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2017 Minerals Yearbook

ZEOLITES [ADVANCE RELEASE]

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Zeolites

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In 2017, natural zeolites were mined by six companies in the United States. Mine production increased by 10% to 82,400 metric tons (t) from 75,200 t in 2016, and sales increased by 14% to 81,300 t from 71,300 t. The major end uses for natural zeolites in 2017 were animal feed, odor control, and water purification, in decreasing order by tonnage; these three applications collectively accounted for nearly 75% of domestic sales. Imports and exports of natural zeolites (other than gem quality) were each estimated to be less than 1,000 t, and world production was estimated to be in the range of 1.0 to 1.3 million metric tons (Mt), all unchanged from those in 2016 (table 1).

Zeolites are a group of hydrated aluminosilicate minerals of the alkali and alkaline earth metals with a microporous crystalline structure. Approximately 50 naturally occurring zeolite minerals have been identified, but only a handful (chabazite, clinoptilolite, erionite, mordenite, and phillipsite) have commercial applications and are abundant in nature. Zeolites are valuable for a variety of absorption, filtering, and ion exchange applications because they contain loosely bound cations within their crystal lattice that can be exchanged by other cations or by molecular water. Each zeolite mineral has a unique crystal structure that imparts distinct physical and chemical characteristics. Zeolite deposits in the United States were primarily formed by the alteration of volcanic tuffs in alkaline lake deposits, open hydrologic systems, and hydrothermal environments. They predominantly occur in Arizona, California, Idaho, Nevada, New Mexico, Oregon, Texas, and Wyoming (Eyde and Holmes, 2006, p. 1039–1048).

Sustained mining of natural zeolites in the United States did not begin until the early 1970s. Prior to the 1950s, natural zeolites were considered to be mineralogical curiosities that filled vugs and fractures in igneous rocks. Large deposits of zeolite-rich volcanic tuffs were discovered in the Western United States during the late 1950s, and many large mining and petroleum companies conducted exploration programs between 1950 and the mid-1980s. Although these programs uncovered additional resources, markets for natural zeolites did not develop as anticipated, and only a few hundred metric tons of zeolites were mined annually through the mid-1970s. By the mid-1980s, most of the major companies had withdrawn from the industry owing to low annual production and sales. Small-scale mining companies then stepped in and gradually developed the natural zeolites market into the small yet sustainable industry that exists today. Domestic production and sales have steadily increased since the early 1990s, although production significantly declined for a few years after 1994 owing to an imbalance between production and market demand. In 2017, mine production of natural zeolites was double that in 2000 (fig. 1).

End uses for naturally occurring zeolite minerals have changed considerably since the 1970s. Zeolites were initially treated as bulk commodities, with producers seeking large-volume markets. Pet litter applications became the mainstay of the industry, representing more than 50% of annual sales in the mid-1980s. However, producers recognized that low-value bulk sales of zeolites could not sustain the industry and began developing value-added applications. Pet litter currently commands a far smaller share of the overall market, and use in other applications such as animal feed, fertilizer carrier, oil and gas absorbent, odor control, synthetic turf, traction control (ice melt), wastewater treatment, and water purification has increased.

Synthetic zeolites are manufactured by chemical processes and exhibit more uniform chemical composition, crystal lattice structure, and pore size than natural zeolites. Whereas natural zeolites have fixed properties, synthetic zeolites can be engineered to satisfy exact specifications for a particular application. Consequently, natural zeolites cost significantly less than their synthetic counterparts but are not suitable for certain commercial end uses. Synthetic zeolites are primarily used as water softening agents in detergents and catalysts in petroleum refining. Synthetic zeolites dominate the global zeolite market; the worldwide value of synthetic zeolite sales totals tens of billions of dollars, whereas the value of natural zeolite sales is probably on the order of tens of millions of dollars.

Production

Domestic data for natural zeolites in 2017 were collected by means of a voluntary canvass of the U.S. mining industry. Survey forms were sent to seven companies, and responses or estimated data were received from all.

Nine natural zeolite mines operated by six companies were active in 2017, and two mines operated by one additional company were idle. The Owyhee Mining Co. (Medford, OR) received a mining permit in 2015 for a site near Rome, OR (Bend Bulletin, The, 2015) but had not reached the commercial production stage by yearend 2017. Chabazite was mined in Arizona, and clinoptilolite was mined in California, Idaho, New Mexico, Oregon, and Texas (table 2). Domestic mine production of natural zeolites increased by 10% to 82,400 t from 75,200 t in 2016 (table 1). Most of the tonnage consisted of clinoptilolite, and the remainder was mostly chabazite, with minor quantities of ferrierrite, mordenite, and phillipsite (Eyde, 2018). New Mexico was the leading producer of natural zeolites in 2017, followed by California, Idaho, Texas, Oregon, and Arizona, in descending order of production.

In 2017, KMI Zeolite Inc. (Amargosa Valley, NV) dismantled the processing plant that it had acquired from St. Cloud Mining Co. (Winston, NM) in 2016 and finished construction of a new facility capable of producing more than 35,000 metric tons per year (t/yr) of granular or powdered clinoptilolite, a tenfold increase in comparison with the former plant. The company planned to further expand its production

capacity in February 2018 (Conrad K. Wagenaar, President, KMI Zeolite Inc., written commun., October 31, 2017).

In April 2017, Kirkland Mining Co. (Skull Valley, AZ) began the permitting process for a mine in central Arizona. The deposit contains a low concentration of zeolites and consists of ash that would be used as a pozzolanic material in the concrete industry. Kirkland expected to produce a maximum of 500,000 t/yr of pozzolan once the mine was fully operational, but the average zeolite content of that output was unknown (Eyde, 2018; Kirkland Mining Co., undated).

Consumption

In 2017, sales of natural zeolites increased by 14% to 81,300 t compared with 71,300 t in 2016 (table 1). Domestic uses for natural zeolites were, in decreasing order by quantity, animal feed, odor control, water purification, oil and grease absorbent, unclassified end uses, fertilizer carrier, gas absorbent (and air filtration), pet litter, desiccant, wastewater treatment, soil amendment, traction control (ice melt), synthetic turf, aquaculture, and fungicide or pesticide carrier. Animal feed, odor control, and water purification collectively accounted for nearly 75% of the domestic sales tonnage. Data for individual markets were withheld to avoid disclosing company proprietary data.

Total sales of natural zeolites rose in 2017 primarily owing to higher sales for animal feed (19% increase), fertilizer carrier (more-than-threefold increase), and odor control (30% increase) relative to those in 2016. The rise in sales of animal feed corresponded with an increase of 6% in domestic consumption of energy feeds (primarily corn) during the fiscal year from September 2016 through August 2017 in comparison with that during the prior fiscal year (U.S. Department of Agriculture, 2018). Among the specified end uses, sales of natural zeolites also increased for aquaculture, desiccant, gas absorbent, oil and grease absorbent, and pet litter. Sales of natural zeolites for fungicide or pesticide carrier, water purification, and wastewater treatment all decreased. Comprehensive information regarding the sales trends for soil amendment, synthetic turf, and traction control was not available. Outside of the United States, natural zeolites were primarily used in cement pozzolans and other construction materials, filtration, odor control, and soil amendments (Eyde, 2018).

Prices

Prices for natural zeolites vary with the percentage of zeolites present in the product, the chemical and physical properties of the zeolite mineral(s), particle size, surface modification and (or) activation, and end use. In 2017, unit values (free on board, mine or plant) obtained through the U.S. Geological Survey canvass of domestic zeolite producers ranged from an estimated $100 to $300 per metric ton. The average estimated unit value was roughly $140 per metric ton, unchanged from that in 2016.

Foreign Trade

Comprehensive trade data were not available for natural zeolites because they were included under the generic U.S. Census Bureau Harmonized Tariff Schedule code 2530.90.8050 (mineral substances not elsewhere specified or included). Some zeolites may have also been classified as part of an ion-absorption unit or labeled as ion-exchange media rather than as zeolite. Imports and exports of natural zeolites (other than gem-quality specimens) in 2017 were estimated to be less than 1,000 t each, unchanged from those in 2016. Nearly all of the U.S. zeolite trade was in synthetic zeolite products.

World Review

Countries that mine large tonnages of zeolites typically use them in low-value, high-volume construction applications, such as dimension stone, lightweight aggregate, and pozzolanic cement. A significant percentage of the material sold in some countries also likely consists of ground or sawn volcanic tuff that contains only a small proportion of zeolite minerals. As a result, production data for some countries may not accurately indicate the quantities of natural zeolites used in the high-value applications that are reflected in the domestic production data. In addition, most countries either do not report production of natural zeolites or report output with a 2- to 3-year lag time. Therefore, data in this section were estimated except where otherwise noted.

World production of natural zeolites in 2017 was estimated to be between 1.0 and 1.3 Mt, unchanged from that in 2016. China was the leading producer of natural zeolites, with production estimated to be in the range of 200,000 to 300,000 t (including crude ore). The second-ranked producer was the Republic of Korea with 120,000 t, followed by New Zealand with 100,000 t (reported), the United States with 82,400 t (reported), Turkey with 70,000 t, Cuba with 56,500 t (reported), Jordan with 20,000 t (crude zeolitic tuff), and Mexico with 2,200 t. In 2016, the leading producer countries were China, with an estimated range of 200,000 to 300,000 t (including crude ore); the Republic of Korea with 122,000 t (reported); New Zealand with 80,000 t (reported); the United States with 75,200 t (reported); Turkey with 71,600 t (reported); Cuba with 52,800 t (reported); Jordan with 21,800 t (reported, crude zeolitic tuff); and Mexico with 2,150 t (reported). Countries thought to produce natural zeolites but for which insufficient data were available to make reliable production estimates included Argentina, Armenia, Australia, Bulgaria, Canada, Georgia, Germany, Greece, Hungary, Indonesia, Iran, Italy, Japan, the Philippines, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, and Ukraine.

Outlook

Historical trends and a significant capacity expansion at one major U.S. operation in 2017 suggest that domestic production of natural zeolites will increase in 2018. In the United States, a significant portion of natural zeolite sales are linked to livestock industries; zeolites are used in animal stalls to control odors and as an additive in animal feed to enhance nutrient uptake and reduce digestive issues. Globally, natural zeolite sales are partially linked to the construction industry, where zeolites and (or) zeolitic tuffs are sold as dimension stone, lightweight aggregate, and pozzolanic cement. Economic trends in these industries are expected to continue to influence production and sales of natural zeolites in the coming years.

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TABLE 1
SALIENT NATURAL ZEOLITE STATISTICS[1]

		2013	2014	2015	2016	2017
United States:						
Production	metric tons	69,500	62,800	75,100	75,200 [r]	82,400
Sales	do.	68,300	62,500	73,200	71,300 [r]	81,300
Exports[e]	do.	<1,000	<1,000	<1,000	<1,000	<1,000
Imports[e]	do.	<1,000	<1,000	<1,000	<1,000	<1,000
World production[e]	million metric tons	1.0–1.6	1.0–1.3	1.0–1.3	1.0–1.3	1.0–1.3

[e]Estimated. [r]Revised. do. Ditto.

[1]Table includes data available through February 25, 2019. Data are rounded to no more than three significant digits.

TABLE 2
DOMESTIC NATURAL ZEOLITE PRODUCERS, BY TYPE, IN 2017[1]

State and company	Type of zeolite
Arizona:	
St. Cloud Mining Co.	Chabazite.
UOP LLC	Do.
California:	
KMI Zeolite Inc.	Clinoptilolite.
St. Cloud Mining Co.	Do.
Idaho, Bear River Zeolite Co., Inc.	Do.
New Mexico, St. Cloud Mining Co.	Do.
Oregon, Teague Mineral Products	Do.
Texas, Zeotech Corp.	Do.

Do. Ditto.

[1]Table includes data available through February 25, 2019.

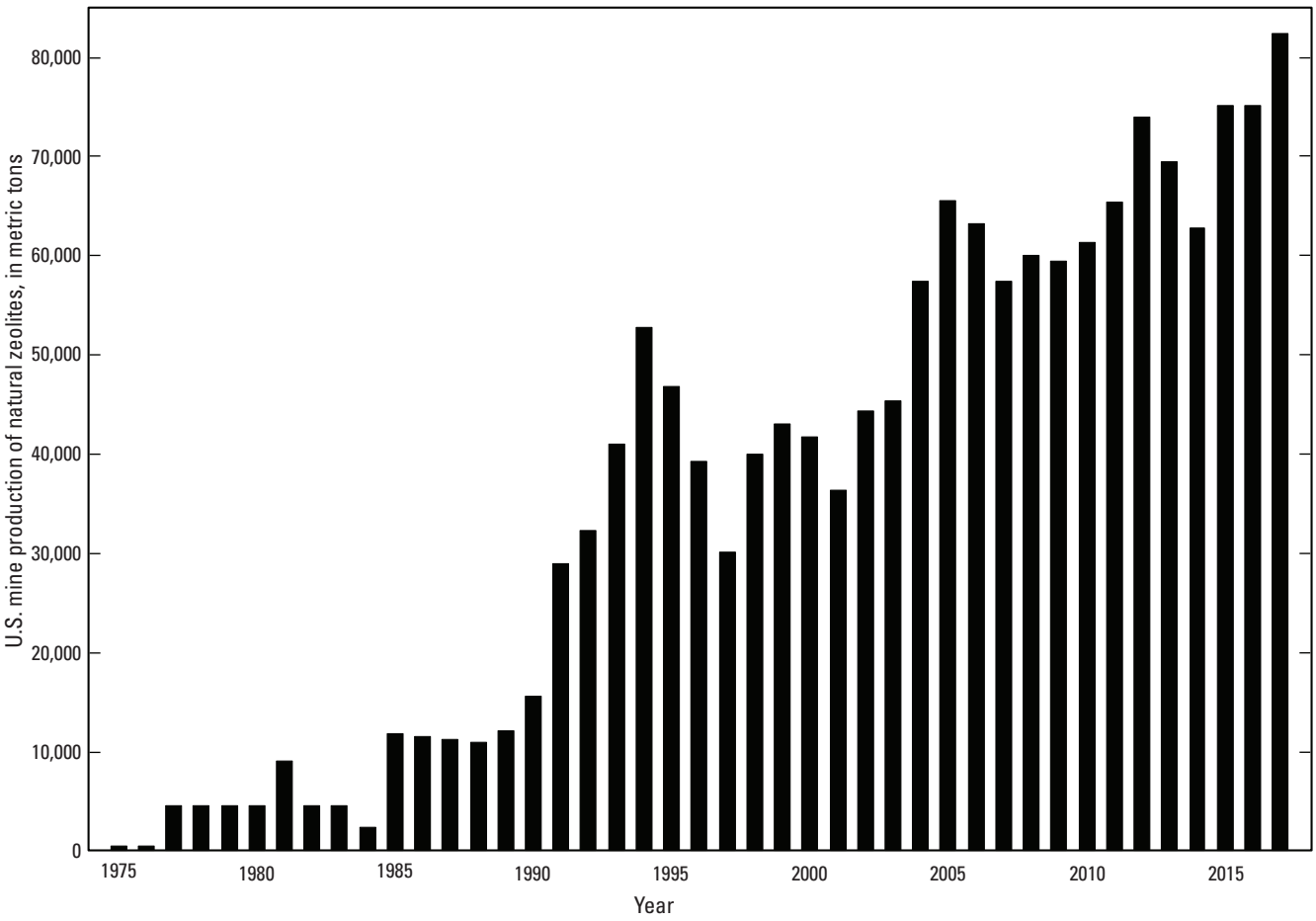

Figure 1. Mine production of natural zeolites in the United States, 1975 through 2017. Production was estimated based on historical data for some years prior to 1988.