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Limestones in Central Texas Suitable for the Manufacture of Rock Wool

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Description and extent of the rock wool industry.—Rock wool or mineral wool, as it is sometimes called, is a substance composed of very fine, interlaced mineral fibers having the appearance of loose wool. It is manufactured out of suitable fluxing rocks, slags, or clays and composed principally of the silicates of calcium, aluminum, and magnesium. Rock wool was first manufactured in Germany and Wales about 1840 and used as an insulator for furnaces. Its manufacture in this country began in 1875 when a plant was established at Anhope, New Jersey. It was first manufactured in Ohio at Cleveland in 1888, at St. Louis in 1897, and at Alexandria, Indiana, in 1907. Rock wool was first used to insulate houses in 1927, and since then, the industry has expanded rapidly. In 1928 there were eight plants operating with a production of 50,000 tons annually; in 1940, 68 plants were in operation producing about 350,000 tons. In 1942 the total production amounted to 500,000 tons valued at $22,500,000. The plants are distributed as follows: Indiana, 16; Ohio, 9; Illinois, 7; New Jersey, 7; Kentucky, 6; Oklahoma, 1; Missouri, 1; New York, 1. A rock wool plant is being operated at Temple, and a small experimental plant was temporarily operated at New Braunfels. A plant at El Paso is temporarily closed.

Uses.—Rock wool is extensively used for insulation against both heat and cold. Many tons are purchased yearly in Texas for insulating roofs, walls of homes, refrigerators, water coolers, water heaters, and for a covering for hot water pipes and boilers. A recent Government circular[1] shows that complete insulation of a house with rock wool saves 30 per cent of fuel consumption used for heating purposes.

Present source.—Most of the mineral wool used in Texas comes from Indiana, Illinois, and Ohio. Shipping rates usually amount to nearly as much as the original value of the wool. Accordingly, and because of the large demand likely to arise following the war, it is desirable to develop a local Texas supply. For success, however, the plant must be centrally located in the State, accessible to railroads and good highways, and where a good fuel supply is available.

Method of manufacture.—Mineral wool is manufactured by crushing and melting, in a cupola, reverberatory, or electric furnace, siliceous limestone or slag and blowing, by air or steam, the molten material in the form of a fine spray into a cooling chamber. The strong blast of air or steam spins the molten liquid out into long, minute threads which cool quickly and fall to the floor in the form of wool, containing small, shot-like beads of molten, glass-like rock. The solidified shot is combed out of the wool in a special machine and the wool bagged and sold. The chief manufacturing problem is to construct a furnace which will handle large quantities of crushed and screened rock cheaply and that will produce a uniform melt.

Selection of wool rock.—The selection of the right quality of wool rock is equally as important as a well-designed furnace. The problem is to obtain a sufficient quantity of rock of a low melting point and uniform quality that will yield a wool of good color and fine texture. Limestone melts at about 2442 degrees Fahrenheit under a pressure of 1025 atmospheres[2] and silica sand at about 2678 degrees Fahrenheit, but if the two are combined in the correct intimate mixture, the combined mass of rock will melt at a temperature as low as 1500 degrees Fahrenheit. Adding a second substance to lower the melting point is known as fluxing; limestone is a flux for sand rock. The ideal combination would be to find a siliceous rock containing the correct amount of limestone (calcium carbonate), so that the rock would melt silica at the lowest possible melting point. This would be a rock having a chemical composition of about 60 per cent SiO_2 and 40 per cent CaO. Low melting siliceous rocks are known as wool rocks. The difficulty in finding a low melting siliceous rock is that most rocks contain other ingredients besides calcium carbonate and silica, such as magnesium carbonate, aluminum oxide, and iron oxide. These ingredients affect the melting point and the color of the wool. Most of the furnaces now producing rock wool are of the cupola type and operate at about 3000 degrees Fahrenheit. In order to select good wool rocks, it is necessary to determine the chemical composition and the melting point. The chemical limits for wool rocks, according to leading authorities, are as follows:

Chemical limits for good wool rock.

	Logan (per cent)	Thoenen (per cent)	Goudge (per cent)	Fryling (per cent)
SiO_2	22.5–49.0	39.0–46.0	34.0–44.0	35–65
R_2O_3	5.5–15.4	13.0–16.0	13.7–21.0	0–33
CaO	21.0–68.0	31.0–32.0	21.5–30.5	5–50
MgO	4.0–18.8	11.6–16.8	13.0–18.9	0–32

It is evident from this that any rock having a silica content ranging from 22 per cent to 50 per cent, a lime content of 21 to 60 per cent, and a low per cent of iron oxide is worth sampling and testing in a pilot plant for rock wool manufacture.

[1]Thermal insulation of buildings: U. S. Bur. Standards Cir. 376, 11 pp., Oct. 17, 1929.

[2]Limestone, when heated, if not placed under pressure, will decompose into carbon dioxide and calcium oxide.

Composition of rock wool.—Rock wool experts[3] consider that mineral wool consists of approximately a 50-50 mixture of acidic and basic oxides. These ratios are usually calculated according to Goudge's method; that is, the ratio of the sum of the granules of the acid oxides, A, to a corresponding sum of the basic oxides, B, should be approximately 1:1. Typical analyses of rock wool are shown in the following table in which the ratios are computed.

Analyses of mineral wools.[4]

No.	Wool	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Miscellaneous	A/B
1	Mineral wool	40.1	18.6	0.0	28.1	11.1	0.4	1:11
2	Mineral wool	40.8	12.6[a]		28.9	17.7	0.0	0:842
3	Rock wool	36.9	19.5	1.14	33.8	7.8	0.6	1:02
4	Rock wool	34.5	16.1	0.70	29.8	18.2	0.7	0:749
5	Rock wool	44.0	10.3	1.90	41.8	0.6	1.4	1:113
6	Rock wool	42.8	1.4	0.0	51.7	2.8	1.3	0:734

[a]Iron and aluminum oxides combined.

These analyses indicate that although the ratio of acid to basic oxides (A/B) in mineral wool approaches a 1 to 1 mixture, they may also depart considerably from this ideal ratio, as indicated by samples two, four, and six.

Progress of work on examination of siliceous limestones in Texas.—It has been known for a long time that certain of the Pennsylvanian limestones in central Texas contained silica. It was thought worth while to investigate the chemical composition and melting point of a number of samples to ascertain if wool rock existed and, if so, to try to determine which were the best and most favorably located ledges for rock wool quarrying. The work is now under way, although not nearly completed, and this paper is only intended as a preliminary report of progress.

The Lower Pennsylvauian limestones have been mapped in detail, sections measured, and about 150 samples collected in various parts of the outcrop. Of these only a few contain the correct composition for wool rock. One ledge in the upper part of the section kuown as the Lemons Bluff member of the Marble Falls formation contains sufficient silica to be promising. The results of the preliminary sampling are shown in the following table. These localities are thought to be worth further testing as sources of wool rock.

Partial analyses of siliceous limestones showing per cent of SiO_2 and CaO.
Sample No. 1 analysed by J. E. Stullken; samples No. 2-15 analysed by R. M. Wheeler.

Sample No.	Location	SiO_2	CaO	$MgCO_3$	Fe_2O_3	R_2O_3	Organic matter
1	1 mile northeast of railroad station and one-half mile east of high school in Marble Falls, Burnet County	43.10	22.26	—	—	5.65	—
2	0.3 mile west of county line, old Cavern road, White ranch, McCulloch County	30.60	37.20	—	—	?	—
3	0.3 mile west of San Saba County line, old Cavern road, White ranch, McCulloch County	21.24	42.10	—	—	?	—
4	Road to King Spring, Sloan ranch, east of the north gate, San Saba Couuty	38.42	29.80	—	—	?	—
5	Wire gate between ranch houses on Pfluger ranch, Kimble County	18.26	41.40	—	—	?	—
6	1 mile northeast and one-half mile east of high school in Marble Falls, Burnet County	43.10	22.22	2.34	3.32	5.65	5.50
7	Greenwood bluff on Sulfur Branch, 3 miles southwest of Lampasas, Lampasas County	27.03	38.42	—	0.08	—	—
8	Wilberns formation, 0.9 mile south of Erna near west line of Mason County	22.36	41.35	—	0.107	1.79	—
9	Wilberns formation, 1 mile south of Erna near west line of Mason County	42.84	28.90	—	0.015	0.167	—

[3]Goudge, Logan, and others.

[4]van Voorhis, J. M., The mineral wool industry in New Jersey: Dept. Con. Dev., Bull. 56, p. 41, 1942.

Sample No.	Location	SiO_2	CaO	$MgCO_3$	Fe_2O_3	R_2O_3	Organic matter
10	Upper Marble Falls, bed 2, intersection of White ranch road and Cavern road west of San Saba County line, 3.1 miles south and 0.2 mile east of White ranch house, McCulloch County	19.84	34.8	——	——	——	——
11	Upper Marble Falls, bed 3, intersection of White ranch road and Cavern road west of San Saba County line, 3.1 miles south and 0.2 mile east of White ranch house, McCulloch County	21.24	42.1	——	——	——	——
12	Upper Marble Falls, bed 4, intersection of White ranch road and Cavern road west of San Saba County line, 3.1 miles south and 0.2 mile east of White ranch house, McCulloch County	14.56	45.4	——	——	——	——
13	Upper Marble Falls, bed 6, intersection of White ranch road and Cavern road west of San Saba County line, 3.1 miles south and 0.2 mile east of White ranch house, McCulloch County	48.04	26.7	——	——	——	——
14	Lemons Bluff member of Marble Falls above conglomerate lentil on bluff north of King Spring on Sloan ranch, San Saba County	42.6	52.00	——	——	——	——
15	Lemons Bluff member, Wheeler ranch, 3 miles west of Lampasas at Milwhite prospect, Lampasas County	22.36	41.35	0.197	0.107	0.703	——

The following samples taken from vertical cliffs at measured intervals from the base are thought to be favorable rock for wool manufacture. However, melting and blowing tests are necessary before final qualities of rock can be ascertained.

Partial analyses of wool rock in bluff at mouth of Bluff Creek, San Saba County; each foot sampled beginning at the base of the cliff. Analyses made by I. W. Walling.

Feet from base	SiO_2	CaO	Fe_2O_3	Total
30	23.6	40.7	0.42	96.72
29	61.7	19.4	0.43	96.83
28	61.3	18.4	0.80	95.1
27	75.5	11.2	0.76	96.26
26	68.7	14.0	0.45	94.15
25	28.5	37.7	0.62	96.32
24	25.3	39.1	0.50	95.5
23	15.9	44.1	0.39	94.99
22	13.5	46.6	0.39	97.09
21	15.3	47.2	0.40	99.9
20	53.3	22.5	1.36	94.86
19	54.3	22.0	1.00	94.60
18	55.6	21.4	0.24	94.04
17	10.5	45.4	0.41	92.01
16	48.9	25.6	0.48	95.08
15	56.5	19.8	0.36	92.26
14	52.5	22.8	1.24	94.44
13	57.2	19.6	1.39	93.55
12	17.5	42.6	0.34	93.94
11	53.0	22.1	1.05	93.45
10	55.6	20.0	0.43	91.73
9	49.2	24.9	1.16	94.76
8	59.0	18.2	0.28	91.68
7	14.4	44.2	0.43	93.73

Feet from base	SiO_2	CaO	Fe_2O_3	Total
$5\frac{1}{2}$	60.6	17.8	0.49	92.79
$4\frac{1}{2}$	44.6	27.5	1.06	94.76
$2\frac{1}{2}$	59.8	17.4	1.22	92.02
$1\frac{1}{2}$	56.6	19.4	1.39	92.69
1	55.0	20.3	1.59	92.78
1°	57.9	19.6	1.22	94.12

Partial analyses of wool rock in ledges at Indian Bluff on Donalson Creek, Lampasas County. Analyses made by I. W. Walling.

Sample No.	Distance from base of cliff in feet	SiO_2	$CaCO_3$	CaO	Fe_2O_3
8	25	35.9	52.7	29.5	0.93
7	22	42.8	46.7	26.2	0.82
6	19	41.3	50.2	28.1	0.63
5	15	44.0	47.7	26.7	0.93
4	12	33.1	57.9	32.5	0.62
3	9	24.6	69.2	38.8	0.55
2	$6\frac{1}{2}$	40.8	47.2	26.4	0.82
1	$3\frac{1}{2}$	39.2	58.7	32.9	0.78

The following partial analyses of Marble Falls limestones from various typical localities in the Llano region of central Texas show that the limestones are low in silica and will not make good material for the manufacture of rock wool unless blended with pure quartz sands in the correct proportion. These non-siliceous limestones are confined to the middle and lower members of the Marble Falls while the siliceous limestones, which are suitable for rock wool, are in the upper member.

Partial analyses of non-wool rock from various localities in central Texas. Analyses made by R. M. Wheeler.

Locality No.	Formation	Locality	SiO_2	CaO
BURNET COUNTY				
27-T-2	Smithwick	North bank of Colorado River on Marble Falls—Smithwick road, one-fourth mile east of Pangle Crossing	90.74	1.60
KIMBLE COUNTY				
134-T-9	Strawn	3000 feet southwest of Morgan ranch silos on Llano River	56.96	15.50
134-T-13	Big Saline member of Marble Falls	Mouth of Falls Branch on Little Saline Creek	1.16	54.60
134-T-2	Big Saline member of Marble Falls, bed 3	Mouth of Big Saline Creek	1.18	54.40
	Big Saline member of Marble Falls, bed 1	Mouth of Big Saline Creek	1.30	54.50
134-T-27	Strawn	Wire gate between ranch house and Pfluger lodge on Pfluger ranch	18:26	41.40
134-T-27	Marble Falls, upper ledge of Big Saline member	Wire gate between ranch house and Pfluger lodge on Pfluger ranch	9.20	47.80
134-T-3A	Upper Strawn	East side of Llano River at Camp Walton	64.36	6.80
MASON COUNTY				
159-T-25	Big Saline member of Marble Falls	North side of Honey Creek	10.00	49.00
159-T-25	Big Saline member of Marble Falls	North side of Honey Creek	9.98	48.90
McCULLOCH COUNTY				
153-T-385	Big Saline member of Marble Falls	Sluiceway at west end of Shropshire Lake, $3\frac{1}{4}$ miles southeast of Brady	2.80	53.0

Locality No.	Formation	Locality	SiO_2	CaO
McCulloch County cont.				
153-T-40	Big Saline member of Marble Falls	350 feet downstream from the forks of Brady Creek	8.68	49.80
153-T-54	Marble Falls, chert layer	North side of Cavern road, 300 feet west of San Saba—McCulloch County line	91.30	2.45
153-T-54	Marble Falls	North side of Cavern road, 300 feet west of San Saba—McCulloch County line	7.02	50.80
S-32	Marble Falls, bed 1	Intersection of Cavern road and Neil to White ranch road, $3^1/_2$ miles south and one-fifth mile east of White ranch house (old Sellman ranch)	6.94	47.40
S-32	Marble Falls, bed 7a	Intersection of Cavern road and Neil to White ranch road, $3^1/_2$ miles south and one-fifth mile east of White ranch house (old Sellman ranch)	12.40	37.6
S-32	Marble Falls, bed 7b	Intersection of Cavern road and Neil to White ranch road, $3^1/_2$ miles south and one-fifth mile east of White ranch house (old Sellman ranch)	8.18	49.7
*S-29—see below.)				
SAN SABA COUNTY				
205-T-66	Marble Falls	North side of Simpson Creek on San Saba—Chappel road, $1^1/_2$ miles southwest of San Saba	9.70	49.7
205-T-110	Marble Falls	One-fourth mile west of Bloody Hand Bluff on Turkey Roost Creek	13.26	45.20
205-T-106	Marble Falls	0.2 mile southwest of Lemons Camp on San Saba River near fault	5.56	31.00
McCULLOCH COUNTY				
* S-29	Marble Falls	3120 feet north of the Neil and White ranch road gate near fence	2.74	53.50
SAN SABA COUNTY				
205-T-107	Sloan member of Marble Falls, bed 1	Section southeast of Lemons Camp on San Saba River	9.12	46.10
205-T-107	Sloan member of Marble Falls, bed 4, 8 feet from base	Section southeast of Lemons Camp on San Saba River	80.13	10.80
205-T-107	Sloan member of Marble Falls, bed 4, 14 feet from base	Section southeast of Lemons Camp on San Saba River	8.34	41.40
205-T-107	Sloan member of Marble Falls, bed 8, 14 feet from base	Section southeast of Lemons Camp on San Saba River	11.74	47.70
205-T-107	Sloan member of Marble Falls, bed 7, 3 feet from base	Section southeast of Lemons Camp on San Saba River	3.26	54.70
	Sloan member of Marble Falls, 5 feet above Ellenburger	100 feet above crossing on King's Branch on Sloan ranch	3.40	52.30
	Smithwick	South side of San Saba—Bend road, $1^1/_2$ miles west of Bend	53.78	5.1
	Marble Falls	Oolitic limestone on Bend-Aylor ranch road at Marble Falls—Barnett contact	2.68	55.26
	Marble Falls	Oolitic limestone three-fourths mile south and 1 mile west of Bend near gate on Yates ranch	0.41	55.22

Discussion.—Two types of rock occur in the Llano region which have the correct composition to make rock wool: (1) The upper portion of the Erna member of the Wilberns formation which has a very fine, very pure silica sand and silica silt mixed in the correct proportion with calcium carbonate. It occurs in the form of a white limestone. (2) The Lemons Bluff member of the Marble Falls limestone which has the silica in the form of very fine sponge spicules intimately mixed in the correct proportions with calcium carbonate. It occurs as a dark gray, nearly black limestone which, when roasted, turns light gray or white. The largest deposits of wool rock of fairly high and uniform grade appear to be those along Donalson Creek in Lampasas County and along San Saba River on the Sloan and Lemons ranches in San Saba County. Deposits closest to railroad and electrical power lines for fuel are those near Marble Falls, Burnet County. Deposits closest to natural gas supplies are those near Brady in McCulloch County. All deposits will need more sampling, more testing, and the running of sample batches of wool before a final site for manufacturing rock wool can be satisfactorily selected.

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