LIMESTONE AND LIME.

By G. F. Loughlin.

DISTRIBUTION AND QUALITY.

Limestone, including high-magnesium limestone or dolomite, has been demonstrated by work of the United States Geological Survey to be so widely distributed and so abundant in the United States that there is no doubt whatever of an adequate supply to meet all unprecedented demands, even though it is realized that stone sufficiently pure to yield lime of the highest grades forms but a small fraction of the whole. Limestone is quarried and lime is manufactured in 43 of the 48 States, and large deposits are favorably situated with respect to industrial centers, especially in the Central and Eastern States.

The northeasternmost deposits worked are in the Rockland district of southern Maine and include both high-calcium and magnesian limestone of excellent quality. Although these deposits are small compared to the vast supplies of the Middle Atlantic and East Central States, their position near tidewater has made Maine one of the foremost of the lime-producing States, with principal markets in eastern New England and New York.

Limestones and dolomites are present in both eastern and western Vermont. The western belt, which includes the famous marble deposits, is by far the more valuable. It extends southward through western Massachusetts and Connecticut and eastern New York. The larger part of the rock in this belt is of dolomitic character, but the great extent of the high-calcium rock in it may be realized when it is remembered that practically all the enormous output of marble, as well as of lime, in Vermont, Massachusetts, and Connecticut is high-calcium rock of excellent quality.

Limestones in northern New York are prevailingly high in calcium but include considerable dolomite. They extend in a nearly continuous semicircular belt along the west shore of Lake Champlain, southwestward to the vicinity of Saratoga Springs, then westward and northwestward to the east end of Lake Ontario. Another belt extends eastward from Buffalo through the large cities of central

New York to Albany, then southward to Kingston, and southwestward into New Jersey and Pennsylvania.

In eastern Pennsylvania this main belt is flanked on the southeast by areas of high-calcium and high-magnesium limestones, which supply high-grade material to the region around Philadelphia, Pa., and Wilmington, Del., and include some of the largest lime plants in the country. The main belt, which also includes high-calcium and high-magnesium rock, extends continuously from Easton, Pa., southwestward across Maryland, along the great valley region of Virginia and eastern Tennessee, across the northwest corner of Georgia, and into Alabama as far as the Birmingham district. Other belts, relatively narrow, extend in sinuous courses through western and central Pennsylvania, western Maryland, and eastern West Virginia, joining the main belt in southwestern Virginia. These immense supplies of limestone consist prevailingly of relatively impure rock, some of which is adapted for manufacturing natural cement or, when mixed with shale from neighboring deposits, for manufacturing Portland cement; but the quantity of high-grade rock present is not only sufficiently extensive for all commercial demands but also well situated with respect to markets, as is shown by the fact that Virginia and West Virginia are among the first six and Tennessee and Alabama among the first fifteen of the lime-producing States. The great quantities of furnace flux used in the Birmingham district, Ala., are of high-grade dolomite from this extensive belt. Published analyses of high-grade dolomite in this belt are few, but the deposits they represent are so distributed as to indicate that workable beds are present throughout the length of the belt.

In the Carolinas limestones occur principally in small beds which are too poorly situated and in which the rock is too impure to be of more than local interest. The deposits at Boilstone, N. C., and Gaffney, S. C., however, yield or have yielded high-calcium lime of good quality.

The limestone deposits in the Coastal Plain region of the Southern States include for the most part marls and soft limestones, too impure to be of more than local interest for the production of lime. The only lime-producing center of importance is Ocala, Fla. High-grade material is known to be present at several other places, but very few of these are near industrial centers.

The broadest and most continuous limestone area in the country extends through parts of all the Central States. Its northern limit in the United States is along Lake Huron, in northern Michigan. From this region it extends in a belt of prevailingly magnesian limestone through eastern Wisconsin to northern Illinois, where it divides into an eastern and a western branch. The eastern branch extends

from the Chicago district into Indiana and Ohio, both States containing immense quantities of high-calcium and high-magnesium stone of great commercial importance. The belt continues southward through Kentucky and middle Tennessee to northern Alabama but has been relatively unproductive in these States, although some of its beds contain high-calcium stone of excellent quality. Dolomitic limestone occurs near Louisville, Ky.

The west branch of the great dolomitic belt in northern Illinois extends into Iowa and southern Minnesota. In Iowa it is continuous with high-calcium limestone that extends southward into Missouri, where it divides into two branches, one following Mississippi River to Cape Girardeau and connecting across southern Illinois with the deposits in Kentucky, the other extending westward and southwestward into Arkansas and Oklahoma and the southeast corner of Kansas. These two branches nearly surround a great area of dolomitic limestone in the south-central part of Missouri and the northern part of Arkansas.

Besides these vast and commercially important deposits, there are several beds of high-calcium limestone in Kansas, Oklahoma, Texas, Colorado, Wyoming, and South Dakota. In and across the Rocky Mountains extensive deposits of limestone and dolomite are present in every State. The small production of the majority of these States is quite in contrast with the extent of the deposits, which have been systematically developed only where they are sufficiently accessible to large cities.

PRODUCTION, IMPORTS, AND EXPORTS.

PRODUCTION.

The importance of limestone in the mineral industry is shown by the quantity and value of limestone and lime sold in the United States from 1911 to 1915, the latest year for which complete statistics are available.

Limestone and lime marketed in the United States, 1911–1916.

	Limestone (value).	Lime.		
		Quantity (short tons).	Value.	Average price per ton.
1911	$33,897,612	3,392,915	$13,689,054	$4.03
1912	36,729,800	3,529,462	13,970,114	3.96
1913	38,745,429	3,595,390	14,648,362	4.07
1914	33,894,155	3,380,928	13,268,938	3.92
1915	35,229,866	3,589,699	14,336,756	3.99
1916	(a)	[b] 4,150,000	[b] 17,845,000	[b] 4.30

[a] Figures not yet available. [b] Estimated.

Of the total value of limestone recorded, which does not include that used for Portland cement, about two-thirds represents crushed stone and building stone of different grades. The remaining third represents stone used for furnace flux and in chemical industries, the most important of which are alkali works, carbonic acid plants, glass factories, and paper mills. About one-third of the total lime is used in the building industry. The remainder is used mainly in agriculture, chemical works, paper mills, tanneries, and sugar factories.

The foregoing table shows decreases for both limestone and lime in 1914, when the early stages of the European war caused a general industrial depression. This depression, especially in the building trades, lasted until late in 1915, and the recovery in production for that year is due principally to a revival of metallurgic and chemical industries which overshadowed continued decrease in the production of crushed stone and most kinds of structural stone. The marked increase in production in 1916 may be inferred from the great gain in estimated sales of lime, which was accomplished in spite of shortage of labor and cars and large increase in cost of production. In fact, the quantity of lime that can be produced in the United States to meet unprecedented demands is limited by the capacity of limekilns, the supply of labor and fuel, and adequacy of transportation facilities rather than by the quantity of available stone.

IMPORTS.

Imports of limestone and lime represent only an insignificant part of the total quantity consumed annually in the United States, amounting in 1915 to 2,224 tons, valued at $21,707. By far the greater part of these imports comes from Canada, which in 1915 supplied 1,727 tons, valued at $15,290. This quantity should be affected at present only by conditions of labor, fuel supply, and transportation. Even if the Canadian imports were for any reason completely cut off, domestic stone or lime could be readily shipped to any of the markets affected. Imports of lime from other countries comprise specially prepared materials adapted for certain uses and in 1915 were recorded as follows by the Bureau of Foreign and Domestic Commerce, Department of Commerce: Germany, 604,000 pounds, valued at $5,547; Mexico, 227,800 pounds, valued at $723; England, 2,300 pounds, valued at $134; Japan, 1,000 pounds, valued at $11; Hongkong, 200 pounds, valued at $2. There is no apparent reason why these small quantities can not, if necessary, be displaced by domestic lime; in fact, the place of at least one European magnesian lime (Wienerkalk, or Vienna lime) is already said to have been taken by domestic lime.

EXPORTS.

Exports of lime have gone mainly to Canada, 148,458 barrels of 200 pounds, valued at $82,258, being shipped in 1915. The total exports for that year were 162,229 barrels, valued at $106,312, and included small quantities, ranging from 2 to 5,201 barrels, sent to Mexico, countries in Central and South America, the West Indies, England, Australia, New Zealand, and French Oceania. Increase in exports of lime, like that in domestic sales, is governed by the demand and facilities of production and marketing, as the supply of limestone is practically inexhaustible.

MILITARY IMPORTANCE OF LIMESTONE AND LIME.

All industries, of course, are affected directly or indirectly by the war, but some, owing to the nature of their products, have attracted particular attention. Such, for example, are operations in the iron and steel industry, including the location of armor-plate plants; the manufacture of nitrates and related products; and intensive agriculture. Other industries that would be affected by cutting off of supplies include glass manufacture, especially for optical work, and paper manufacture, for which wood pulp has been imported. Special problems caused by armies in the field, such as purification of water supply and of sewage, may also be mentioned. In all of these, as well as many more, limestone is used, and most of them require high-calcium stone of high grade (containing 95 per cent or more of carbonate). For example, limestone for optical glass must be practically free from iron and aluminum; lime for nitrate manufacture must be as free as possible from silica, alumina, iron, and magnesia. Although rock of so high a grade forms only a small fraction of the limestone deposits of the country, it is nevertheless sufficiently abundant and accessible to industrial centers.

For some uses, however, dolomite or high-magnesium lime is preferred or required. These materials are especially available for blast-furnace flux, being preferable to limestone for this purpose in some localities; for dead-burned dolomite in the basic open-hearth process of steel manufacture, where it takes the place of Austrian magnesite; for the manufacture of magnesium and magnesium salts, an industry supplied in the Pacific coast region from deposits of magnesite but made possible in the East by the cutting off of European imports; also for special grades of magnesian lime to replace material that had been imported prior to the war. Dolomite is also required in the sulphite process of paper manufacture and in certain branches of the tanning industry.

For the last two as well as certain other uses of dolomite, or magnesian limestone, freedom from more than 2 or 3 per cent of impurities is required; and one inquiry has been received by the United States Geological Survey for a dolomite containing not more than 0.05 per cent of iron. Available analyses of limestone and dolomite in which impurities, especially iron and alumina, are separately and accurately determined are relatively scarce, and it is urged that the owners of limestone and dolomite deposits hereafter have more accurate analyses of their stone and burned lime made. Even for uses where impure stone may be suitable or even required, as in sintered dolomite, the quantity of the different impurities doubtless has a direct bearing on the quality of the burned material.

There is, furthermore, a tendency on the part of some producers of building lime to investigate the influence of impurities on the workability of the lime and its strength after setting. The need of greater accuracy in limestone analyses is therefore becoming a matter of general interest to lime producers, as well as of vital importance to certain industries affected by the present abnormal conditions.

Limestone and lime for agriculture need not necessarily be of very high grade. Although insoluble impurities tend to lessen the percentage of lime available for improving the soil, they are not actively injurious to plant growth, and it may be more economical to use a local lime than to go to the expense of purchasing a higher-grade lime in a distant market. Both calcium and magnesium limestones or limes are suitable for counteracting acidity of the soil, although their use should depend on the kind of crops to be raised. The supply of limestone available for agriculture is therefore unlimited, and its widespread occurrence and low cost are important factors in the intensive cultivation during war time of land that, in recent years at least, has not been prepared for the growing of crops. From the fact that limestone and lime, by reacting with minerals of the soil, render such constituents as potash and phosphorus more available and also aid in the growth of the bacteria that render nitrogen available, it is obvious that lime will not only serve to counteract acidity of soils but in some soils will serve as a substitute for fertilizers whose price may be expected to rise with a marked increase in demand.