



2016 Minerals Yearbook

ZEOLITES [ADVANCE RELEASE]

ZEOLITES

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In 2016, natural zeolites were mined by at least seven companies in the United States. Mine production declined slightly to 73,400 metric tons (t) from 75,100 t in 2015, and sales decreased by 5% to 69,500 t from 73,200 t. The major end uses for natural zeolites during 2016 were animal feed, water purification, and odor control, 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 revised estimates for 2015 (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 (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 animal feed, gas absorbent, odor control, wastewater treatment, and water purification applications have 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. An estimated 80% and 15% of the synthetic zeolites sold annually are for use as water softening agents in detergents and catalysts in petroleum refining, respectively (Roskill Information Services Ltd., 2003, p. 100). Synthetic zeolites dominate the global zeolites market; the worldwide value of synthetic zeolite sales is thought to total 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 were collected by means of a voluntary survey of the U.S. mining industry. Survey forms were sent to 13 operations; responses were received from 10, and the remaining 3 operations were idle in 2016. Reported data accounted for 100% of the total domestic production and sales listed in table 1.

At least seven companies mined natural zeolites in the United States during 2016. The Owyhee Mining Co. (Medford, OR) might also have produced natural zeolites after receiving a mining permit in 2015 for a site near Rome, OR (Bend Bulletin, The, 2015), and the Daleco Resources Corp. (West Chester, PA), which had been developing a zeolite deposit near Marfa, TX, appeared to have halted operations. Specific information on the status of these projects was not available. Chabazite was mined in Arizona, and clinoptilolite was mined in California, Idaho, New Mexico, Oregon, and Texas (table 2). Domestic mine production of zeolites decreased slightly to 73,400 t from 75,100 t in 2015. Most of the tonnage consisted of clinoptilolite, and the remainder was mostly chabazite, with minor quantities of ferrierrite, mordenite, and phillipsite (Eyde, 2016). New Mexico was the leading producer of natural zeolites in 2016, followed by California, Idaho, Texas, Oregon, and Arizona.

In 2016, KMI Zeolite Inc. (Amargosa Valley, NV) acquired St. Cloud Mining Co.'s (Winston, NM) zeolite processing plant in Amargosa Valley, NV. KMI dismantled the existing plant and constructed a new facility capable of producing more than

40,000 metric tons per year (t/yr) of granular or powdered clinoptilolite. The company started processing all ore from its Death Valley, CA, mine at the new plant by yearend 2016 and was reclaiming its former Sandy Valley, NV, property (Conrad K. Wagenaar, President, KMI Zeolite Inc., written commun., October 19, 2016).

The Wyoming State Geological Survey released a report concluding that Wyoming contains minable resources of natural zeolites. The agency confirmed previously explored occurrences, identified additional deposits, and published geologic descriptions and geochemical data for the studied outcrops (Wyoming State Geological Survey, 2016).

Consumption

In 2016, sales of natural zeolites decreased by 5% to 69,500 t compared with 73,200 t in 2015. Domestic uses for natural zeolites were, in decreasing order by quantity, animal feed, water purification, odor control, unclassified end uses, oil and grease absorbent, fungicide or pesticide carrier, pet litter, wastewater treatment, gas absorbent (and air filtration), fertilizer carrier, soil amendment, aquaculture, and desiccant. In contrast to 2015, no sales were reported for miscellaneous sorbent or synthetic turf; however, these applications were likely included in the unclassified end uses. At least one U.S. company shipped zeolite for the treatment of radioactive effluent at nuclear powerplants around the world (Eyde, 2016). Animal feed, water purification, and odor control collectively accounted for nearly 75% of the domestic sales tonnage. Data for individual markets were withheld to avoid disclosing company proprietary data.

Sales of natural zeolites fell in 2016 primarily owing to lower sales for animal feed (6% decrease) and water purification applications (11% decrease) relative to those in 2015. The decline in sales for animal feed corresponded with a decrease of 3% in domestic consumption of energy feeds (primarily corn) during the fiscal year from September 2015 to August 2016 in comparison with that during the prior fiscal year (U.S. Department of Agriculture, 2017). Among the specified end uses, sales of natural zeolites also fell for gas absorbent, pet litter, and wastewater treatment. Information regarding the sales trend for miscellaneous sorbent and synthetic turf was not available, and sales for all other uses increased. The greatest increase in sales tonnage was for oil and grease absorbent, followed by odor control and fungicide or pesticide carrier, and the greatest decrease in sales tonnage was for animal feed, followed by water purification and gas absorbent. Outside of the United States, natural zeolites were primarily used in cement pozzolans and other construction materials, filtration, odor control, and soil amendments (Eyde, 2016).

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 2016, unit values (free on board, mine or plant) obtained through the U.S. Geological Survey canvass of domestic zeolite producers ranged from about \$100 to \$400 per metric ton, with unit values for most

operations ranging from \$100 to \$200 per metric ton. The average unit value was roughly \$140 per metric ton, down from \$150 per metric ton in 2015.

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. On the basis of information provided by representatives of domestic companies, imports and exports of natural zeolites (other than gem-quality specimens) in 2016 were estimated to be less than 1,000 t each, unchanged from those in 2015 (revised estimates). 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 2016 was estimated to be between 1.0 and 1.3 Mt, unchanged from that in 2015. Global output from 2012 through 2015 was revised significantly downward owing to reported data for 2011 and 2014 production in China (891,000 t of crude zeolite ore in 2011 and 306,400 t in 2014 compared with the previous estimates of 1.8 to 2.2 Mt) (Ministry of Land and Resources P.R.C., 2013, p. 937; 2016, p. 65). In 2016, China was the leading producer of natural zeolites, with production estimated to be in the range of 200,000 to 500,000 t (including zeolitic tuffs for construction applications). The second-ranked producer was the Republic of Korea with 191,000 t, followed by New Zealand with 80,000 t, the United States with 73,400 t (reported), Turkey with 55,000 t, Cuba with 51,000 t, Jordan with 13,000 t (zeolite tuff), Mexico with 2,300 t, and Indonesia with 1,500 t. 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, Iran, Italy, Japan, the Philippines, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, and Ukraine.

In April, Blue Pacific Minerals Ltd. (New Zealand), the only producer of natural zeolites in New Zealand, completed construction of a processing plant with production capacity of more than 100,000 t/yr (Voxy, 2016). In July, Canadian Zeolite Corp. (Canada) began to process and sell zeolites from a deposit

in British Columbia. The company's mining permit allowed for the extraction of 50,000 t/yr and expansion of the pit as needed (Canadian Zeolite Corp., 2016a, b).

Outlook

Historical trends suggest that production of natural zeolites in the United States will remain steady or increase slightly in 2017. The U.S. Department of Agriculture projected that the number of grain-consuming animal units in the fiscal year from September 2016 to August 2017 would be essentially unchanged from that in the prior fiscal year, suggesting that U.S. sales of animal feed, the leading end use for natural zeolites, may be essentially unchanged in 2017 (Capehart and Liefert, 2016, p. 2). Globally, a significant portion of natural zeolite sales are linked to the construction industry, where zeolites and (or) zeolitic tuffs are sold as dimension stone, lightweight aggregate, and pozzolanic cement. World production of natural zeolites may increase slightly in 2017 if the global economy grows at a slightly higher rate of 3.4% in 2017 compared with 3.1% in 2016, as predicted by the International Monetary Fund (2017).

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GENERAL SOURCES OF INFORMATION

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TABLE 1
SALIENT ZEOLITE STATISTICS¹

		2012	2013	2014	2015	2016
United States:						
Production	metric tons	74,000	69,500	62,800	75,100	73,400
Sales	do.	70,500	68,300	62,500	73,200	69,500
Exports ^e	do.	<1,000 ^r	<1,000 ^r	<1,000 ^r	<1,000 ^r	<1,000
Imports ^e	do.	<1,000 ^r	<1,000 ^r	<1,000 ^r	<1,000 ^r	<1,000
World production ²	million metric tons	1.1–1.7 ^{r, e}	1.0–1.6 ^{r, e}	1.0–1.3 ^r	1.0–1.3 ^{r, e}	1.0–1.3 ^e

^eEstimated. ^rRevised. do. Ditto.

¹Data are rounded to no more than three significant digits.

²World production for the years prior to 2016 was revised significantly downward owing to new reported data for 2011 and 2014 production in China.

TABLE 2
DOMESTIC ZEOLITE PRODUCERS, BY TYPE, IN 2016

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.
Steelhead Specialty Minerals, Inc.	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.	

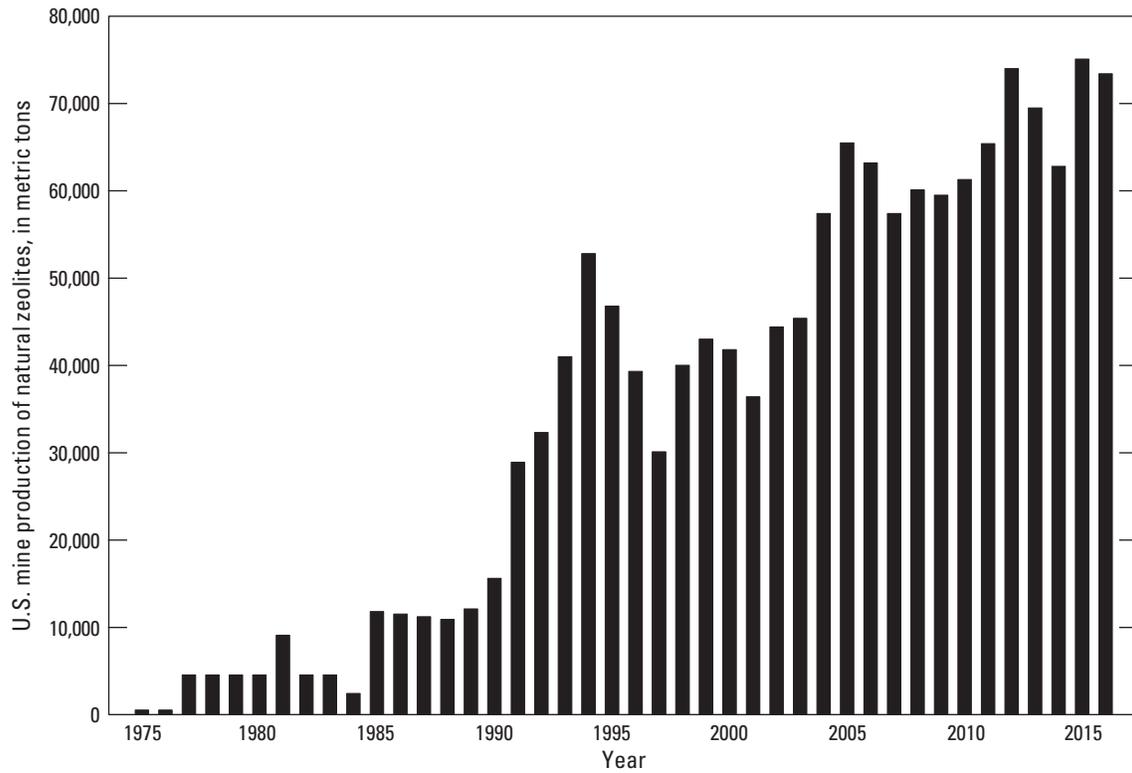


Figure 1. Mine production of natural zeolites in the United States, 1975 through 2016. Production was estimated based on historical data for some years prior to 1988.