52.50	1.30	43.47	100.92	11		Fite ?
2756	12-17N-22E	5.62	1.61	51.00	0.94	41.53	100.70			St. Joe
2757	12-17N-22E	6.68	1.31	50.60	0.74	40.70	100.01			Boone ?
6152	25-19N-21E	5.84	1.07	52.49	0.84	40.53	100.77			St. Joe

a. P_2O_5: 0.59% b. P_2O_5: 1.27% c. P_2O_5: 2.63%

Table III (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	CRAIG COUNTY									
502*	7-25N-21E	3.80	2.43	51.60	0.52	41.06	99.92	4+	1	Mayes
4967	27-25N-21E	5.64	1.46	53.02	none	41.62	101.74			Mayes
	DELAWARE COUNTY									
7988*	1-20N-23E	4.94	0.88	51.94	none	42.05	99.81	20	15	Boone
8031	1-20N-23E	4.00	1.16	52.88	none	42.32	100.36	6	18	Boone
8018	16-20N-23E	2.72	0.60	53.17	none	41.78	98.27	10	4	Boone
8027*	26-20N-23E	4.68	0.84	52.58	none	42.38	100.48	5	2	Boone
8017*	27-20N-23E	2.72	0.98	53.20	none	41.74	98.64	6	4	Boone
8020	33-20N-23E	3.64	0.96	52.86	none	41.54	99.00	18	2	Boone
8021	33-20N-23E	2.64	0.78	52.81	none	41.53	97.76	8	10	Boone
7991*	16-21N-24E	2.26	0.78	52.64	none	43.55	99.23	10	5	Boone
2135*	18-22N-23E	6.46	0.80	52.26	none	41.00	100.52	18	14	Boone
2136	29-22N-23E	8.02	0.70	51.08	none	40.08	99.88	20		St. Joe
1889	17-23N-25E	4.34	0.50	53.22	trace	41.76	99.82	7	35	Boone ?
905[a]	1-24N-23E	2.90	1.15	52.94	none	41.97	100.30			Boone q
906[b]	1-24N-23E	3.30	0.95	52.83	none	41.53	99.85			Boone q
910[c]	12-24N-23E	3.12	1.29	52.40	none	41.89	99.73	8	2	Boone q
1330[d]	12-24N-23E	2.38	1.20	53.61	none	41.60	99.83			Boone q
1928*	27-24N-23E	3.70	3.06	54.29	none	42.59	103.64	90?	26	St. Joe
1796	22-24N-24E	5.04	0.70	52.84	none	41.46	100.04	30	10	St. Joe
	GARVIN COUNTY									
4819*	20-3N-3E	7.20	1.00	51.15	none	40.13	99.48	4	0	Stratford
	JOHNSTON COUNTY									
1061	19-3S-5E	5.40	2.02	52.22	none	40.97	100.61	50		Arbuckle
1452*	4-2S-8E	5.92	1.44	51.36	none	40.30	99.02			Wapanucka
1453*	9-2S-8E	3.18	0.75	53.04	none	41.62	98.59			Wapanucka
1456	9-2S-8E	6.00	0.78	52.02	trace	40.81	99.61			Wapanucka
	LOVE COUNTY									
434	31-6S-2E	2.60	1.12	52.88	0.60	42.14	99.36			Goodland
	MAYES COUNTY									
5076*	12-19N-20E	6.78	2.21	51.45	none	40.57	101.01			St. Joe
1613*	10 and 15 21N-19E	4.36	1.14	53.16	none	41.71	100.37		1	Mayes

a. P_2O_5, 1.34% b. P_2O_5, 1.24% c. P_2O_5, 1.03 d. P_2O_5, 1.05

Table III (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
1618*	22-21N-19E	3.60	1.22	53.08	trace	41.65	99.55			Mayes ?
1635*	10-22N-20E	2.70	1.68	52.47	0.34	42.50	99.69			Mayes ?
6149*	15-22N-21E	6.04	1.58	50.93	1.14	41.01	100.74			St. Joe
5093*	23-22N-21E	6.48	2.00	51.52	none	40.66	100.68	20	10	St. Joe
	McCURTAIN COUNTY									
1323*	34-6S-22E	4.04	2.02	52.30	0.70	41.79	100.85	30		Goodland
	MUSKOGEE COUNTY									
567*	29-15N-20E	4.00	2.04	52.10	0.62	41.56	100.32			Pitkin ?
568*	29-15N-20E	6.90	1.44	51.04	0.60	40.70	100.68			Pitkin ?
572*	29-15N-20E	3.00	1.33	52.68	0.82	42.22	100.05			Pitkin ?
7289*	18-16N-20E	4.12	1.62	51.95	0.50	41.71	99.90			Pitkin ?
	NOWATA COUNTY									
6906*	12-26N-14E	5.38	2.39	50.95	0.86	40.54	100.12			Hogshooter
6897*	14-26N-14E	4.62	1.64	51.70	0.76	40.96	99.68	4		Hogshooter
7271*	30-27N-15E	5.26	2.44	50.38	0.72	40.04	100.18			Hogshooter
7262*	31-27N-15E	4.36	1.71	51.31	0.70	41.45	99.53			Hogshooter
	OSAGE COUNTY									
7315*	31-20N-12E	4.82	3.62	50.50	0.46	39.60	100.68	4		Lost City
7980	9-22N-12E	4.16	1.16	52.84	none	41.51	99.67			Avant ?
	PAWNEE COUNTY									
5450*	14-21N-6E	4.24	2.18	52.50	none	41.62	100.54	5	1-40	?Stonebreaker
8014	30-22N-6E	2.00	1.24	53.14	none	41.76	98.14	7	10	Brownville
5446*	16-24N-5E	4.94	1.30	52.76	none	41.71	100.71	11	3	Red Eagle?
	ROGERS COUNTY									
2525*	15-20N-14E	5.26	1.02	53.76	none	40.04	100.08	3	9	Oologah
1740*	22-20N-14E	4.64	1.26	51.92	trace	40.74	98.56	40	0	Oologah
1102*	23-20N-14E	4.82	1.69	52.00	0.10	40.91	99.52	1	5	Oologah Q
2972	6-22N-16E	1.70	3.90	52.75	none	42.68	101.03	20		Oologah
4400	2-22N-17E	2.56	4.47	50.65	none	39.78	97.46	2	3	Tiawah ?
7981*	36-24N-15E	2.58	1.88	52.72	none	42.11	99.29	10	0-5	Pawnee ls?
7983*	36-24N-15E	2.52	2.20	50.40	2.68	42.52	100.32	10	0-5	Altamont?
	SEMINOLE COUNTY									
4318*	1-5N-6E	4.70	1.80	52.48	none	41.18	100.16	4		Belle City

Table III (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
	TEXAS COUNTY									
5014	33-3N-17E	7.88	0.78	49.31	1.88	39.00	99.84	5	1	Caliche
	TULSA COUNTY									
327*	6-19N-12E	2.76	2.15	52.74	0.20	41.60	99.45	2.5	6	Lost City
362*	6-19N-12E	3.60	3.23	49.30	2.76	41.69	100.58	24?	14	Hogshooter?
288*	18-19N-12E	1.60	4.87	52.00	none	40.80	99.27	12	8	Lost City
289	26-19N-12E	4.00	3.91	46.86	3.50	40.59	98.86	3.5	0-3	Checkerboard
1148*	10-19N-14E	6.72	1.72	50.70	0.60	40.43	100.17			Oologah Q
1371*	14-19N-14E	7.04	1.44	50.76	0.28	40.14	99.66	20		Oologah
1155*	15-19N-14E	6.92	1.55	50.90	0.54	40.53	100.44	11	10-30	Oologah
1603	17-19N-14E	3.50	1.60	53.14	none	41.69	99.93	35	5-10	Oologah Q
1094*	23-19N-14E	6.24	1.33	51.16	1.10	41.34	101.17	25	0-30	Oologah
363*	27-18N-14E	6.60	3.02	47.00	3.40	40.59	100.61	4	3	Ft. Scott
329*	11-19N-10E	5.00	2.52	51.20	none	40.17	98.89	2	1	Paola ?
292*	24-19N-11E	2.80	2.08	52.90	none	41.51	99.43	4	2	Lost City^Q
293*	24-19N-11E	2.60	2.66	52.60	none	41.27	99.38	4	2	Lost City^Q
294*	24-19N-11E	2.20	1.92	53.00	none	41.58	99.98	4	2	Lost City^Q
326*	6-19N-12E	2.30	2.54	52.82	0.40	41.88	99.94	2.5	6	Lost City
1095*	23-19N-14E	2.96	1.19	53.08	0.48	42.17	99.88	25	0-20	Oologah
349*	27-19N-14E	3.30	4.01	47.10	4.10	41.42	99.93	10	10	Oologah
1097*	27-19N-14E	4.76	1.14	52.02	0.40	41.25	99.57	15		Oologah
1098*	27-19N-14E	4.00	1.14	52.02	0.76	41.64	99.56	12		Oologah
2449*	4-20N-14E	2.76	0.80	52.20	none	41.62	97.38	8		Oologah
2253*	28-20N-14E	4.00	1.80	52.00	1.06	41.96	100.82	6.5		U.Oologah^Q
2263*	28-20N-14E	4.86	0.80	52.12	0.90	41.87	100.55	23.5		L.Oologah^Q
2265*	28-20N-14E	7.74	1.00	49.60	1.42	40.47	100.23	23.5		L.Oologah^Q
2273*	28-20N-14E	6.64	1.22	51.14	0.46	40.62	100.08	23.5		L.Oologah^Q
	WAGONER COUNTY									
574*	25-16N-19E	4.40	2.65	51.26	0.94	41.25	100.50			Pitkin-Morrow?
575*	25-16N-19E	6.50	2.25	50.48	0.50	40.16	99.89			Pitkin-Morrow?
898*	29-18N-19E	6.92	2.95	50.82	trace	39.87	100.56	20	5	Pitkin-Morrow?
	WASHINGTON COUNTY									
7311[a]	32-23N-13E	11.00	10.45	42.17	0.90	30.18	99.41			Hogshooter
7269[b]	28-24N-13E	5.44	3.28	49.12	1.00	39.34	99.28			Hogshooter

a. P_2O_5: 2.62% b. P_2O_5: 1.10%

Table III (continued)

Lab. No.	Location	Ins.	R_2O_3	CaO	MgO	CO_2	Total	Th.	Ovb.	Formation
7998*	13-25N-12E	2.58	1.60	51.52	none	42.67	98.37	5	0-5	Dewey
7999*	24-25N-12E	2.34	1.10	52.47	none	43.29	99.20	10	0-5	Dewey
7259*	34-25N-13E	6.40	3.08	49.43	1.08	39.46	99.45			Hogshooter
7992*	7-26N-13E	3.58	2.80	50.51	none	41.14	98.03	4	10-20	Dewey
6905*	9-26N-14E	5.02	1.47	51.42	1.14	41.40	100.45	3	24	Hogshooter
6890*	9-26N-14E	4.86	2.50	50.40	1.50	40.96	100.22	1.5	22	Hogshooter
6893*	9-26N-14E	4.62	1.65	51.26	1.10	40.57	99.20	2	15	Hogshooter
6898*	9-26N-14E	5.84	1.73	49.90	1.94	40.83	100.24	5	10	Hogshooter
6902*	9-26N-14E	3.96	2.27	51.65	1.06	41.10	100.04	7		Hogshooter
6892*	17-26N-14E	5.04	1.31	51.52	0.44	40.74	99.05	1.5	4-8	Hogshooter
7864*	26-27N-13E	5.20	2.36	50.14	0.72	40.26	99.58	9	10	Dewey
7865*	26-27N-13E	4.80	2.24	50.88	0.50	40.94	99.91	5	5	Dewey
7866*	26-27N-13E	5.12	2.47	50.25	0.52	40.36	99.63	4	1	Dewey
8000*	26-27N-13E	3.38	1.12	52.64	none	42.76	99.90	8	1	Dewey Q

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