In 2008, natural zeolites were mined by eight companies in the United States with three other companies working from stockpiled materials or zeolites purchased from other producers for resale. Mine production was 60,100 metric tons (t), and U.S. consumption was 58,500 t. The major markets were in animal feed, pet litter, water purification, and odor control, in decreasing order by tonnage. These four applications accounted for more than 80% of domestic consumption. Exports and imports of natural zeolites (other than gem-quality) were estimated to be less than 200 t each. 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, and Wyoming. Zeolites in these deposits are chabazite, clinoptilolite, erionite, mordenite, and phillipite. 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 9 responded. Responses accounted for more than 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 2008. 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 in California, Idaho, New Mexico, and Texas. New Mexico was the leading producing State in 2008. Domestic production of zeolites was 60,100 t compared with 57,400 t in 2007.

Bear River Zeolite Co. (a subsidiary of United States Antimony Corp.) reported that sales increased by 30% to 11,900 t in 2008 compared with 9,150 t in 2007 (United States Antimony Corp., 2009, p. 10). Daleco Resources Corp., through its subsidiary Clean Age Minerals, Inc., completed an evaluation of its Marfa, TX, zeolite deposit. The study area contained 35 Mt of proven reserves, 14.7 Mt of probable reserves, and 18.1 Mt of inferred resources. The company planned to market the zeolites into agricultural, energy, and industrial markets (Daleco Resources Corp., 2008).

Zeox Mineral Materials Corp. entered into agreements to complete the purchase of a processing plant from Machinery and Equipment Co., Inc. in Butte, MT, for $2 million. The plant had the capacity to process more than 120,000 metric tons per year. Zeolites used for down-hole cement formulations by the oil and natural gas industry will be produced at this facility for the Canadian and northern United States markets (Zeox Corp., 2008a, b).

**Consumption**

About 58,500 t of natural zeolites was sold in 2008 in the United States compared with 57,100 t in 2007. Domestic uses for natural zeolites were, in decreasing order by tonnage, animal feed, pet litter, water purification, odor control, miscellaneous uses, fungicide or pesticide carrier, oil absorbent, wastewater cleanup, gas absorbent, horticultural applications (soil conditioners and growth media), aquaculture, desiccant, and catalyst. Animal feed, pet litter, water purification, and odor control applications, in decreasing order by quantity, accounted for more than 80% of the domestic sales tonnage. Increased sales of natural zeolites were reported for animal feed, aquaculture, desiccant, fungicide and pesticide carriers, gas absorbent, oil absorbent, and water purification applications. Sales declined slightly for fertilizer, odor control, pet litter, and wastewater treatment applications.

**Prices**

Prices for natural zeolites vary with zeolite content and processing. Unit values, obtained through the U.S. Geological Survey canvass of domestic zeolite producers, ranged from $55 to $225 per metric ton. The bulk of the tonnage sold was between $100 and $150 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 coarser than 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. Eyde (2008) reported that the price for clinoptilolite granules was $150 per ton, and modified clinoptilolite and extruded and activated chabazite products sold for as much as $8 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 were not available for natural zeolites. In 2008, exports and imports of natural zeolites (other
than gem-quality) were estimated to be less than 200 t each. The bulk of the U.S. zeolite trade was in synthetic zeolite products.

World Review

World production of natural zeolites probably remained in the range of 2.5 to 3 Mt based on reported production by some countries and production estimates published in trade journals. Estimates for individual countries were: China (including pozzolan applications), 1.75 to 2.25 Mt; Jordan (nearly all for pozzolan applications), 400,000 to 450,000 t; the Republic of Korea, 160,000 t; Japan (including pozzolan applications), 140,000 to 160,000 t; Turkey, 100,000 t; the United States, 60,100 t; Slovakia, 60,000 t; Indonesia (including pozzolan applications), 30,000 to 50,000 t; Ukraine (including pozzolan applications), 20,000 to 40,000 t; Hungary, 20,000 to 30,000 t; New Zealand, 17,000 t; Cuba, 16,500 t; Bulgaria (excluding pozzolan applications), 15,000 t; South Africa, 10,000 to 15,000 t; Australia and Spain, 5,000 to 10,000 t each; Canada, Greece, Italy, the Philippines, and Russia, 3,000 to 5,000 t each; and Mexico, 700 t. Small amounts of natural zeolites (probably less than 1,000 to 2,000 t) also were produced in Argentina, Germany (excluding pozzolan applications), Serbia, and Slovenia.

Pozzolans are finely ground siliceous or siliceous and alumino-silicate materials that react with calcium hydroxide, in the presence of moisture, at ordinary temperatures to form compounds possessing cementitious properties (Bruce, 2005).

In general, natural zeolite production data are not available for most countries. Countries mining large tonnages of zeolites typically use them in low-value applications. 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. It is also likely that a significant percentage of the material sold as zeolites in some countries is ground or sawn volcanic tuff that contains only a small amount of zeolite. Some examples of such usage are dimension stone (as an altered volcanic tuff), lightweight aggregate, pozzolanic cement, and soil conditioners.

Zeox Corp. announced the formation of Zeox Minerals de Mexico, S.A. de C.V. and the signing of a purchase agreement on a chabazite deposit in Sonora. Exploration and analysis of the deposit was scheduled for 2008. Potential markets for the chabazite include lightweight down-hole cement for the gas and oil industries, catalyst, environmental remediation, and purification of air, gas, nuclear waste, and water streams (Zeox Corp., 2008c).

Outlook

U.S. sales of natural zeolites have increased to 60,100 t in 2008 from 3,630 t in 1974. For the past 4 years, production and sales have moderated following a slight decline after 2005. Although producers would like to increase sales tonnages, the cost of transportation has been a limiting factor. Consequently, considerable effort has been placed on developing value-added products to improve returns on investments.

Production and sales of natural zeolites probably will increase in the long term. For the immediate future, growth in sales will be slow although values may increase because of value-added processing. If pozzolan markets can be developed for natural zeolites in the United States, annual tonnage sales could increase at a higher rate than currently experienced. World sales of natural zeolites probably will continue to increase because much of the tonnage is sold for high-volume, lower value markets that continue to increase, more than in the United States.

References Cited


Zeox Corp., 2008c, Zeox expands operations into Mexico: Vancouver, British Columbia, Canada, Zeox Corp. press release, June 17, 1 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publication


Other


International Natural Zeolite Association.

International Zeolite Association.

Mining Engineering, monthly.

<table>
<thead>
<tr>
<th>State and company</th>
<th>Type of zeolite</th>
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<tr>
<td>Arizona:</td>
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<tr>
<td>GSA Resources, Inc.</td>
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<td>UOP LLC</td>
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<td>Bear River Zeolite Co.</td>
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<td>Teague Mineral Products Co.</td>
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<td>New Mexico, St. Cloud Mining Co.</td>
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<td>Texas, Zeotech Corp.</td>
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Do. Ditto.

\(^1\)Addwest Mineral International Ltd., Moltan Co., and Steelhead Specialty Minerals, Inc. worked from stocks or purchased zeolites from other producers for resale.