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2014 Minerals Yearbook

LIME [ADVANCE RELEASE]

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Lime

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In 2014, lime production in the United States (including that in Puerto Rico) was 19.5 million metric tons (Mt) and had a value of $2.38 billion (table 1). Based on unrounded data, this was an increase of about 285,000 metric tons (t) from that of 2013. Lime consumption increased in all major market sectors (chemical and industrial, construction, environmental, and metallurgical). On average, lime prices increased by $1.30 per metric ton, continuing a 10-year trend.

The U.S. lime industry is characterized by high barriers to entry, which include an industry dominated by a few large-scale producers with nationwide supply and distribution networks, a scarcity of high-quality limestone deposits on which the required zoning and mining permits can be obtained, the need for lime plants and facilities to be located close to markets with access to suitable transportation networks to allow for cost-effective production and distribution, environmental regulations making it difficult to permit new lime kilns, and the high capital cost of the plants and facilities. Production capacity increases are usually met by retiring older kilns and using the existing air quality permits for new, more efficient, higher capacity kilns that have reduced air emissions.

In 2014, the U.S. lime industry consisted of 29 companies, down from 30 in 2013, because of Mississippi Lime Co.'s acquisition of Huron Lime, Inc. in January (Mississippi Lime, Co., 2014). Of the 29 companies, 14 companies produced lime products for sale, 10 companies produced lime that was used entirely for internal company purposes, and 5 companies did both. Owing to its reactivity and short shelf life, lime is not stockpiled in large amounts and data on stocks are not collected. On an annual basis, lime "sold or used" is considered to be equivalent to production and consumption. Lime, as quicklime, is a basic chemical produced in 29 States and Puerto Rico.

The term lime as used throughout this report refers primarily to six chemicals produced by the calcination of high-purity limestone or dolomite, followed by hydration where necessary. There are two high-calcium forms of lime—high-calcium quicklime (calcium oxide, CaO) and high-calcium hydrated lime [calcium hydroxide, $Ca(OH)_2$]. There are four calcium-magnesium (dolomitic) forms—dolomitic quicklime ($CaO \cdot MgO$), dolomitic hydrate type N [$Ca(OH)_2 \cdot MgO$], dolomitic hydrate type S [$Ca(OH)_2 \cdot Mg(OH)_2$], and refractory dead-burned dolomite ($CaO \cdot MgO$). The terms "type N" and "type S" refer to "Normal hydrated lime" and "Special hydrated lime" that are differentiated primarily by the compounds' plasticity (ability to retain water) and oxide content. There are also air-entrained versions of these hydrates designated as "type NA" and "type SA."

At present, all commercially produced lime in the United States is manufactured from limestone or dolomite, but lime also can be produced from a variety of calcareous materials, such as aragonite, chalk, coral, marble, and shell. Lime also is regenerated (produced as a byproduct) by carbide plants, wood pulp mills, sugar mills, and water-treatment plants. Regenerated lime volumes, however, are not included in this report.

Production

Domestic production data for lime were derived by the U.S. Geological Survey (USGS) from a voluntary survey of U.S. operations. The survey was sent to primary producers of quicklime and hydrate, but to avoid double counting, it was not sent to independent hydrators that purchase quicklime for hydration. Quantity data were collected for 28 specific and general end uses, and value data were collected by type of lime. Of the 90 operations that were canvassed in 2014, data were received for 78 operations, including 5 that were idle during the entire year. Data received represented 96% of the total lime sold or used by producers listed in tables 1–5. Production data for the nonrespondents were estimated based on prior-year production data and other information.

In 2014, quicklime was produced at 77 lime plants, including 31 plants with colocated hydrating plants. Hydrated lime also was produced at 15 standalone hydrating facilities, including 3 plants where the kilns had been shut down but hydrate was manufactured from quicklime produced offsite. These numbers do not necessarily agree with the number of plants reported in table 1 because, for data collection purposes, some company operations have been combined at the respondent's request. In a few States with no quicklime production, hydrating plants used quicklime shipped from other States. There were also stationary lime slurry plants in some States where lime was converted to liquid form by the addition of water prior to sale; this product is sometimes called milk-of-lime. In addition to stationary slurry plants, there were mobile hot lime slurry production systems designed to slake quicklime or slurry hydrated lime to the percentage of solids required for specific jobs.

Data on lime sold or used in the United States are reported by U.S. Census Bureau region (table 2). In 2014, States having production in excess of 2 Mt were, in descending order, Missouri, Alabama, and Kentucky. States with production of between 1 and 2 Mt that can be revealed were, in descending order, Ohio, Texas, and Nevada.

In 2014, production, or the total amount of lime sold or used by domestic producers, including Puerto Rico, was 19.5 Mt (table 1), a slight increase compared with that of 2013. The total included the commercial sale or captive consumption by producers (described by the term "used") of quicklime, hydrated lime, and dead-burned refractory dolomite. Data were incomplete on the production of hydrated lime because some producers do not report data on downstream hydrating plants. Traditionally, most U.S. lime production sold or used is in the

form of high-calcium quicklime. In 2014, production of high-calcium quicklime increased slightly to 14 Mt and dolomitic quicklime decreased by 4.6% to 2.73 Mt (table 1). The production of high-calcium hydrate and dolomitic hydrate each increased by about 7% compared to that in 2013. Commercial sales of quicklime and hydrate increased slightly to 18.1 Mt, whereas lime produced for captive consumption decreased by 4% to 1.34 Mt.

At yearend, the top 10 lime companies were, in descending order of U.S. lime production, Carmeuse Lime and Stone, Lhoist North America, Graymont Ltd., Mississippi Lime Co., Martin Marietta Magnesia Specialties LLC, United States Lime & Minerals, Inc., Unimin Corp. (doing business as Southern Lime Co.), Cheney Lime & Cement Co., Pete Lien & Sons, Inc., and ArcelorMittal USA Inc. These companies reported production from 50 lime plants and 11 separate hydrating plants and accounted for nearly 94% of the combined commercial lime sales and nearly 90% of total lime production.

Graymont Ltd. continued installation of a vertical shaft parallel flow regenerative lime kiln at its Pleasant Gap, PA, plant. Construction of the new kiln was expected to increase the plant's capacity by 25% and to be completed by yearend 2015 (Graymont Ltd., 2012; 2015, p. 27). In June, Graymont announced that it would resume limestone quarry operations at the previously mined Hendricks Quarry in Garfield Township in the Upper Peninsula of Michigan pending regulatory approval (Graymont Ltd., 2014).

On April 22, Carmeuse Lime and Stone received an air quality permit from the Virginia Department of Environmental Quality for the installation of two gas-fired vertical shaft kilns at its Clear Brook plant near Winchester, VA. The kilns would replace the plant's existing rotary lime kiln. Each kiln would have a capacity to produce 400 tons per day, the combination of which would double the plant's previous operating capacity (Carmeuse Lime and Stone, 2014).

Consumption

In 2014, U.S. lime consumption increased in all major market sectors. The percentage breakdown of lime consumption by general end-use sectors was essentially unchanged from that of 2013 at 37% for metallurgical uses, 31% for environmental uses, 22% for chemical and industrial uses, 9% for construction uses, and 1% for refractories (table 3). Although lime consumption in most metallurgical uses was slightly lower, lime consumption in steel electric arc furnaces increased by 7.5% to 3.15 Mt, an alltime high. These end-use data were based on lime sold or used by domestic producers and do not include lime imports.

Commercial sales accounted for 93% of total U.S. lime consumption and 93% of domestic production. Captive lime accounted for the remainder of consumption and was used in the production of steel in basic oxygen furnaces (BOFs), magnesia production, precipitated calcium carbonate production, sugar refining, and refractories (dead-burned dolomite). Almost all end-use data on captive lime consumption were withheld to avoid disclosing company proprietary information. As a result, table 3 only lists the total quantity (commercial plus captive) by end use. Additional end uses with captive consumption are listed in footnote 5 of table 3.

In steel production, quicklime is used as a flux and slagging agent to remove impurities, such as phosphorus, silica, and sulfur. The steel industry accounted for 30% of lime sold and used by domestic lime producers. According to the World Steel Association (2015), U.S. steel production in 2014 increased slightly from that of 2013; lime consumption for total steel and iron uses in 2014, was slightly greater than that of 2013 (table 3).

In nonferrous metallurgy, lime is used in the beneficiation of copper ores to neutralize the acidic effects of pyrite and other sulfides and to maintain the proper pH in the flotation circuits. Lime is used to process alumina and magnesia, to extract uranium from gold slimes, and to recover nickel by precipitation.

Gold and silver are recovered using heap leaching and by conventional milling and subsequent leaching of the slurry. Heap leaching involves crushing the ore, mixing it with lime for pH control and sometimes agglomeration, and stacking the ore in heaps on specially prepared pads for treatment with cyanide solution. Lime is used to maintain the pH of the cyanide solution at a level between 10 and 11 to maximize the recovery of precious metals and to prevent the creation of hydrogen cyanide gas.

Lime consumption data for nonferrous metallurgical uses [aluminum and bauxite processing, flotation processing of sulfide ores (principally copper and gold ores), and unspecified nonferrous uses] are combined to avoid disclosing company proprietary data and are reported in table 3 under "Metallurgical: Nonferrous metallurgy." In 2014, lime consumption in nonferrous metallurgy decreased by 5% to 1.39 Mt (table 3), which slightly exceeded the most recent peak of 1.37 Mt reached in both 2007 and 2008. Although specific data are not collected on lime consumption for copper or gold recovery processes, they make up a large part of the nonferrous metallurgy market. Recovery of copper from flotation concentrates increased only slightly compared with that of 2013 (Brininstool, 2015). Domestic gold production, however, decreased by about 8% compared with that of 2013 (George, 2015).

Lime is used in numerous processes to treat discharges in active or abandoned mines. These processes include the treatment of acid-mine drainage from operating and abandoned mines, specialized treatment processes such as catalyzed cementation of arsenic and other heavy metals, and treatment of mine tailings from the recovery of precious metals to recover cyanides.

Lime is used, generally in conjunction with soda ash (Na_2CO_3), for softening municipal and plant process water. This precipitation process removes soluble calcium and magnesium cations (and to a lesser extent, ferrous iron, manganese, strontium, and zinc cations) that contribute to the hardness of water. This process also reduces carbonate alkalinity and total dissolved solids. Lime consumption for drinking water treatment decreased slightly in 2014 compared with that of 2013 (table 3).

In sewage treatment, the traditional role of lime is to control pH in the sludge digester, where it removes dissolved and suspended solids that contain phosphates and nitrogen compounds. Lime also aids in clarifying and in destroying harmful bacteria. The leading use in sewage treatment is to stabilize the resulting sewage sludge. Sewage sludge stabilization, also called biosolids stabilization, reduces odors, pathogens, and putrescibility of the solids. Lime stabilization involves mixing quicklime with the sludge to raise the temperature and pH of the sludge to minimum

levels for a specified period of time. In 2014, lime consumption for all sludge treatment increased by 37% compared with that of 2013 (table 3). Most of the increase was in the treatment of industrial and hazardous wastes.

In flue gas treatment (FGT) systems serving coal-fired powerplants, incinerators (most are waste-to-energy powerplants), and industrial plants, lime is injected into the flue gas to remove gaseous pollutants, particularly sulfur dioxide (SO_2) and hydrochloric acid (HCl). Many FGT systems at utility powerplants are now designed to produce byproduct gypsum from the captured SO_2. This byproduct material is suitable for use in manufacturing gypsum wallboard, as an additive in portland cement, and as a soil amendment in agriculture. Hydrated lime may be used in another FGT-related market—to control sulfur trioxide (SO_3) emissions from selective catalytic reduction (SCR) systems installed at powerplants to control emissions of nitrogen oxides (NO_x). Utility powerplants were by far the largest consumers of lime for FGT and accounted for 91% of the total FGT lime market in 2014 (table 3). Incinerators, industrial boilers, and other FGT uses accounted for the remaining 9%. In 2014, lime consumption decreased slightly in the utility powerplant FGT market, but increased in the other FGT markets. Most of the increase was in the industrial and other FGT uses sector, where lime consumption increased by 45% compared with that of 2013. Lime consumption in the incinerators sector also increased by 15%. The use of hydrated lime in FGT in 2014 increased to 17% (table 4). Much of this increase was attributed to the expanding treatment of SO_3 emissions from SCR systems at utility powerplants.

Lime is used by the pulp and paper industry in the basic kraft pulping process where wood chips and an aqueous solution of sodium hydroxide and sodium sulfide (called liquor) are heated in a pressurized digester. The cooked wood chips (pulp) along with spent liquor are discharged (blown) under reduced pressure to a washing or evaporating system, respectively. The pulp is then screened, washed, and sent directly to a paper machine or to a bleaching plant. Lime is sometimes used to produce calcium hypochlorite bleach for bleaching the paper pulp. The spent liquor is processed through a recovery furnace, where dissolved organics are burned to recover waste heat, sodium sulfide, and sodium carbonate. The recovered sodium sulfide and sodium carbonate are diluted with water and then treated with slaked lime to recausticize the sodium carbonate into sodium hydroxide (caustic soda) for reuse. The byproduct calcium carbonate is calcined in a lime kiln to recover lime for reuse. The paper industry also uses lime as a coagulant aid in the clarification of plant process water. In 2014, consumption for pulp and paper production increased by about 3% compared with that of 2013 (table 3).

Lime is used in the manufacture of a wide range of chemicals, including precipitated calcium carbonate (PCC), a specialty filler used in premium-quality coated and uncoated papers, paint, and plastics. The most common PCC production process used in the United States is the carbonation process. Carbon dioxide (CO_2) is bubbled through milk-of-lime to form a precipitate of calcium carbonate and water. The reaction conditions determine the size and shape of the resulting PCC crystals. Lime used for PCC production decreased by 11% compared with that of 2013 (table 3).

The chemical industry also uses lime in the manufacture of alkalis. Other chemical uses include the production of calcium carbide, which is formed when quicklime is combined with coke; calcium carbide, in turn, is used to make acetylene and calcium cyanide. Lime is also used to make calcium hypochlorite bleaches, citric acid, petrochemicals, and many other chemicals.

In sugar refining, milk-of-lime is used to raise the pH of the product stream, precipitating out colloidal impurities. The lime itself is then removed by reaction with CO_2 to precipitate calcium carbonate.

An experimental agricultural use for hydrated lime that has been undergoing field trials is as an additive to crop residues, such as corn stover, to produce cattle feed that can replace a substantial portion of the grain normally fed to cattle. The crop residue is ground, treated with hydrated lime slurry, and then stored in an oxygen-free container—typically a plastic "ag bag" or a bunker—for at least a week. The hydrated lime makes the crop residue digestible by the cattle. This treated crop residue can replace about 20% of grain fed to the cattle, and, with the addition of wet distiller grains (byproducts of corn ethanol production) to provide protein, the treated crop residue may be able to replace more than 60% of grain feed (Archer Daniels Midland Co., 2013). The extent of lime use in this sector in 2014 was unknown.

Hydrated lime is used in oil and gas drilling as a source of alkalinity and calcium in both oil- and water-base drilling fluids. Drilling fluid applications include increasing the pH, providing excess lime as an alkalinity buffer, flocculating bentonite drilling muds, removing soluble carbonate (CO_3^{2-}) ions, controlling corrosion, and activating fatty-acid oil-base mud additives (M-I LLC, 2011).

In the construction sector, hydrated lime is used in hot mix asphaltic concrete as an antistripping agent. Stripping is generally defined as a loss of adhesion between the aggregate surface and the asphalt binder in the presence of water. Lime also is used in cold, in-place recycling for the rehabilitation of distressed asphaltic concrete pavements. Existing asphaltic concrete pavement is pulverized using a milling machine, and a hot lime slurry is added along with asphalt emulsion. The cold recycled mix is placed and compacted by conventional paving equipment, which produces a smooth base course for the new asphaltic concrete surface. In 2014, sales of lime for use in asphaltic concrete decreased slightly compared with those for 2013 (table 3).

Hydrated lime and quicklime also are used to stabilize fine-grained soils in place of materials that are employed as subbases, such as hydraulic clay fills or otherwise poor-quality clay and silty materials obtained from cuts or borrow pits. Lime also is used in base stabilization, which includes upgrading the strength and consistency properties of aggregates that may be judged unusable or marginal without stabilization. Common applications for lime stabilization include the construction of airfields, building foundations, earthen dams, parking areas, and roads.

Lime sales for soil stabilization tend to be cyclical, especially in large market areas such as Texas. In the soil stabilization market, lime competes with portland cement, cement kiln dust, fly ash, and other additives (liquid enzymes, for example). The choice of material for soil stabilization depends on availability,

price, contract specifications, soil chemistry, and State and Federal funding in the case of highway construction projects. Public spending on highway construction, excluding operation and maintenance, was $91.9 billion in 2014, up from the $88.4 billion spent in 2013 (U.S. Congressional Budget Office, 2015). Lime consumed for soil stabilization in 2014 increased by 21% compared with that of 2013 (table 3).

Hydrated lime is used in the traditional building sector in some mortars, plasters, and stuccos. Standard masonry cement mortars that include lime exhibit superior workability balanced with appropriate compressive strength, as well as low water permeability and superior bond strength. Lime is a major constituent in exterior and interior plasters and stuccos, enhancing the durability, strength, and workability of these finishes. A small amount of hydrated lime also is used in the renovation of old structures built with lime mortars, which were standard before the development of portland cement mortars. Modern portland cement-base mortars are incompatible with old lime mortars. Hydrated lime also is used to make synthetic hydraulic lime, which is produced by blending powdered hydrated lime with pulverized pozzolanic or hydraulic materials.

The U.S. Census Bureau collects data on spending for private and public residential construction and 16 categories of nonresidential construction. In 2014, the U.S. value of private residential construction increased slightly and that of nonresidential construction increased by 11% when compared with those of 2013 (U.S. Census Bureau, undated). Almost all lime sold in 2014 for building use was in the form of hydrate [256,000 t (table 4) out of 269,000 t of total lime in 2014 (table 3)]. In 2014, sales of total lime consumed in traditional building materials, such as in aerated concrete, mortar, plaster, and whitewash, increased by 13% compared with those of 2013 (table 3). Most of the lime sold for construction uses was produced at a few plants in Nevada, Ohio, Texas, and Wisconsin.

Dead-burned dolomite, also called refractory lime, is used as a component in tar-bonded refractory brick or monolithics manufactured for use in BOFs. Refractory brick also is used in the lining of many treatment and casting ladles, in argon-oxygen decarburization and vacuum-oxygen decarburization converters, in electric arc furnaces, and in continuous steel casting. The data on dead-burned dolomite reported in this chapter (table 3) were rounded to one significant figure to avoid disclosing company proprietary data; unrounded data showed that the production of dead-burned dolomite in 2014 decreased slightly compared with that of 2013. Magnesita Refractories Co. at its York, PA, plant, and Carmeuse at its Millersville, OH, plant, were the only significant producers of dead-burned dolomite. Although dead-burned dolomite is the primary form of lime used in refractories, hydrated lime may be used to produce silica refractory brick used to line industrial furnaces.

Prices

The USGS calculates unit values of lime products from the quantity and value data reported for lime sold or used by the lime producers on a free-on-board plant basis, including the cost of containers. These provide average values that eliminate variables, such as potentially significant differences between list prices and individual supply contracts. There are no published lime prices in trade publications, so historically the data listed in table 5 have been used as representative of U.S. lime prices. To avoid revealing company proprietary data, value data for dead-burned dolomite have not been reported separately but are included with the weighted average of all types of lime. Prices for most types of lime recorded slight increases in 2014 compared with those for 2013, ranging from $1.30 to $2.30 per metric ton and rising no more than 2%. The price for dolomitic hydrate was the exception with an increase of $4.30 per ton. The total weighted average price of all lime types in 2014 increased by 1.5%. With the exception of the dolomitic hydrate price, the annual increases in 2014 were the smallest reported during the past decade in which the total annual average price increased by $5.53 per metric ton, or by 6.4% per year.

Foreign Trade

The United States exported and imported calcined dolomite (dolomitic lime), hydrated lime (slaked lime), hydraulic lime, and quicklime. Total exports and imports of lime comprised just a fraction of the total amount produced domestically in 2014—1.6% and 2.1%, respectively. Total exports of lime were 319,000 t valued at $57.5 million. About 92% of exports went to Canada, with most of the remaining exports going to Oman (3%), Mexico (3%), and Russia (1%) (table 6). Total imports of lime were 414,000 t valued at $67.7 million, with 90% from Canada, 4% from Mexico, and 6% from other countries (table 7). Canada provided 99% of high-calcium quicklime, 69% of slaked lime, and 50% of dolomitic (calcined dolomite) lime imports.

No tariffs are placed on imports of hydraulic lime, quicklime, and slaked lime from countries with normal trade relations (NTR) with the United States. A 3% ad valorem tariff is placed on imports of calcined dolomite from NTR countries.

World Review

In 2014, global lime production was estimated to be 360 Mt. The leading lime producing countries were China (65%), the United States (5%), India (4.5%), Russia (3%), and Brazil (2%) (table 8). Lime is mostly traded on a regional basis because it has been a low-value bulk and reactive product that could not be shipped long distances and compete with lime produced locally. Most countries have limestone or dolomite deposits and are able to manufacture lime for their own consumption. There may be some trade between countries on a regional basis where distances are not too great, such as within the European Union, or to supply lime products of a quality not locally available.

With the exception of some industrialized nations, accurate lime production data for individual countries are difficult to obtain and are commonly incomplete. In addition to production by large commercial lime companies, lime is produced by small-scale manufacturers operating simple kilns to supply local consumers and by industries producing lime for internal consumption. Also, there is frequently misreporting of crushed limestone production data as lime. In some cases, lime sales data have been used as a surrogate for country production figures.

Outlook

Economic forecasts predict sustained growth in the domestic economy in terms of growth in the U.S. real gross domestic product (GDP). The U.S. real GDP is forecast to grow at a rate of 2.7% in 2015, about 2.8% in 2016, and 2.4% in 2017 (World Bank, The, 2015). Lime sales in markets such as chemical and industrial, construction, and steel are expected to increase with improvements in the overall economy.

The outlook for FGT (lime's second-leading market) is more difficult to predict. With the recent boom in natural gas exploration, large increases in natural gas reserves, and low natural gas prices, some U.S. electric utilities have increasingly shifted their fuel use from coal to natural gas. Natural gas also has the advantage of causing lower levels of air emissions than coal and, as a result, does not usually require SO_2 scrubbing; this could lead to decreased FGT lime consumption.

Wet limestone scrubbing (WLS) has been the preferred SO_2 removal technology for coal-fired powerplants in recent decades, but two potential issues with WLS have arisen. With the possible domestic regulation of greenhouse gases (GHGs) in the future, the use of WLS becomes problematic because the process generates CO_2 (a GHG) as a byproduct. Also, WLS requires some form of purge stream to prevent the accumulation of chlorides, high concentrations of dissolved sulfate, and trace impurities such as mercury and oxides of arsenic, boron, and selenium. Treatment methods have been and continue to be developed to remove these contaminants, but regulations are tightening with regard to disposal of powerplant wastewater streams. Two emerging technologies—novel integrated desulfurization and circulating fluidized bed scrubbing (also called circulating dry scrubbing)—combine features of existing technologies and offer excellent SO_2 removal with efficient reagent use. Hydrated lime is the primary reactant in both systems (Buecker, 2011). As a result, the FGT market is expected to increase during the next 3 to 5 years despite powerplants switching from coal.

References Cited

Archer Daniels Midland Co., 2013, ADM Second Crop™—How it works: Decatur, IL, Archer Daniels Midland Co. (Accessed April 23, 2013, at http://www.adm.com/en-US/products/grain-farmer-services/SecondCrop/HowItWorks/Pages/default.aspx.)

Brininstool, Mark, 2015, Copper in December 2014: U.S. Geological Survey Mineral Industry Surveys, May, 13 p. (Accessed August 26, 2015, at http://minerals.usgs.gov/minerals/pubs/commodity/copper/mis-201412-coppe.pdf.)

Buecker, Brad, 2011, Circulating dry scrubbers—A new wave in FGD?: Power Engineering, v. 115, no. 11, November 1. (Accessed April 30, 2013, at http://www.power-eng.com/articles/print/volume-115/issue-11/features/circulating-dry-scrubbers-a-new-wave-in-fgd.html.)

Carmeuse Lime and Stone, 2014, Carmeuse attains PSD air permit on April 22, 2014: Pittsburgh, PA, Carmeuse Lime and Stone press release, July 16, 2 p. (Accessed August 27, 2015, at http://www.carmeusena.com/news/carmeuse-attains-psd-air-permit-april-22-2014.)

George, M.W., 2015, Gold in December 2014: U.S. Geological Survey Mineral Industry Surveys, April, 5 p. (Accessed August 26, 2015, at http://minerals.usgs.gov/minerals/pubs/commodity/gold/mis-201412-gold.pdf.)

Graymont Ltd., 2012, Graymont embarks on multi-million dollar expansion of its Pleasant Gap, PA lime complex: Vancouver, British Columbia, Canada, Graymont Ltd. news release, October 10. (Accessed August 27, 2015, at http://www.graymont.com/en/news/graymont-embarks-multi-million-dollar-expansion-its-pleasant-gap-pa-lime-complex.)

Graymont Ltd., 2014, Graymont moving forward with new limestone operation in Michigan's Upper Peninsula: Richmond, British Columbia, Canada, Graymont Ltd. news release, June 12. (Accessed August 27, 2015, at http://www.graymont.com/en/news/graymont-moving-forward-new-limestone-operation-michigan-s-upper-peninsula.)

Graymont Ltd., 2015, 2014 sustainability report: Richmond, British Columbia, Canada, Graymont Ltd., April 27, 40 p. (Accessed August 27, 2015, at http://www.graymont.com/sites/default/files/brochures/pdf/graymont_sr_2014.pdf.)

M-I LLC, 2011, Lime: Houston, TX, M-I SWACO product sheet, 2 p. (Accessed April 30, 2013, at www.slb.com/~/media/Files/miswaco/product_sheets/lime.pdf.)

Mississippi Lime, Co., 2014, Mississippi Lime Company acquires Huron Lime: St. Louis, MO, Mississippi Lime Co. press release, January 6, 1 p. (Accessed on August 26, 2015, at https://www.mississippilime.com/2014/01/mississippi-lime-acquires-huron-lime/.)

U.S. Census Bureau, [undated], Construction spending—Historical value put in place: U.S. Census Bureau. (Accessed August 26, 2015, via http://www.census.gov/construction/c30/historical_data.html.)

U.S. Congressional Budget Office, 2015, Supplemental tables—Public spending on transportation and water infrastructure, 1956 to 2014: U.S. Congressional Budget Office, table W–1, March 2. (Accessed September 17, 2015, via https://www.cbo.gov/publication/49910.)

World Bank, The, 2015, Global economic prospects: Washington, DC, The World Bank, June, 1 p. (Accessed August 31, 2015, at http://www.worldbank.org/en/publication/global-economic-prospects/summary-table.)

World Steel Association, 2015, World crude steel output increases by 1.2% in 2014: Brussels, Belgium, World Steel Association press release, January 22. (Accessed August 26, 2015, at http://www.worldsteel.org/media-centre/press-releases/2015/World-crude-steel-output-increases-by-1.2--in-2014.html.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Directory of Lime Plants in the United States in 2014. Mineral Industry Surveys, 2015.

Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.

Lime. Ch. in Mineral Commodity Summaries, annual.

Lime in the United States—1950 to 2001. Mineral Industry Surveys, 2002.

Lime in the United States—1960 to 2009. Mineral Industry Surveys, 2011.

Lime Kiln Dust as a Potential Raw Material in Portland Cement Manufacturing. Open-File Report 2004–1336, 2004.

Limestone and Dolomite. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

Chemistry and Technology of Lime and Limestone. John Wiley & Sons, Inc., 1980.

Lime. Ch. in Industrial Minerals and Rocks (7th ed.). Society for Mining, Metallurgy, and Exploration, Inc., 2006.

Lime. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

Lime and Limestone—Chemistry and Technology, Production and Uses. Wiley-VCH Verlag GmbH, 1998.

Lime/Limestone Ch. in Chemical Economics Handbook. IHS Chemical.

TABLE 1
SALIENT LIME STATISTICS[1]

		2010	2011	2012	2013	2014
United States[2]						
Number of plants[3]		85	87	87	85	86
Lime sold or used by producers:						
Quantity	thousand metric tons	18,300	19,100	18,800	19,200	19,500
Value[4]	thousand dollars	1,950,000	2,130,000	2,230,000	2,320,000	2,380,000
Average value	dollars per metric ton	107.00	111.50	118.50	121.10	122.40
Quicklime:						
High-calcium	thousand metric tons	13,300	13,900	13,600	13,800	14,000
Dolomitic	do.	2,570	2,690	2,790	2,870	2,730
Total	do.	15,900	16,600	16,300	16,600	16,800
Hydrated lime:						
High-calcium	do.	1,910	2,010	2,000	2,050	2,190
Dolomitic	do.	239	230	253	260	279
Total	do.	2,150	2,240	2,260	2,310	2,470
Dead-burned dolomite[5]	do.	200	200	200	200	200
Lime sold by producers:						
Quicklime[6]	thousand metric tons	14,700	15,400	15,200	15,500	15,700
Hydrated lime	do.	2,140	2,240	2,250	2,310	2,470
Total	do.	16,900	17,700	17,500	17,800	18,100
Value[4]	thousand dollars	1,790,000	1,950,000	2,050,000	2,140,000	2,210,000
Lime used by producers:						
Quantity	thousand metric tons	1,380	1,430	1,340	1,390	1,340
Value[4]	thousand dollars	169,000	183,000	177,000	184,000	173,000
Exports:[7]						
Quantity	thousand metric tons	215	231	212	270	319
Value[8]	thousand dollars	36,200	40,100	36,700	48,200	57,500
Imports for consumption:[7]						
Quantity	thousand metric tons	445	512	468	394	414
Value[9]	thousand dollars	61,500	69,900	68,300	64,100	67,700
Consumption, apparent[10]	thousand metric tons	18,500	19,400	19,100	19,300	19,500
World, production	do.	310,000 r	320,000 r	340,000 r	350,000 r	360,000 e

eEstimated. rRevised. do. Ditto.

[1]Data are rounded to no more than three significant digits except for world production data, which are rounded to two significant digits; may not add to totals shown. Excludes regenerated lime.

[2]Includes Puerto Rico.

[3]Includes most producer-owned hydrating plants not located at lime plants.

[4]Selling value, free-on-board plant.

[5]Data are rounded to no more than one significant digit to avoid disclosing company proprietary data.

[6]Includes dead-burned dolomite.

[7]Source: U.S. Census Bureau.

[8]Free alongside ship valuation.

[9]Cost, insurance, and freight valuation.

[10]Defined as sold or used plus imports minus exports.

TABLE 2
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY U.S. CENSUS BUREAU REGIONS

Region or division and year	Hydrated (thousand metric tons)	Quicklime[1] (thousand metric tons)	Total (thousand metric tons)	Percent of total	Value (thousands)	Percent of total
2013:						
Northeast[2]	154	1,030	1,180	6	$165,000	7
Midwest[3]	809	6,700	7,500	39	895,000	39
South:						
South Atlantic[4]	230	609	839	4	114,000	5
East South Central[5]	216	4,440	4,650	24	524,000	23
West South Central[6]	671	1,120	1,790	9	200,000	9
West[7]	231	2,970	3,200	17	424,000	18
Total	2,310	16,900	19,200	100	2,320,000	100
2014:						
Northeast[2]	170	1,010	1,180	6	163,000	7
Midwest[3]	887	6,820	7,710	40	932,000	39
South:						
South Atlantic[4]	213	591	804	4	109,000	5
East South Central[5]	224	4,410	4,630	24	531,000	22
West South Central[6]	739	1,260	2,000	10	227,000	10
West[7]	238	2,890	3,130	16	419,000	18
Total	2,470	17,000	19,500	100	2,380,000	100

[1]Includes dead-burned dolomite.
[2]Region includes Massachusetts and Pennsylvania.
[3]Region includes Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
[4]Division includes Florida, Georgia, Puerto Rico, Virginia, and West Virginia.
[5]Division includes Alabama, Kentucky, and Tennessee.
[6]Division includes Arkansas, Louisiana, Oklahoma, and Texas.
[7]Region includes Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming.

TABLE 3
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE[1, 2, 3]

(Thousand metric tons)

Use	2013 Quantity[4]	2014 Quantity[4]
Chemical and industrial:		
Fertilizer, including aglime	82	82
Glass	178	186
Paper and pulp	916	942
Precipitated calcium carbonate	900	803
Sugar refining	680	647
Other chemical and industrial[5]	1,480	1,590
Total	4,240	4,250
Metallurgical:		
Steel and iron:		
Basic oxygen furnaces	2,560	2,410
Electric arc furnaces	2,930	3,150
Other steel and iron	296	322
Total	5,780	5,880
Nonferrous metallurgy[6]	1,460	1,390
Total metallurgical	7,240	7,270
Construction:		
Asphalt	212	207
Building uses	239	269
Soil stabilization	1,010	1,220
Other construction	56	43
Total	1,520	1,740
Environmental:		
Flue gas treatment:		
Utility powerplants	3,680	3,660
Incinerators	169	194
Industrial boilers and other flue gas treatment	113	164
Total	3,960	4,020
Sludge treatment:		
Sewage	100	110
Other, industrial and hazardous	124	196
Total	224	306
Water treatment:		
Acid-mine drainage	87	85
Drinking water	868	861
Wastewater	566	517
Total	1,520	1,460
Other environmental	240	190
Total environmental	5,950	5,980
Refractories (dead-burned dolomite)	200 [7]	200 [7]
Grand total	19,200	19,500

[1]Includes Puerto Rico.

[2]Data are rounded to no more than three significant digits; may not add to totals shown. Excludes regenerated lime.

[3]The U.S. Geological Survey does not collect value data by end use; in previous years value data were estimated.

[4]Includes lime sold and used, where "used" denotes lime produced for internal company use for basic oxygen furnaces, magnesia, paper and pulp, precipitated calcium carbonate, refractories, and sugar refining.

[5]May include alkalis, calcium carbide and cyanamide, calcium hypochlorite, citric acid, food (animal or human), oil and grease, oil well drilling, petrochemicals, tanning, and other uses. Magnesia is included here to avoid disclosing proprietary data.

[6]Includes aluminum and bauxite, magnesium, metals concentration (copper and gold), and other nonferrous uses.

[7]Data are rounded to no more than one significant digit to avoid disclosing company proprietary data.

TABLE 4
HYDRATED LIME SOLD OR USED IN THE UNITED STATES, BY END USE[1, 2, 3]

(Thousand metric tons)

Use	2013 Quantity[4]	2014 Quantity[4]
Chemical and industrial	600	643
Construction:		
Asphalt	191	182
Building uses	238	256
Soil stabilization	412	465
Other construction	7	6
Total	848	909
Environmental:		
Flue gas treatment:		
Utility powerplants	227	269
Incinerators	30	31
Industrial boilers and other flue gas treatment	49	56
Total	305	356
Sludge treatment:		
Sewage	25	30
Other sludge treatment	54	69
Total	80	99
Water treatment:		
Acid-mine drainage	27	27
Drinking water	156	157
Wastewater	202	183
Total	386	367
Other environmental	52	52
Metallurgy	39	44
Grand total	2,310	2,470

[1]Includes Puerto Rico.
[2]Data are rounded to no more than three significant digits; may not add to totals shown. Excludes regenerated lime.
[3]The U.S. Geological Survey does not collect value data by end use; in previous years value data were estimated.
[4]Includes hydrated lime sold and used, where "used" denotes lime produced for internal company use in the building, chemical and industrial, and metallurgical sectors.

TABLE 5
LIME PRICES IN THE UNITED STATES, BY TYPE[1]

Type	2013[2]		2014[2]	
	Dollars per metric ton	Dollars per short ton	Dollars per metric ton	Dollars per short ton
Sold and used:				
Quicklime	117.80	106.80	119.10	108.00
Hydrate	140.60	127.50	142.20	129.00
Weighted average all types[3]	121.10	109.80	122.40	111.10
Sold:				
High-calcium quicklime	114.70	104.00	116.60	105.80
Dolomitic quicklime	126.30	114.50	128.60	116.60
Average quicklime	116.60	105.80	118.40	107.50
High-calcium hydrate	137.60	124.80	138.90	126.00
Dolomitic hydrate	164.20	148.90	168.50	152.80
Average hydrate	140.60	127.50	142.30	129.10
Weighted average all types[3]	120.10	109.00	121.90	110.60

[1]Average value per ton, free-on-board plant, including cost of containers.
[2]Unit values in metric and short tons were rounded independently.
[3]Includes dead-burned dolomite.

TABLE 6
U.S. EXPORTS OF LIME, BY TYPE[1]

(Metric tons and dollars)

Type and country	2013		2014	
	Quantity	Value[2]	Quantity	Value[2]
Calcined dolomite:				
Argentina	243	68,600	462	158,000
Brazil	4,510	1,360,000	1,840	628,000
Canada	51,500	9,610,000	60,700	12,400,000
Colombia	18	14,200	--	--
Germany	6,900	2,220,000	--	--
Japan	56	69,400	--	--
Mexico	374	116,000	356	113,000
Taiwan	38	41,500	19	21,200
United Arab Emirates	66	82,900	99	64,900
Venezuela	98	99,200	63	63,300
Other	254 r	97,000 r	205	58,000
Total	64,100	13,800,000	63,700	13,500,000
Hydraulic lime:				
Bahamas, The	108	37,200	22	7,020
Canada	5,780	1,340,000	6,260	1,420,000
Israel	9	10,200	31	107,000
Saudi Arabia	1	3,260	50	95,600
Other	75 r	29,400 r	35	149,000
Total	5,970	1,420,000	6,400	1,780,000
Quicklime:				
Canada	151,000	23,000,000	202,000	30,200,000
China	4	3,000	4	3,050
Costa Rica	497	201,000	221	45,400
Ecuador	15	30,200	11	23,500
Ireland	20	30,000	278	338,000
Mexico	8,620	1,140,000	7,700	1,030,000
Russia	10,300	1,900,000	3,600	2,090,000
Other	96 r	79,200 r	108	194,000
Total	170,000	26,400,000	214,000	33,900,000
Slaked lime, hydrate:				
Aruba	9	2,560	23	5,550
Bermuda	17	4,500	34	6,530
Canada	21,500	4,280,000	24,000	5,300,000
Costa Rica	232	96,200	452	188,000
Korea, Republic of	34	234,000	46	313,000
Nigeria	469	140,000	251	73,600
Oman	6,050	1,300,000	9,470	2,100,000
Venezuela	1,420	474,000	185	43,200
Other	251 r	97,800 r	473	197,000
Total	30,000	6,630,000	34,900	8,230,000
Grand total	270,000	48,200,000	319,000	57,500,000

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Free alongside ship valuation.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF LIME, BY TYPE[1]

(Metric tons and dollars)

	2013		2014	
Type and country	Quantity	Value[2]	Quantity	Value[2]
Calcined dolomite:				
Canada	21,400	4,750,000	22,300	7,720,000
Italy	133	106,000	151	139,000
Other	25	17,800	22,100	45,800
Total	21,500	4,880,000	44,600	7,900,000
Hydraulic lime:				
Canada	5	6,190	171	27,900
China	957	666,000	--	--
Dominican Republic	97	33,600	245	79,800
France	206	150,000	209	170,000
Italy	19	11,300	21	7,150
Other	17 r	6,520 r	1	6,780
Total	1,300	874,000	647	292,000
Quicklime:				
Canada	314,000	46,100,000	319,000	48,400,000
Dominican Republic	185	84,500	--	--
Mexico	3,090	594,000	1,450	285,000
Switzerland	100	47,500	16	7,100
United Kingdom	2	13,000	3	35,800
Other	340	337,000	330	373,000
Total	318,000	47,200,000	320,000	49,100,000
Slaked lime, hydrate:				
Belgium	551	296,000	324	171,000
Canada	36,400	7,430,000	33,700	6,890,000
France	43	72,500	46	76,900
Germany	38	126,000	22	116,000
Honduras	164	34,100	165	39,000
Italy	55	185,000	59	179,000
Japan	56	71,500	30	62,200
Mexico	15,000	2,620,000	13,900	2,640,000
Netherlands	384	195,000	307	157,000
United Kingdom	101	141,000	6	15,300
Other	3 r	13,500 r	125	49,900
Total	52,800	11,200,000	48,700	10,400,000
Grand total	394,000	64,100,000	414,000	67,700,000

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Cost, insurance, and freight valuation.

Source: U.S. Census Bureau.

TABLE 8
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	2010	2011	2012	2013	2014[e]
Australia, sales[e]	2,200	2,200	2,200	2,100	2,000
Austria	734	801	768 [r]	764 [r]	760
Belgium[4]	1,439 [r]	1,509 [r]	1,427 [r]	1,404 [r]	1,400
Bosnia and Herzegovina	339	489	398	387 [r]	410
Brazil	7,761	8,235	8,300	8,350	8,300
Bulgaria	1,309	1,495	1,425	1,400	1,500
Canada	1,863 [r]	1,937 [r]	1,965 [r]	1,856 [r]	1,945 [p, 5]
Chile[e]	890	860	970	950	900
China[e]	190,000	200,000	220,000	230,000	230,000
Croatia	330	271	207 [r]	185 [r]	205 [5]
Czech Republic[e]	1,000	1,000	1,000	1,000	1,000
Egypt[e]	800	800	800	800	790
Finland[e]	460	460 [r]	450 [r]	450 [r]	460
France	3,800	3,900	3,900	3,900	3,900
Germany	6,856	7,113	6,672	6,883 [r]	6,900
Hungary	260	250	230	249 [r]	272 [5]
India[e]	14,000	15,000	15,000	16,000	16,000
Iran[e]	2,700	2,800	2,800	2,800	2,800
Ireland[e]	220	300	300	300	310
Israel	658	715	770 [r]	300 [r]	310
Italy[e, 4]	5,800 [r]	5,800 [r]	5,800 [r]	3,640 [r]	3,600
Jamaica[e]	300	300	300	300	290
Japan, quicklime only	8,547	8,005	7,581	7,619 [r]	7,911 [5]
Kazakhstan	887 [r]	960 [r]	908 [r]	869 [r]	870
Korea, Republic of[e]	4,400 [r]	5,100 [r]	5,200 [r]	5,000 [r]	5,100
Malaysia, sales[e]	1,000	1,000	1,100	1,100	1,400
Peru[e]	220	220	220	230	240
Poland	1,799	2,036	1,779	1,665	1,700
Romania	1,703 [r]	1,679 [r]	1,708 [r]	1,698 [r]	1,700
Russia[e]	9,500 [5]	10,100 [5]	10,800 [r]	10,902	11,000
Serbia	239	274	239 [r]	279 [r, e]	320
Slovakia	986	971	903 [r]	813 [r]	820
Slovenia[e]	100 [r]	100 [r]	100 [r]	100 [r]	100
South Africa, burnt lime sales	1,292	1,539	1,209	1,187 [r]	1,200
Spain, sales[e]	1,900	1,900	1,800	1,900	1,900
Sweden[e]	700	700	700	700	700
Taiwan[6]	322 [r]	318 [r]	287 [r]	282 [r]	261 [3]
Thailand, sales[e]	800	800	800	800	800
Tunisia	343 [r]	282 [r]	340	293 [r]	300
Turkey, sales[e, 7]	4,300	4,300	4,500	4,500	4,400
Ukraine	4,220 [r]	4,487 [r]	4,415 [r]	3,892 [r]	3,700
United Arab Emirates[e]	170	340	400	450	430
United Kingdom[e]	1,500	1,500	1,500	1,500	1,500
United States, including Puerto Rico	18,300	19,100	18,800	19,200	19,500 [5]
Venezuela[e]	400	400	400	400	360
Vietnam[e]	1,454 [5]	850 [r]	850 [r]	850 [r]	850
Other[e, 8]	1,700 [r]	1,600 [r]	1,900 [r]	2,000 [r]	2,100
Grand total	310,000 [r]	320,000	340,000	350,000	360,000

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Totals (grand and "other") and estimated data are rounded to no more than two significant digits, except for U.S. production, which is rounded to no more than three significant digits. Data may not add to totals shown.

[2]Includes data available through October 29, 2015.

[3]In addition to the countries listed, Argentina, Chad, Iraq, Lebanon, Mexico, Nigeria, North Korea, Pakistan, Saudi Arabia, Syria, and several other nations produce lime, but output data are not reported; available general information is inadequate to formulate reliable estimates of output levels.

[4]Includes hydraulic lime.

[5]Reported figure.

TABLE 8—Continued
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

[6]Source: Taiwan Department of Statistics, Ministry of Economic Affairs.
[7]Production estimate based on sales only; data may be incomplete.
[8]Includes Algeria, Azerbaijan (construction only), Belarus, Congo (Kinshasa), Cuba, Cyprus (hydrated), Denmark (sales), Eritrea, Ethiopia, Guatemala, Jordan, Kenya, Kuwait, Kyrgyzstan, Libya, Macedonia, Malawi, Mauritius, Moldova, Mongolia, Montenegro, New Zealand (sales), Nicargua, Norway, Panama, Paraguay, Philippines, Portugal, Qatar, Senegal, Switzerland, Tanzania, Turkmenistan, Uganda, Uruguay, and Zambia.