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High Magnesia Marble from Sharp Mountain Area of Llano County, Texas

Introduction

This circular on high magnesian marble is issued at the present time because of numerous inquiries made recently for high magnesia rock. The first samples of the rock here described were collected in Llano County, Texas, by C. L. Baker and G. A. Parkinson in 1932 during a search for building stone, a project carried on jointly by the Bureaus of Engineering Research and Economic Geology. Additional samples were collected by G. A. Parkinson and V. E. Barnes in January, 1938.

Chemical Analyses and Technologic Discussion

E. P. Schoch

Report of analyses of magnesium marbles submitted to the Bureau of Industrial Chemistry by G. A. Parkinson of the Bureau of Engineering Research from the following localities:

Analysis No.	Locality
C4300	From Stribling ranch along Sharp Mountain road, 6 miles southeast of Llano and near southwest end of Sharp Mountain. This sample is from the site now occupied by E. B. Snead's terrazzo chip quarry.
C4308	From Elmore Stewart property about 2 miles south of Llano on Sharp Mountain road and about 50 steps south of gate across road.
C4309	From Stribling ranch from same locality as No. C4300. This sample is a carefully collected average sample of the rock exposed by E. B. Snead during his recent quarrying for terrazzo chips.
C4312	From Hammond property and Dezendorf's terrazzo chip quarry about 6 miles southeast of Llano, close to northeast end of Sharp Mountain.
C4318	From Stribling ranch near road at top of hill about 75 steps north of Snead's terrazzo chip quarry.
C4319	From Stribling ranch near extreme south end of deposit and about 0.7 miles southwest from Snead's quarry.
C4320	From Stribling ranch about 75 steps south from west pit and about half a mile southwest from Snead's quarry.
C4321	From Stribling ranch west pit about half a mile southwest from Snead's quarry.
C4322	From Stribling ranch east pit which is about 30 steps from west pit and about half a mile southwest from Snead's quarry.

Analysis Made by E. P. Schoch and J. E. Stullken

Analysis No.	C4300	C4308	C4309	C4312	C4318	C4319	C4320	C4321	C4322
Magnesium oxide	42.10%	19.55%	33.89%	20.72%	18.56%	19.30%	19.62%	20.84%	19.89%
Calcium oxide	3.87	29.74	13.21	30.11	31.30	28.21	29.58	30.62	27.77
Aluminum oxide and iron oxide	2.49	2.91	3.10	1.70	2.45	2.98	1.91	1.03	2.94
Silica	0.37	2.88	0.92	3.55	1.24	12.06	8.06	0.40	15.16
Ignition loss	50.60	44.86	49.70	44.24	46.48	37.12	40.38	47.59	34.31
Total	99.43	99.94	100.82	100.32	100.03	99.67	99.55	100.48	100.07
Carbon dioxide	48.98	44.67	47.33	44.15	44.81	36.55	39.91	46.11	34.10

On the assumption that all of the magnesium oxide is present in the form of carbonate, while only as much calcium carbonate is present as corresponds to the remainder of the carbon dioxide not combined with magnesium oxide, the following results have been calculated:

Magnesium carbonate	88.04	40.88	70.86	43.33	38.81	40.36	41.03	43.58	41.59
Calcium carbonate	6.91	53.08	23.57	49.03	55.86	35.23	42.07	53.15	28.20

On these samples, only two, namely C4300 and C4309, may be classed as magnesite. The others have essentially the composition of dolomites as high magnesian limestones. This is readily seen by comparing their analyses with those of products obtained elsewhere:

Range of Composition of Magnesite (Adapted from Eckel, pp. 153-154, 1928.)

	California, Washington Nevada	Quebec	Europe and Asia
Silica (SiO_2)	0.14% to 11.82%	0.74% to 3.08%	0.22% to 5.25%
Al and Fe oxides (Al_2O_3) & (Fe_2O_3)	0.08% to 2.46%	0.16% to 2.04%	trace to 4%
Lime (CaO)	trace to 5.9%	5.8% to 10.06%	0.06% to 2.46%
Magnesia (MgO)	37.19% to 46.9%	37.76% to 41.34%	41.89% to 47.35%

Dolomites or high magnesian limestones from other localities have the compositions shown in the following table taken from Eckel's "Cements, Limes, and Plasters", page 158, 1928 edition:

Silica (SiO_2)	3.24	7.75	—	0.48	0.08	0.73	0.44	0.87	0.20	0.70
Alumina (Al_2O_3)	0.17	1.48	—	0.20		0.35	1.22	0.57	0.23	0.95
Iron oxide (Fe_2O_3)	0.23		0.02		0.25		trace	0.25		0.80
Lime (CaO)	29.58	31.00	31.01	31.31	30.46	32.73	30.73	31.40	30.04	30.50
Magnesia (MgO)	20.84	16.46	21.79	21.03	21.48	19.37	20.87	19.95	22.28	20.05
Carbon dioxide (CO_2)	45.54	42.47	47.35	46.98	47.58	46.58	45.85	n.d.	47.14	45.24

Localities of Samples for which Analyses are Given Above

1. Morrisville, Calhoun County, Ala.
2. E. Talladega County, Ala.
3. Inyo Marble Co., Inyo, Calif.
4. East Canaan, Conn.
5. Canaan, Conn.
6. Jasper, Ga.
7. Cockeysville, Md.
8. Ossining, N. Y.
9. Tuckahoe, N. Y.
10. Gates, Monroe Co., N. Y.

Magnesite is used for making refractories, e.g., magnesia brick. When highly purified, it can be used for making metallic magnasium by the electric furnace method. It can be purified by three distinct chemical methods, in which the gently calcined material is treated with either (a) carbon dioxide, or (b) a solution of sugar, or (c) a solution of magnesium chloride; or by hand-picking in the quarry; or possibly by floatation. In making magnesia bricks, the magnesia must be "dead burned", then ground and wetted with a slurry of gently calcined magnesia and iron oxide, then molded and burned again. Sometimes the calcined magnesia is mixed with asphalt as a binder, molded, and burned again.

Gentle calcining of magnesia requires a temperature of not exceeding 1650° F., while "dead burning" requires a temperature of 2750° F. The fuel required *per ton* of raw ore is approximately as follows:

	At 1650° F.		At 2750° F.	
	Theoretical	Actual	Theoretical	Actual
Electrical	63 K.W.H.	About 125 K.W.H.	89.5 K.W.H.	About 200 K.W.H.
Fuel	2150000 Btu.	About 8 million Btu.	3070000 Btu.	About 18 million Btu.
Lignite	300 lbs.	About 1200 lbs.	Coke 220 lbs.	Coke 1200 lbs.

Dolomite and similar high magnesian limestones are now used extensively, dead burned, as a refractory in steel works. They are also used, gently calcined, for cooking paper pulp and similar uses; and also to make light carbonate of magnesia for pipe insulation, etc. In California the liberated carbon dioxide is collected and compressed into cylinders.

To what extent these products can be made and sold in this part of the United States will depend upon the extent of development of other industries here. A market for magnesia bricks may be developed here even now. It is unlikely that magnesia products can be shipped from here to northern manufacturing centers in competition with Canadian products. But the development of paper manufacture and perhaps of the iron industry in East Texas would call for an extensive use of these magnesite deposits.

Geologic Discussion and Statistics on Production

V. E. Barnes and G. A. Parkinson

The outcrop from which samples C4300 and C4309 were obtained is poorly exposed at the surface, being topographically low. The rest of the samples are from well exposed topographically high outcrops, and since magnesium carbonate is less stable than calcium carbonate it is possible that low and buried portions of the marble band are magnesia-rich. This possibility should be checked by further trenching and by analysis of additional samples.

Briefly stated, the geologic history of the Llano area in which this rock is found is as follows: A sedimentary series of shales in part sandy, in part carbonaceous, and in part calcareous was interbedded with more or less impure limestones, followed by deep burial beneath other rocks. The whole series was folded and intruded, thus producing great metamorphic changes in the sedimentary series. Erosion has uncovered these deeply buried metamorphosed rocks, and at the surface now are graphite schists, amphibolites, and marbles. The highly magnesian marbles may have been enriched in their magnesia content from melton rocks intruded nearby. A petrographic study of the dolomitic marbles reveals the presence of silicate minerals such as tremolite, wollastonite, and diopside which were formed during metamorphism. The samples analysed contain between a fraction of 1 per cent and 15 per cent of combined silica present in minerals of this type.

The production of magnesite in the United States is largely from Washington and California, with possibly small amounts from Vermont where flotation has recently been used to separate magnesite from talc. As shown in the following table from the Yearbook of the United States Bureau of Mines, approximately 30 per cent of the magnesite used in the United States is imported.

Production and Imports of Magnesite in the United States, 1934-1936

	1934		1935		1936	
	Short tons	Value	Short tons	Value	Short tons	Value
Cruse:						
Mined	100,973	$730,630[1]	177,154	$1,192,052[1]	207,119	$1,411,684[1]
Sold by producers	1,588	18,393	1,626	22,345	1,669	24,420
Imports for consumption	50	706	49	1,084	59	1,130
Caustic calcined:						
Sold by producers	4,110	120,525	6,049	170,326	7,998	221,410
Imports for consumption	1,553	36,031	1,441	36,076	2,196	49,674
Dead burned:						
Sold by producers	41,953	772,233	72,438	1,361,949	89,979	1,713,527
Imports for consumption	22,921	368,014	24,674	429,830	42,608	662,567

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[1] Partly estimated.

Imports are largely from Austria, Czechoslovakia, Russia, and Italy. The Italian imports are probably mostly of Austrian origin. In view of recent European events, it seems likely that imports will be drastically curtailed, especially from Austria.

If the foreign situation and the high freight rates from the western States to the centers of consumption are considered, a deposit of magnesite in Texas would be very favorably situated, even though additional investigation shows the deposit to be of marginal grade. A further incentive to development in this area is the proximity to Buchanan Dam, a source of cheap electricity.