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ZEOLITES

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ZEOLITES

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In 2005, natural zeolites were mined and processed by 10 companies in the United States. Mine production was 65,500 metric tons (t), and U.S. consumption was 58,000 t. Major markets were in animal feed, water purification, and pet litter applications and accounted for more than 70% of domestic consumption. Exports were estimated to be between 3,000 and 7,000 t, and imports of natural zeolite (other than gem-quality) were estimated to be between 500 and 1,000 t. World production was estimated to be in the range of 2.5 million to 3 million metric tons (Mt).

Zeolites are hydrated aluminosilicates of the alkaline and alkaline-earth metals. About 40 natural zeolites have been identified during the past 200 years; the most common are analcime, chabazite, clinoptilolite, erionite, ferrierite, heulandite, laumontite, mordenite, and phillipsite. The most commonly mined varieties of natural zeolites are clinoptilolite and chabazite. More than 150 zeolites have been synthesized; the most common are zeolites A, X, Y, and ZMS 5. Natural and synthetic zeolites are used commercially because of their unique absorption, catalytic, ion exchange, and molecular sieve properties.

Commercial zeolite deposits in the United States are associated with the alteration of volcanic tuffs in alkaline lake deposits and open hydrologic systems. Commercial deposits in the United States 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

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.

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 96% of the production and end-use data.

Ten companies mined natural zeolites in the United States in 2005. One other company 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 65,500 t compared with an estimated 57,400 t of production in 2004.

Bear River Zeolite Co. (BRZ) (a subsidiary of United States Antimony Corporation, Thompson Falls, MT) agreed to provide 3,000 metric tons per month of zeolite to an unspecified purchaser in the concrete industry. The purchaser will provide $1 million to allow Bear River to construct a grinding circuit at its Preston, ID, plant for this product. Production and processing are to start in 2006 (United States Antimony Corporation, 2005).

Consumption

Approximately 58,000 t of natural zeolite was sold in 2005 in the United States compared with an estimated 49,100 t in 2004. Domestic uses for natural zeolite were, in decreasing order by tonnage, animal feed, water purification, pet litter, fungicide or pesticide carrier, horticultural applications (soil conditioners and growth media), desiccant, odor control, oil absorbent, gas absorbent, wastewater cleanup, aquaculture, and catalyst. Animal feed, pet litter, and water purification applications accounted for more than 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, fungicide and pesticide carriers, and water purification applications. The largest decline in tonnage sales was for pet litter.

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 metric 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 3,000 and 7,000

t. Imports of natural zeolites (other than gem-quality) were estimated to be between 500 and 1,000 t in 2005. The bulk of the U.S. zeolite trade was in synthetic zeolite products.

World Industry Structure

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, 1.5 to 2.0 Mt; the Republic of Korea, 150,000 t; Japan, 140,000 to 160,000 t; the United States, 65,500 t; Cuba, 37,500 t; Hungary and Turkey, 30,000 t each; Slovakia, 25,000 t; New Zealand, more than 18,000 t; Bulgaria and South Africa, 15,000 t each; Australia, 10,000 to 12,000 t; Georgia, 6,000 t; Canada, Italy, and the Commonwealth of Independent States, 4,000 t each; Greece, 3,000 t; and Ecuador, 2,070 t. 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.

World Review

Australia and Southeast Asia.—Major uses for zeolites in the Australasian region were in aquaculture, livestock feed, and waste water treatment. Marketing of zeolites in Australia focused on stock feed additives and waste water treatment. In Indonesia, the primary market was aquaculture for prawn farming. Natural zeolites produced in New Zealand were less specialized with sales for absorbents, horticulture, poultry and stock feed additives, and waste water treatment. Three companies mined zeolites in Australia—Envirozel Ltd., Supersorb Minerals NL, and Castle Mountain Enterprises Ltd. Envirozel marketed mainly for agriculture, animal nutrition, and water treatment and purification applications. Supersorb Minerals marketed its zeolites as absorbents for horticultural uses. With combined sales of 10,000 to 12,000 t, growth was expected to be slow. With water shortages in parts of Australia, zeolites were used to purify gray water (water drained from baths, showers, sinks, and washing machines) so prospects were encouraging. NZ Natural Zeolite (a division of Resource Refineries Ltd.) was the only major producer in New Zealand. The company marketed mainly absorbents for animal litter and hazardous chemical spill applications but had developed paper filler grades, stock feed additives, soil amendments, and water treatment products. Production at NZ Natural Zeolite exceeded 18,000 metric tons per year (Hill, 2005).

Canada.—C_2C Zeolite Corp. of Peachland, British Columbia, agreed to acquire 100 hectares of zeolite mining claims near Kamloops, British Columbia. C_2C Zeolite also has staked another 240 hectares adjacent to the Kamloops claims. The zeolite in the deposit is chabazite with potential uses in desiccant and catalysis applications and for purification of oxygen, argon, and hydrogen (Canadian Institute of Mining, Metallurgy and Petroleum, 2005§[1]).

Zeo-Tech Enviro Corp., Vancouver, British Columbia, announced that it had completed drilling, blasting, and crushing 10,000 t of zeolites at its mine (Zeo-Tech Enviro Corp., 2005). United Zeolite Products Ltd. (UZP) (a joint venture between Zeo-Tech, C_2C, Thelon Ventures Ltd. of Vancouver, British Columbia, and First American Scientific Corp. of Delta, British Columbia) completed construction and testing of its processing plant in Princeton, British Columbia (Thelon Ventures Ltd., 2005). UZP was contracted to supply Halliburton Group Canada micronized zeolite for use in gas- and oil-well cementing systems.

Outlook

Production and sales of natural zeolites continue to make a slow climb as recognition of their versatility has increased. Starting from a few hundred tons with no sustained production in the mid-1970s, zeolite production increased to 65,500 t in 2005. There was a rapid rise in production with the opening of a major zeolite mine in the early 1990s. This, however, was followed by a sharp decline in production, ending in 1997, as supply outstripped demand. The ratio of production to consumption in 1994 was 1.5, contrasting with a more typical 1.15 to 1.25 observed in prior years. Since then, production has more closely mirrored consumption, showing only a little variability from year to year.

Historically, pet litter was the dominant market for natural zeolites, accounting for more than 50% of sales through 1995. Sales to animal feed and horticulture markets began to increase around 1994, growing to claim a significant portion of sales by 1997. Other markets, such as aquaculture, desiccant, and wastewater cleanup, were developed but remained as minor markets. Around 2002, interest in the use of natural zeolites for water treatment began to increase, particularly in Canada, and this market has grown considerably. In 2005, reported sales for water treatment (for municipal water treatment and pool filtration) surpassed that for pet litter and became the second ranked market after animal feed applications, which became the leading market for natural zeolites in 2004.

This progress in marketing natural zeolites is encouraging, given that natural zeolites have been considered to be a commodity of great potential since the industry's beginning in the late 1960s. Also encouraging is the continued development through surface treatment and ion exchange of zeolite products and the opening of new markets, such as lightweight aggregate for specialty concrete products. Based on trends of the past 10 years, production and sales of natural zeolites probably will increase by at least 4% to 5% per year for the next 2 to 3 years.

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[1]A reference that includes a section mark (§) can be found in the Internet Reference Cited section.

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TABLE 1
DOMESTIC ZEOLITE PRODUCERS AND SUPPLIERS IN 2005

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