OKLAHOMA GEOLOGICAL SURVEY

Robert H. Dott, Director

MINERAL REPORT No. 6

DOLOMITE
AND
MAGNESIUM LIMESTONE

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April 1940

FOREWORD

The object of this report is to make available the chemical analyses and locations of samples of better grades of Oklahoma dolomites that have been collected and analyzed by the Oklahoma Geological Survey, and by the State Mineral Survey, (WPA Project 65-65-538); and to present a summary of the general distribution of dolomites and magnesium limestones in Oklahoma and a discussion of the general uses of these materials.

Information on locations of deposits, thicknesses, and chemical analyses are taken partly from results of the State Mineral Survey field and laboratory sheets on file in the Oklahoma Geological Survey offices, and in part from field work of the Oklahoma Geological Survey and laboratory analyses by the Survey chemists. Additional data on some of these deposits is available at the Oklahoma Geological Survey, Norman.

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IN PREPARATION:

Asphalt

DOLOMITE
AND
MAGNESIUM LIMESTONES

Dolomite is a rock mineral composed of calcium and magnesium carbonate with the chemical formula $CaCO_3$. $MgCO_3$, or sometimes written $CaMg(CO_3)_2$. A pure dolomite is composed of 54.35 percent calcium carbonate, and 45.65 percent magnesium carbonate; or carbon dioxide (CO_2), 47.9 percent; calcium oxide (CaO), lime, 30.4 percent; and magnesium oxide (MgO) 21.7 percent. (1)*

Dolomite resembles limestone in general appearance, but is slightly harder and heavier, and does not effervesce as readily in cold acid. Dolomite is rather widely distributed, but is not nearly so abundant as limestone.

Many limestones contain varying amounts of magnesium carbonate, and various terms have been used to designate these limestones. A general classification (2), (3) uses the term limestone where the magnesium carbonate is less than 10 percent, magnesium limestone if the percentage is 10 to 40 percent, and dolomite if the magnesium carbonate is 40 to 45 percent. Another classification (4) lists limestones as having less than 5 percent magnesium carbonate; magnesium limestone up to 15 percent magnesium carbonate, and high magnesium limestone above 15 percent magnesium carbonate. The term dolomitic limestone is often used to describe limestones containing magnesium in proportions less than that required to form a pure dolomite. In this report, analyses are given only where magnesium carbonate is greater than 10 percent and total magnesium and calcium carbonate above 90 percent.

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* See bibliography at the end of this report.

GENERAL USES

Dolomite may be used for many of the purposes for which limestones are used in industrial and chemical processes. In certain processes, some users prefer high calcium limestone and others prefer dolomite or magnesium limestones. However, in other processes, even a small amount of magnesium in the limestone is objectionable, and in a few instances, dolomite can be used where limestone is not satisfactory.

Uses of dolomite for which chemical properties are important include: manufacture of refractories, as a source of basic magnesium carbonate for heat insulation, paper manufacture, lime mortars and plasters, blast furnace flux, plastic magnesia, glass manufacture, source of carbon dioxide, technical carbonate, and other chemicals, agriculture (for soil treatment and as a fertilizer), paints, kalsomine, whitewash, varnishes, Vienna lime, ceramics, prepared whiting, in manufacture of rubber, in tanning, in preparing fungicides, and as a mineral filler in a number of products.

Uses for which physical properties are important include: building stone, crushed stone, coal mine dusting, asphalt filler, and other miscellaneous uses. For most of these uses, either limestone or dolomite can be used, and for some purposes, as building stone, other types of rocks are available.

Increasing importance of industrial chemistry, the development of new products, and new uses for materials, lend added potential importance to raw materials used in chemical industries. In a recent study of the minerals used as raw material in the manufacture of 150 important industrial chemicals, magnesium minerals were listed as 24th in importance.(6) While this ranking is well below that of limestone which ranked 6th place in frequency of use, dolomites would be of considerable value in association with other chemical raw materials should chemical industries develop in Oklahoma. The thicker deposits are generally associated with limestones, some of them not far from petroleum, natural

Lime Mortars and Plasters: In some areas, dolomites are used extensively for making lime. For many uses, either a high calcium or a calcium-magnesium lime is satisfactory, but for a number of purposes, either one type or the other is required. High magnesium lime is much used for finishing-coat plaster because of its higher plasticity. Dolomitic lime mortars have a higher strength than limestone lime mortars.

Chemical Industries: Dolomite is not used in as many industrial chemical processes as limestone, but is of considerable importance. A large amount of carbon dioxide is obtained from dolomites. In one process, the crushed dolomite is treated with sulfuric acid to liberate carbon dioxide, and leaving a solution of magnesium sulphate containing precipitated calcium sulphate. The solution is evaporated to recover the magnesium (Epsom salts).

Agricultural: Dolomite or magnesium limestones may be used for treatment of sour soils and to furnish essential plant minerals. Little attention has been given to magnesium requirements for plant growth until comparatively recent years, and available literature (8) (9) indicates that soil men are not yet in complete agreement on the magnesium requirements of soils.

Magnesium compounds are present in the seeds, fruits, flowers, roots, and tubers of plants to a greater extent than calcium; while calcium is more abundant than magnesium in the leaves, stems, and wood. It is well known that magnesium is a constituent of the chlorophyl molecule. (9)

While dolomite offers a source of magnesium, it is not water soluble and therefore not readily available for plant food as raw dolomite. When mixed with superphosphates to form a fertilizer mixture, the magnesium and the superphosphates react to form soluble magnesium compounds. However, magnesium of dolomite is known to become slowly available, probably through the action of plant acids, and if in sufficient quantity, will supply plant needs. Other magnesium compounds in more soluble gas, and coal, which are also of great importance to the chemical industry.

Some recent developments in use of dolomites in industry include a "specially prepared dead-burned dolomite in glass manufacture to replace lime and raw dolomite in the glass mix. Reported advantages are that it is relatively free from dust, carries enough alumina to replace part of the feldspar, and has a specific gravity near that of glass sand." (7)

Uses of Dolomite Where Chemical Composition is of Importance

Refractories: Bureau of Mines statistics indicate that approximately half a billion tons of dead-burned dolomite are used each year for refractories in steel and other types of furnaces. It is used as a substitute for magnesite refractories largely because of lower cost at most of the steel centers. Magnesite must be shipped from the west coast or imported.

Technical Carbonate: Sometimes called hydro-magnesite or basic magnesium carbonate, is used in the manufacture of molded insulation. It is mixed with asbestos, 85 percent technical carbonate and 15 percent asbestos, molded, dried, cut to sizes desired, for use chiefly as pipe and boiler insulation. Rock wool possibly could be substituted for asbestos. Technical carbonate may be made from dolomite by a process of calcining, slaking with water, recharging the calcium oxide with carbon dioxide, and recovering the basic hydrated magnesium carbonate formed during the process.

Paper Mills: In the sulphite process of paper manufacture, either limestone, magnesian limestones, or dolomite may be used as a base for making the acid liquor, consisting of magnesium and calcium bisulphites, which is used in dissolving all constituents, except cellulose, from wood. Two chief systems are in use, the tower system, and the milk of lime system. Magnesium content is objectionable in the tower system, but in the milk of lime system, dolomite is preferred.

form are also available in commercial fertilizers.

Dolomite Brick: Processes for manufacturing refractory brick from dolomite that are reported as efficient for some purposes as magnesite brick, and at less cost, have been developed recently. (10)

USES OF OKLAHOMA DOLOMITES

Dolomite has not been produced in Oklahoma to any considerable extent for its magnesium content. Most extensive use has been as a building stone, especially in the western part of the state where the Permian dolomites are generally the most durable building stone available. No large quarries in these dolomites have been reported, but in many localities small amounts have been taken out for local building purposes.

One quarry has been reported in the Cotter dolomite in sec. 17, T. 23 N., R. 25 E., Delaware County, where the stone is removed for agricultural purposes. Analysis No. 8239 was made from a sample from this quarry.

Oklahoma Dolomites

No detailed, comprehensive study has been made of the dolomites of Oklahoma, but enough chemical analyses are available to indicate that the state has large quantities of dolomite of fairly high purity. Most of the dolomites and high magnesium limestones are found in the Arbuckle and Wichita Mountains, belonging to the Arbuckle group of rocks, of Cambrian and Ordovician age. Dolomite of Ordovician age, known as the Cotter, is found in northeastern Oklahoma, and at least one high grade dolomite of Pennsylvanian age has been found in Osage County. There are several thin, but widespread dolomite beds in the Permian rocks of western Oklahoma.

CAMBRO-ORDOVICIAN

Arbuckle and Wichita Mountains: Dolomites in the Arbuckle group of the Arbuckle and Wichita Mountains occur as series of dolomite beds associated with limestones. Most massive dolomites of this area are in the lower formations of the Arbuckle group, especially the Royer formation of Cambrian age, in the Arbuckle Mountains; the Butterly formation of Cambrian age in the Arbuckle and Wichita Mountains; and the Strange formation in the Wichita Mountains. Other dolomitic beds are present in the upper formations of the Arbuckle group, especially in the West Spring Creek formation in the Arbuckle Mountain area,(11) but these formations are not so dominantly dolomitic as the Royer, Butterly, and Strange.

Dolomitic beds are also known in the Simpson group chiefly in the eastern part of the Arbuckle Mountains, where dolomitic zones are present in the McLish formation. No analyses are available of samples from the Simpson dolomites.

Analyses of several samples collected from the Arbuckle and Wichita Mountains indicate that a large amount of fairly high grade dolomite is available in those areas. Not enough analyses have been made to give any detailed knowledge of the chemical character of the dolomites. Approximate determinations from detailed sampling by C. E. Decker and C.A. Merritt, are published in Oklahoma Geological Survey Circular 15.(12) The samples were collected along Highway 77,south of Davis, Oklahoma, and determinations by Merritt indicate that in the lower 2,250 feet of the Arbuckle group there are about 1,500 feet of dolomites, and most of the remainder in this part of the section is made up of dolomitic limestones. The same dolomites appear to be present farther east and in the Wichita Mountains, at least in part. The upper 5,000 feet of Arbuckle limestones along the highway apparently contain only minor amounts of good dolomite,although dolomitic limestones are reported.

Toward the eastern part of the Arbuckle Mountains, particularly in the area between Scullin and Hickory, and also in the Wichita Mountains, the upper formations of the Arbuckle limestone appear to contain more dolomites. A few analyses have been made of samples from the higher dolomites in the Wichitas but none are available from the eastern Arbuckles.

The following table of formations of the Arbuckle Group is compiled from Decker's recent classification (11), and presented here to indicate the relative positions of the formations from that area listed in Table III.

Table I

Table of Formations of the Arbuckle Group
in the Wichita and Arbuckle Mountains (11)

AGE	GROUP	FORMATIONS AND MEMBERS
ORDOVICIAN	Arbuckle Group	West Spring Creek, (some dolomite in eastern Arbuckles.)
		Kindblade (Dolomite)
		Cool Creek
		Strange (Dolomite, Wichita Mts. only)
		McKenzie Hill McMichel member Chapman Ranch member
CAMBRIAN		Butterly (Dolomite, Arbuckle Mts. only)
		Signal Mountain
		Royer (Dolomite)
		Fort Sill

Note: Cotter dolomite of northeastern Oklahoma is about the same age as the Kindblade formation. The Tyner is equivalent to some of the Simpson formations.

Northeastern Oklahoma: Analyses are available of a few samples of dolomite from Delaware and Cherokee Counties. The samples analyzed contained slightly more impurities than some of the dolomites from the Arbuckle-Wichita Mountain areas. The samples from Delaware County are believed to be from the Cotter dolomite, of about the same age as the Kindblade formation, of the Arbuckle Mountains, and the one analysis from Cherokee County is thought to be from the Tyner formation.

No previous studies have been made of the chemical character of the dolomites in this area, and the present data are little more than enough to indicate that good dolomites may be present. The high-calcium St. Joe limestone member of the Boone formation occurs above the dolomites and should be available near most of the outcrops of the Tyner and Cotter dolomites. The St. Joe would furnish limestone for any operations where such material may be needed in connection with the use of dolomites.

CARBONIFEROUS

Rocks of Carboniferous age cover most of the eastern half of Oklahoma, and include a considerable number of limestone beds. Only one analysis is available from rocks of that age with a calcium-magnesium carbonate content above 90 percent, the standard arbitrarily set for this report. The sample was collected from the Wildhorse limestone near the center of the N$\frac{1}{2}$ sec. 21, T. 22 N., R. 10 E., Osage County, and the analysis included in Table III as laboratory No.6107. At the point where the sample was collected, the entire formation is about 10 feet thick, but only a part of this thickness was represented in the sample.

The analysis is of interest as an indication of the presence of fairly good dolomite in rocks of the Pennsylvania series of that area. Other limestones of Pennsylvanian age are known to contain some magnesium along parts of their outcrops in that area, including such formations as the Avant, Dewey, and Hogshooter limestones. Most of the limestones of northern Oklahoma from Kay County east to Nowata County, become very thin, entirely disappear, or merge into sandstones and shales toward the south.

PERMIAN

Dolomites of Permian age are associated with the gypsums, shales, and sandstones of the Permian red beds of western Oklahoma, in contrast with dolomites of other areas of the state which are usually associated with limestones. In general, these dolomites are found in relatively thin beds which extend for considerable distances. Thickness of individual beds is usually from a few inches up to a few feet. In eastern Washita County, T. 11 N., R. 14 W., 15 feet of dolomite is reported at the base of the Quartermaster formation. (13) (14)

Analyses of several samples that contain above 90 percent calcium and magnesium carbonates are given in Table III. A number of analyses are available from dolomitic deposits in western Oklahoma in which the calcium-magnesium carbonate is between 80 and 90 percent, but these are not included in this report.

Western Oklahoma dolomites are found in Jackson, Greer, Harmon, Kiowa, Washita, Custer, Caddo, Canadian, Blaine, Dewey, Major, Woodward, Woods, and Harper Counties. Dolomite beds that have been named include: Day Creek and Relay Creek; and in the southwest part of the state, the names Mangum, Creta, and Jester (13), have been given to dolomites associated with the Blaine gypsums of that area. Unnamed dolomite beds are also associated with the Blaine gypsums farther north. A massive dolomite is found at the base of the Quartermaster formation in some areas, and locally, in the vicinity of Weatherford, there is a dolomite in the Rush Springs sandstone.

Table II. Table of Permian formations, western Oklahoma, from Blaine gypsum, indicating relative positions of main dolomite beds.

Northwestern Oklahoma	West-Central Oklahoma	Southwestern Oklahoma
	Quartermaster formation Dolomite at base.	
Day Creek dolomite		
Whitehorse group Cloud Chief gypsum Rush Springs sandstone Relay Creek dolomite Marlow formation	Whitehorse group Cloud Chief gypsum Rush Springs sandstone Relay Creek dolomite Marlow formation	Lower Whitehorse
Dog Creek shale		Dog Creek shale
Blaine formation Gypsum and dolomite members.		Blaine formation Includes Mangum, Creta, and Jester dolomites.

Dolomites in western Oklahoma have been of importance to petroleum geologists and others in correlating formations and mapping geology and structure, since some of them can be traced over considerable distances. Because they occur in areas lacking in limestone, they may be of importance to agriculture, should it become necessary to treat soils either to correct sour soils or increase calcium and magnesium content. For correcting acid soils, dolomite is fully as effective as limestone, and increasing attention is being given to the need for magnesium as well as calcium, both of which are supplied by dolomite.

CHEMICAL ANALYSES

Table III includes only those analyses of dolomite and magnesium limestones from Oklahoma now available in the files of the Oklahoma Geological Survey with calcium and magnesium carbonate content of 90 percent or greater. No analyses are included in which the magnesium carbonate is less than 10 percent, and in most of the analyses given, the ratio of calcium to magnesium is about that of a normal dolomite.

The analyses given are not intended as a complete study of the dolomites of Oklahoma, but are presented to call attention to locations from which samples containing less than 10 percent impurities have been collected and analyzed. Most of the important known dolomite formations are represented in the analyses, but sampling was not in sufficient detail to present the chemical character of the entire thickness of outcrops, or any changes in quality of material that may exist in different exposures.

Analyses were made in part by chemists on the State Mineral Survey, (WPA Project 65-65-538) and by S. G. English, H. Sudduth, and C. L. Workman, chemists for the Oklahoma Geological Survey.

Table III. Dolomite Analyses

County	BLAINE				CHEROKEE	COMANCHE			
Location	sec.19 T16N R10W	sec.19 T16N R10W	sec.19 T16N R10W	sec.31 T15N R11W	sec.12 T17N R22E	sec. 8 T2N R12W	sec.20 T2N R12W	sec.20 T2N R12W	sec. 9 T2N R12W
Formation	Blaine	Blaine	Blaine	Relay Creek	Tyner	Strange		Strange	
Lab. No.	2246	2247	2248	2249	2752	6129	6418	6419	6420
Ins. Res.	4.00	3.40	4.18	1.44	1.72	1.48	0.70	0.58	1.20
Al_2O_3	2.49	1.43	2.56	0.20	0.26	0.65	0.39	0.79	0.44
Fe_2O_3	0.57	0.43	1.22	0.50	1.07	0.29	0.43	0.21	0.14
MnO_2	trace	trace	trace	trace	0.08	0.04	0.04	0.04	0.02
P_2O_5	trace	trace	trace	0.76	trace	trace	trace	none	none
CaO	29.16	30.04	28.22	31.88	45.92	30.18	31.20	30.60	31.10
MgO	19.30	19.86	19.70	19.42	7.38	20.46	20.64	20.66	20.54
CO_2	43.74	45.24	43.64	45.66	44.35	46.73	46.29	47.17	46.73
Total	99.26	100.40	99.52	99.68	100.78	99.83	99.69	100.05	100.17
$CaCO_3$	52.04	53.61	50.36	55.66	81.95	53.86	55.68	54.61	55.50
$MgCO_3$	40.36	41.53	41.20	40.61	15.43	42.79	43.16	43.21	42.96

Ins. Res.: Insoluble Residue, chiefly silica.

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County	KIOWA (continued)				MURRAY			OSAGE
Location	sec.36 T6N R16W	sec.26 T6N R14W	sec.16 T6N R14W	sec.36 T6N R16W	sec.18 T2S R2E	sec.18 T2S R2E	sec. 7 T2S R2E	sec.21 T22N R10E
Formation	Kind-blade	Royer	Royer	Kind-blade	Butterly		Royer	Wild-horse
Lab. No.	7781	7784	7786	7787	7782	7783	7785	6107
Ins. Res.	5.60	0.72	1.88	4.28	9.02	1.24	0.38	2.68
Al_2O_3	0 49	0.50	0.46	0.38	0.42	0.41	0.47	1.12
Fe_2O_3	0.21	0.21	0.44	0.14	0.73	0.29	0.29	1.93
MnO_2	0.002	0.06	trace	trace	0.02	0.03	trace	0.44
P_2O_5	none	none	none	none	none	none	none	trace
CaO	29.62	31.03	30.66	31.36	29.72	30.84	31.03	31.00
MgO	19.84	19.72	20.32	18.26	17.94	20.62	20.78	18.00
CO_2	44.74	47.20	46.64	45.48	42.28	46.66	47.34	44.85
Total	100.50	99.44	100.40	99.90	100.13	100.09	100.29	100.02
$CaCO_3$	52.88	55.48	54.65	55.95	53.00	55.05	55.48	55.40
$MgCO_3$	41.40	41.15	42.40	38.05	37.60	43.15	43.35	37.50

Ins. Res.: Insoluble Residue, chiefly silica.

Table III. Dolomite Analyses (continued)

County	JACKSON (continued)				JOHNSTON				KIOWA	
Location	sec.13 T2N R22W	sec.27 T1N R23W	sec.34 T1N R23W	sec.16 T2S R23W	sec.27 T2S R4E	sec.26 T2S R4E	sec.26 T2S R4E	sec.27 T2S R4E	sec.35 T6N R16W	sec.31 T6N R15W
Formation	Creta	Creta or Mangum			Royer	Royer	Royer	Royer	Kindblade	
Lab. No.	5558	5582	5583	5591	2182	2183	2184	2185	6147	7780
Ins. Res.	3.70	6.62	7.00	6.64	1.02	1.06	1.90	0.56	0.72	1.68
Al_2O_3	0.91	0.79	1.09	1.31	1.12	0.79	1.67	1.55	0.40	0.64
Fe_2O_3	0.86	0.71	0.71	0.93	0.36	0.29	0.29	0.71	0.14	0.37
MnO_2	0.02	trace	trace	....	none	none	none	none	trace	0.01
P_2O_5	trace	trace	trace	trace	none	none	none	none	none	none
CaO	31.87	28.68	29.38	29.80	29.16	31.49	30.45	32.40	30.95	31.68
MgO	18.30	20.00	19.30	18.76	21.36	20.00	20.04	18.64	20.70	20.08
CO_2	44.98	44.33	44.11	43.85	46.20	46.54	45.76	45.76	47.70	46.10
Total	99.64	101.13	101.59	101.29	99.22	100.17	100.11	99.62	100.61	100.56
$CaCO_3$	56.88	51.18	52.43	53.18	52.04	56.20	54.34	57.82	55.20	56.51
$MgCO_3$	38.27	41.83	40.36	39.23	44.67	41.83	41.91	38.98	43.20	42.00

County	COMANCHE (continued)				CUSTER	DELAWARE			JACKSON
Location	sec.20 T2N R12W	sec.20 T2N R12W	sec. 9 T2N R12W	sec. 8 T2N R12W	sec. 8 T13N R15W	sec.23 T20N R24E	sec.34 T22N R23E	sec.17 T23N R25E	sec. 3 T2N R22W
Formation	Strange		Strange		Day Creek?	Cotter	Cotter	Cotter[Q]	Mangum
Lab. No.	7744	7745	7746	7747	285	6158	6159	8239	5556
Ins. Res.	0.68	0.98	1.22	0.58	2.80	7.24	4.80	5.98	5.00
Al_2O_3	0.13	0.34	0.37	0.32	0.09	0.49	0.60	0.38	1.00
Fe_2O_3	0.36	0.29	0.21	0.29	0.60	0.64	0.50	0.30	0.71
MnO_2	0.03	0.03	0.02	0.03	0.35	0.11	0.09	0.05	0.03
P_2O_5	trace	none	none	none	none	none	none	none	trace
CaO	30.98	30.69	30.59	30.78	48.00	28.90	29.30	28.80	43.85
MgO	21.18	21.38	21.20	21.76	5 40	19.96	20.40	20.49	7.10
CO_2	47.00	46.74	46.96	46.90	43.55	43.38	44.00	44.19	42.15
Total	100.36	100.45	100.57	100.66	100.79	100.72	99.69	100.19	99.84
$CaCO_3$	55.29	54.77	54.59	54.93	85.66	51.57	52.29	51.40	78.25
$MgCO_3$	44.29	44.71	44.34	45.51	11.29	41.74	42.66	42.85	14.85

Q = Quarry.

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Third Printing, 1981

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