



2006 Minerals Yearbook

ZEOLITES

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Domestic survey data and table were prepared by Maria Arguelles, statistical assistant.

In 2006, natural zeolites were mined by eight companies in the United States with three other companies working from stockpiled materials. Mine production was 63,200 metric tons (t), and U.S. consumption was 55,800 t. The major markets were in animal feed, pet litter, and water purification. These applications accounted for nearly 70% of domestic consumption. Exports were estimated to be between 500 and 1,500 t, and imports of natural zeolite (other than gem-quality) were estimated to be less than 250 t. World production was estimated to be in the range of 2.5 million to 3 million metric tons (Mt).

Commercial zeolite deposits in the United States are associated with the alteration of volcanic tuffs in alkaline lake deposits and open hydrologic systems. These deposits are in Arizona, California, Idaho, Nevada, New Mexico, Oregon, Texas, Utah, and Wyoming. Zeolites in these deposits are chabazite, clinoptilolite, erionite, mordenite, and phillipsite. Other components, such as orthoclase and plagioclase feldspars, montmorillonite, opal, quartz, and volcanic glass, are present in some deposits.

Production

Domestic data for natural zeolites were collected by means of a voluntary survey of the domestic mining industry. Survey forms were sent to 11 companies, and 7 responded. Responses accounted for 98% of the production and end-use data.

Conventional open pit mining techniques are used to mine natural zeolites. The overburden is removed to allow access to the ore. The ore may 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.

Eight companies mined natural zeolites in the United States in 2006. Three other companies did not mine zeolites during the year but sold from stocks or purchased zeolites from other producers for resale (table 1). Chabazite was mined in Arizona, and clinoptilolite was mined and processed in California, Idaho, Nevada, New Mexico, Oregon, Texas, and Wyoming. New Mexico was the leading producer State. Domestic production of zeolites was 63,200 t compared with an estimated 65,500 t of production in 2005.

Daleco Resources Corporation, through its subsidiary Clean Age Minerals Inc., (CAMI) West Chester, PA, and Zinkan Enterprises Inc., Twinsburg, OH, entered into a preliminary

joint venture called ZeoCast Joint Venture, LLC. As part of the venture, CAMI will develop its zeolite deposit near Marfa, TX, to produce a product called ZeoCast, a pozzolan additive for concrete. Zinkan will fund the development of the mine and expansion of the milling facility and provide transportation and marketing assistance (Daleco Resources Corporation, 2006).

Bear River Zeolite Co. (BRZ) (a subsidiary of United States Antimony Corporation, Thompson Falls, MT) began the permitting process to install a fine grinding circuit in its mill in southeastern Idaho and expand storage capacity. The company needed additional capacity to meet demand for finely ground zeolite for animal feed, concrete additive, environmental remediation, and waste water treatment (Industrial Minerals, 2006b). BRZ also commissioned Utah Power to install power lines required to eliminate the use of a fuel-expensive power generator system at the mill (Industrial Minerals, 2006a). Sales revenue in the third quarter of 2006 increased compared with that of the same period in 2005 for BRZ, but high fuel costs for the power generator and lack of a fine grinding mill affected profits. Zeolite prices for BRZ increased to \$148 per metric ton in the third quarter of 2006 compared with \$89 per ton in the third quarter of 2005 (United States Antimony Corporation, 2006).

Consumption

Approximately 55,800 t of natural zeolite was sold in 2006 in the United States compared with an estimated 58,000 t in 2005. Domestic uses for natural zeolite were, in decreasing order by tonnage, animal feed, pet litter, water purification, odor control, horticultural applications (soil conditioners and growth media), oil absorbent, fungicide or pesticide carrier, gas absorbent, wastewater cleanup, desiccant, and aquaculture. Animal feed, pet litter, and water purification applications accounted for nearly 70% of the domestic sales tonnage. Sales in all except two end-use categories increased. The largest increases in tonnage sales were for animal feed applications, and the largest declines in tonnage sales were for fungicide and pesticide carrier, pet litter, and water purification applications.

The conference Zeolite '06, held in Socorro, NM, highlighted new uses being investigated for natural zeolites. The discussions ranged from modeling of the crystalline structure of zeolite minerals to application-oriented work. The conference talks covered a range of topics including deposit formation, theoretical modeling of zeolite structures during adsorption of exchange cations, thermodynamics of ion exchange, radiation and thermal effects on the zeolite structure, environmental applications of zeolites, use of natural zeolites in agriculture, and innovative industrial systems that use zeolites. Surfactant-modified zeolites were shown to be a possible solution to the removal of microbial contamination in groundwater, making it

potable. A system for removing pollutants from storm water in densely populated areas was discussed. The zeolite-base system removed polycyclic aromatic hydrocarbons, mineral oils, and heavy metals. Another sector of interest considering the current issues of petroleum resources was the potential for natural zeolites to pretreat oil sands in Canada. Currently, the bitumen is separated from the sand by flotation. Because it is so viscous, it must be thinned with toluene for shipment by pipeline to the refineries. A Canadian research group found that chabazite can crack the long-chain organics in the bitumen, thereby reducing the viscosity of the bitumen. Such a system could reduce or eliminate the need for toluene to thin the bitumen and reduce costs (Harben, 2006; International Natural Zeolite Association, 2006).

Prices

Prices for natural zeolite vary with zeolite content and processing. Unit values, obtained through the U.S. Geological Survey canvass of domestic zeolite producers, ranged from \$50 to \$140 per ton. The bulk of the tonnage sold ranged from \$80 and \$140 per ton. Eyde and Holmes (2006, p. 1058) reported that prices for industrial or agricultural applications ranged from \$30 to \$70 per ton for granular products down to 40-mesh and from \$50 to \$120 per ton for finer (-40- to +325-mesh) ground material. For such products as pet litter, fish tank media, or odor control applications, prices ranged from \$0.50 to \$4.50 per kilogram. Quoted prices should be used only as a guideline because actual prices depend on the terms of the contract between seller and buyer.

Foreign Trade

Comprehensive trade data are not available for natural zeolites. Exports were estimated to be between 500 and 1,500 t in 2006. Imports of natural zeolites (other than gem-quality) were estimated to be less than 250 t. The bulk of the U.S. zeolite trade was in synthetic zeolite products.

World Review

World production of natural zeolite was estimated to be between 2.5 and 3 Mt based on reported production by some countries and production estimates published in trade journals. Estimates for individual countries were China, 1.75 to 2.25 Mt; the Republic of Korea, 175,000 t; Japan, 140,000 to 160,000 t; the United States, 65,500 t; Cuba, 35,000 to 45,000 t; Hungary and Turkey, 30,000 to 35,000 t each; Slovakia, 25,000 t; New Zealand, 18,000 to 22,000 t; Bulgaria and South Africa, 15,000 t each; Australia, 10,000 to 12,000 t; Georgia, 5,000 to 7,000 t; and Canada, Greece, Italy, and the Commonwealth of Independent States, 3,000 to 5,000 t each. Small amounts of natural zeolite also were produced in Indonesia.

In general, countries mining large tonnages of zeolite often have substituted zeolite-containing tuffs for various applications. Natural zeolites were used in large quantities for such applications as dimension stone (as an altered volcanic tuff), lightweight aggregate, pozzolanic cement, and soil conditioners.

In these cases, the ready availability of zeolite-rich rock at low cost and the shortage of competing minerals and rocks are probably the most important factors for its large-scale use. Also, it is likely that a significant percentage of the material sold as zeolite in some countries is ground or sawn volcanic tuff that contains only a small amount of zeolite.

Canada.—Zeo-Tech Enviro Corp. (Vancouver, British Columbia) completed a storage yard for Heemskirk Canada Ltd. (HCL) (a subsidiary of Heemskirk Consolidated Limited, Melbourne, Australia). The storage yard allows HCL access to stockpiled zeolites throughout the year (Zeo-Tech Enviro Corp., 2006). HCL would purchase the Princeton zeolite mine located in British Columbia, from Zeo-Tech subject to terms. Under the agreement, HCL purchased Zeo-Tech's 6,000-t inventory in the first year and will pay royalties on the next 3 years of production. HCL also will expand its Lethbridge, British Columbia, processing facility to meet customer demands for barite, gypsum, and zeolite products used by the drilling industry (Heemskirk Consolidated Limited, 2006).

Russia.—NIKA Production Commercial Enterprise opened a pilot mine for zeolites in Sakhaptinskaya. The company also began construction of a processing plant. Plans are to supply zeolite for animal feed, heat-insulating products, soil amendments, and water treatment (Industrial Minerals, 2006c).

Outlook

While still considered a mineral of much potential, production and sales of natural zeolites have progressed slowly over the past 40 years. However, sales increased at a much higher rate between 2000 and 2005 (averaging 17%) primarily because of expansion of animal feed and water treatment applications. Sales for water treatment, however, declined significantly in 2006. Animal feed sales doubled between 2003 and 2005, and those for water treatment increased nine-fold between 2001 and 2005. Animal feed probably will continue to be the leading U.S. market, followed by water treatment. Pet litter probably will remain the third largest market for several more years. Fungicide and pesticide applications also increased rapidly in the past 2 years but still remain behind pet litter in market standing. Other zeolite markets have slowly increased during the past 40 years but at much slower growth rates than the previously mentioned markets.

A positive aspect for natural zeolites is their amenability to environmental applications. With increasing population growth, environmental concerns also have increased. In animal feeds, zeolites reduce the odor of animal wastes and help prevent runoff into streams by solidifying the animal water besides providing other benefits. In water treatment, zeolites can remove trace levels of many heavy metals. With surface treatment and ion-exchange, the performance of zeolites for this application can be enhanced to remove other compounds from drinking waters and storm water runoff. Synthetic zeolites also have been demonstrated to act as a disinfectant in various products when exchanged with silver ions. As a pozzolan in concrete, natural zeolites reduce the amount of cement required, which in turn reduces demand for lime, a source of carbon dioxide during production.

Major zeolite markets probably are going to continue to increase at an average annual rate of 7% to 10% for the short term but other markets, such as aquaculture, desiccant, and wastewater cleanup, probably will remain relatively unchanged or experience slow growth.

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TABLE 1
DOMESTIC ZEOLITE PRODUCERS AND SUPPLIERS IN 2006

State and company	Type of zeolite
Arizona:	
GSA Resources, Inc.	Chabazite.
UOP Inc.	Do.
California:	
Ash Meadows Zeolite, LLC	Clinoptilolite.
KMI Zeolite, Inc.	Do.
Steelhead Specialty Minerals, Inc.	Do.
Idaho:	
Bear River Zeolite, LLC	Do.
Steelhead Specialty Minerals, Inc.	Do.
Teague Mineral Products Co.	Do.
Nevada, Moltan Co.	Clinoptilolite/mordenite.
New Mexico, St. Cloud Mining Co.	Clinoptilolite.
Texas, Zeotech Corp.	Do.
Wyoming, Addwest Minerals International Ltd.	Do.