



# 2015 Minerals Yearbook

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## ZEOLITES [ADVANCE RELEASE]

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# ZEOLITES

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**Domestic survey data and tables were prepared by Molly L. Reid, statistical assistant.**

In 2015, natural zeolites were mined by seven companies in the United States. Mine production increased by 20% to 75,100 metric tons (t) from 62,800 t (revised) in 2014, and sales increased by 17% to 73,200 t from 62,500 t (revised). The major end uses for natural zeolites during 2015 were animal feed, water purification, and odor control, in decreasing order by tonnage; these three applications collectively accounted for more than 70% of domestic consumption. Exports of natural zeolites (other than gem quality) were estimated to be between 100 and 300 t, and imports were thought to be less than 50 t. World production was estimated to be in the range of 2.7 to 3.2 million metric tons (Mt) (table 1).

Zeolites are a group of hydrated aluminosilicate minerals of the alkali and alkaline earth metals with a microporous crystalline structure. As of 2006, nearly 50 natural zeolite minerals had been identified, but only a handful (chabazite, clinoptilolite, erionite, mordenite, and phillipsite) have current commercial applications and are abundant in nature. Zeolites are valuable for a variety of absorption, filtering, ion exchange, and molecular sieving 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 and open hydrologic systems. 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 slowly developed the natural zeolite market into the small yet sustainable industry that exists today. Domestic production and sales have steadily increased since the 1970s, although production experienced a significant decline for a few years after 1994 owing to an imbalance between production and market demand (fig. 1).

Zeolite markets 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 growth has taken place in animal feed, gas absorbent, odor control, wastewater treatment, and water purification applications.

## 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 mines and mills, and responses were received from 10. The remaining three operations were idle in 2015. Reported data accounted for 100% of the total domestic production and sales listed in table 1.

Seven companies mined natural zeolites in the United States during 2015, and one company was idle. Chabazite was mined in Arizona, and clinoptilolite was mined in California, Idaho, New Mexico, Oregon, and Texas (table 2). Domestic production of zeolites increased to 75,100 t compared with 62,800 t (revised) in 2014. By tonnage, New Mexico was the leading producer of natural zeolites in 2015, followed by Idaho, Texas, California, Arizona, and Oregon.

Following a 6-year permitting process, the Owyhee Mining Co. received approval in 2015 to mine all minerals at its operation in southeastern Oregon, allowing for the removal of overburden covering the zeolite deposit. The 235-hectare site, located 56 kilometers west of Jordan Valley, OR, contained an estimated 45 Mt of zeolite (Bend Bulletin, The, 2015). In addition, the Bear River Zeolite Co. acquired an additional 243 hectares at its mine in southeastern Idaho and initiated the permitting process for expanding the mining pit. The company was targeting applications in the oil and gas industry as end uses for the expected increase in zeolite production (U.S. Antimony Corp., 2015).

Conventional open pit mining techniques are used to mine natural zeolites. The overburden is removed to allow access to the ore, and the ore may then be blasted or stripped for processing by using front-end loaders or tractors equipped with ripper blades. In processing, the ore is crushed, dried, and milled. The milled ore may be air-classified based on particle size and shipped in bags or bulk. The crushed product may be screened to remove fine material when a granular product is required, and some pelletized products are produced from fine material. Producers also may modify the properties of the zeolite or blend their zeolite products with other materials before sale to enhance their performance (Eyde and Holmes, 2006, p. 1052–1053).

## Consumption

Sales of natural zeolites increased to 73,200 t compared with 62,500 t (revised) in 2014. Domestic uses for natural zeolites in 2015 were, in decreasing order by tonnage, animal feed, water purification, odor control, unclassified end uses, pet litter, fungicide or pesticide carrier, wastewater treatment, gas absorbent (and air filtration), oil and grease absorbent, fertilizer carrier, synthetic turf, soil amendment, and desiccant. In contrast to 2014, no sales were reported for aquaculture, catalysts, or cement. Animal feed, water purification, and odor control accounted for 70% of the domestic sales tonnage. Data for individual applications were withheld to avoid disclosing company proprietary data.

Among the specified end uses, sales of natural zeolites increased for animal feed, fungicide or pesticide carrier, odor control, oil and grease absorbent, and water purification in 2015. Information regarding the sales trend for synthetic turf was not available, and sales for all other applications decreased. Water purification saw the greatest sales tonnage increase, followed by odor control and fungicide or pesticide carrier, and the greatest decreases in sales tonnage were for wastewater treatment, gas absorbent, and pet litter.

Outside of the United States, natural zeolites are primarily used in construction materials and cement pozzolans. Other major global end uses are agricultural soil amendments, odor control, and filtration applications (Eyde, 2015).

## Prices

Prices for natural zeolites vary with the percentage of zeolite 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 2015, unit values obtained through the U.S. Geological Survey canvass of domestic zeolite producers ranged from \$110 to \$950 per metric ton, with unit values for most operations ranging from \$110 to \$220 per metric ton. The average unit value was approximately \$150 per metric ton.

## Foreign Trade

Comprehensive trade data were not available for natural zeolites because they are 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. Exports of natural zeolites (other than gem-quality specimens) in 2015 were estimated to be between 100 and 300 t, unchanged from the prior year (revised estimates). About 40 t of these exports were documented in a commercial trade database, with all shipments going to Denmark (IHS Inc., 2016). About 37 t of imports originating from Turkey were documented (IHS Inc., 2016), and total imports were thought to be less than 50 t, up from less than 25 t in 2014. Nearly all (an estimated 95%) of the U.S. zeolite trade was in synthetic zeolite products.

## World Review

Most countries either do not report production of natural zeolites or production is reported with a 2- to 3-year lag time. Therefore, data in this section are estimated unless otherwise noted.

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 as zeolites in some countries also likely consists of ground or sawn volcanic tuff that contains only a small amount of zeolite minerals. As a result, production data for some countries do not accurately indicate the quantities of natural zeolites used in the high-value applications that are reflected in the domestic production data.

World production of natural zeolites remained in the range of 2.7 to 3.2 Mt in 2015. Global production was thought to be similar to that of 2014 owing to continued economic uncertainties in countries where natural zeolites were sold in large volumes for construction uses. China was the leading producer of natural zeolites in 2015, with production likely in the range of 1.8 to 2.2 Mt (including zeolitic tuffs for construction applications). The second-leading producer was the Republic of Korea with 205,000 t; followed by the United States with 75,100 t (reported); Turkey with 70,000 t; New Zealand with 65,000 t (reported); Cuba with 43,000 t; Jordan with 13,000 t (zeolite tuff); Mexico with 2,000 to 2,500 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.

Blue Pacific Minerals Ltd. of New Zealand began construction of a new zeolite processing plant in 2015. The company expected to double its production and process more than 100,000 metric tons per year (t/yr) as a result of the expansion (Gyekye, 2015). In addition, Canadian Mining Company Inc. received a 5-year permit to mine 50,000 t/yr of zeolites at its Bromley Creek Mine near Princeton, British Columbia, beginning in July 2015 (Canadian Mining Company Inc., 2015).

## Outlook

Historical trends suggest that production and consumption of natural zeolites in the United States will remain unchanged or increase slightly in 2016. Globally, a significant portion of natural zeolite sales are linked to construction, where zeolites and (or) zeolitic tuffs are sold as dimension stone, lightweight aggregate, and pozzolanic cement. World production and consumption of natural zeolites are also likely to remain essentially unchanged in 2016 if many countries continue to face economic uncertainties that could negatively impact construction activities (International Monetary Fund, 2016).

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## GENERAL SOURCES OF INFORMATION

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TABLE 1  
SALIENT ZEOLITE STATISTICS<sup>1</sup>

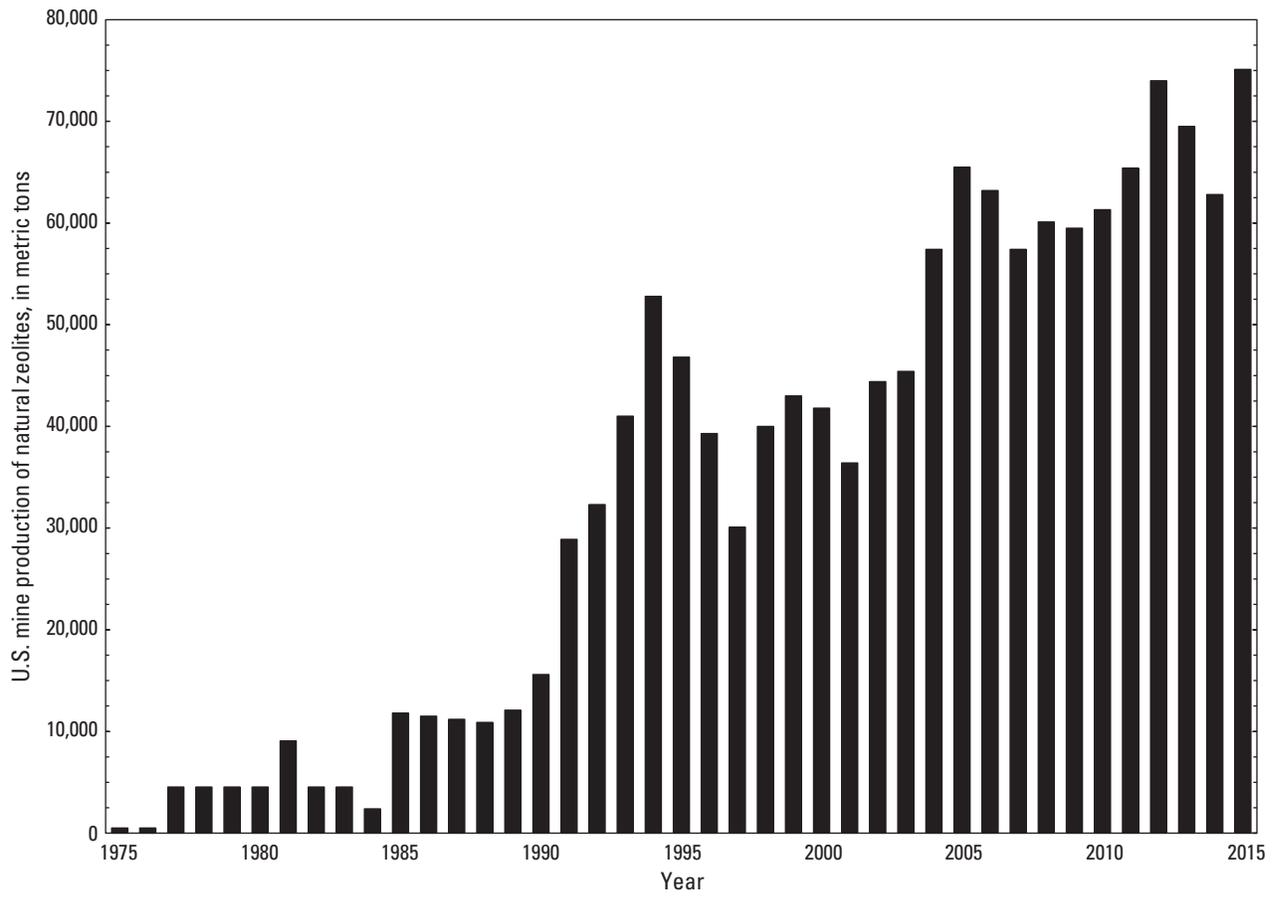
		2011	2012	2013	2014	2015
United States:						
Production	metric tons	65,400	74,000	69,500	62,800 <sup>r</sup>	75,100
Sales	do.	65,200	70,500	68,300	62,500 <sup>r</sup>	73,200
Exports <sup>e</sup>	do.	700–1,500	500–1,000	100–300	100–300 <sup>r</sup>	100–300
Imports <sup>e</sup>	do.	<150	<5	<5	<25	<50
World production <sup>e</sup>	million metric tons	2.8–3.3	2.7–3.2	2.7–3.2	2.7–3.2	2.7–3.2

<sup>e</sup>Estimated. <sup>r</sup>Revised. do. Ditto.

<sup>1</sup>Data are rounded to no more than three significant digits.

TABLE 2  
DOMESTIC ZEOLITE PRODUCERS, BY TYPE, IN 2015

State and company	Type of zeolite
Arizona:	
St. Cloud Mining, Inc.	Chabazite.
UOP LLC	Do.
California:	
KMI Zeolite Inc.	Clinoptilolite.
St. Cloud Mining, Inc.	Do.
Steelhead Specialty Minerals, Inc.	Do.
Idaho, Bear River Zeolite Co., Inc.	Do.
New Mexico, St. Cloud Mining, Inc.	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 2015. Production was estimated based on historical data for some years prior to 1988.