



2010 Minerals Yearbook

ZEOLITES

ZEOLITES

By Robert L. Virta

Domestic survey data and table were prepared by Hodan A. Fatah, statistical assistant.

In 2010, natural zeolites were mined by 10 companies in the United States, with one other company working from stockpiled materials or zeolites purchased from other producers for resale. Mine production was 61,300 metric tons (t) in 2010 compared with 59,500 t in 2009, and U.S. consumption was 60,000 t in 2010 compared with 59,400 t in 2009. The major markets were in animal feed, pet litter, odor control, and water purification, in decreasing order by tonnage. These four applications accounted for more than 70% of domestic consumption. Exports of natural zeolites (other than gem quality) were estimated to be less than 400 t, and imports were estimated to be less than 150 t. World production was estimated to be in the range of 2.8 million to 3.3 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. In the United States, these deposits are in Arizona, California, Idaho, Nevada, New Mexico, Oregon, Texas, 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.

Legislation and Government Programs

The U.S. Environmental Protection Agency, the North Dakota Department of Health, and the University of Cincinnati conducted a health study of 34 individuals to determine if breathing dust containing erionite could cause adverse health effects. Health scientists were concerned because erionite was classified as a human carcinogen by the International Agency for Research on Cancer, exposure to erionite might be linked to excess cancers in several villages in Turkey, and erionite was present in gravels that had been used for decades on roads in North Dakota (International Agency for Research against Cancer, 1998; U.S. Environmental Protection Agency Region 8 and North Dakota Department of Health, 2010, p. 5–9). The study results suggested that workers involved in road maintenance or gravel pits that were exposed to road gravel containing erionite could develop changes in the membranes surrounding the lungs (pleural changes) that historically are associated with exposure to asbestos, and that precautionary measures should be followed concerning such workers (U.S. Environmental Protection Agency Region 8 and North Dakota Department of Health, 2010, p. 5–9, 28–30).

In connection with the health study, the chemical and morphological characteristics of erionite from gravel deposits near Killdear Mountain, ND, were compared with those of erionite from Rome, OR, and the Cappadocia region of Turkey. All samples contained erionite fibers and fiber bundles with dimensions of 0.2 to 10 micrometers (μm) in diameter and 2 μm

to more than 200 μm in length. Airborne erionite fibers from Turkey had higher length-to-width ratios than those from North Dakota. The chemical characteristics of samples from all three locations were similar, and the calculated structural formulae were similar to those of erionite (Lowers and others, 2010).

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 10 responded. Responses accounted for more than 99% 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.

Ten companies mined natural zeolites in the United States in 2010. One 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; clinoptilolite was mined in California, Idaho, Nevada, New Mexico, and Texas. Domestic production of zeolites was 61,300 t compared with 59,500 t of production in 2009. New Mexico was the leading producing State in 2010, followed by Idaho, Texas, Arizona, California, and Nevada.

Bear River Zeolite Co., Inc. (a subsidiary of United States Antimony Corp.) reported that sales revenue increased by 57% to \$2.42 million in 2010 compared with \$1.54 million in 2009. The company shipped 15,300 t of zeolites in 2010 compared with 11,500 t in 2009 (United States Antimony Corp., 2011, p. 21).

Daleco Resources Corp. continued evaluating its clinoptilolite deposit near Marfa, TX. In addition to test samples, Daleco also sold 120 t of unprocessed zeolite for animal feed supplement, wastewater treatment, and miscellaneous uses (Daleco Resources Corp., 2011, p. 9).

Consumption

About 60,000 t of natural zeolites was sold in 2010 in the United States compared with 59,400 t in 2009. Domestic uses for natural zeolites were, in decreasing order by tonnage, animal feed, pet litter, odor control, water purification, gas absorbent

(and air filtration), wastewater cleanup, fertilizer, desiccant, oil absorbent, aquaculture, fungicide or pesticide carrier, and catalyst. Animal feed, odor control, pet litter, and water purification applications accounted for more than 70% of the domestic sales tonnage.

Increased sales of natural zeolites were reported for aquaculture, catalyst, desiccant, gas absorbent, pet litter, soil amendments, and water purification. The largest tonnage increases in sales were for odor control and pet litter applications. Sales for nuclear waste cleanup increased significantly because of a remediation project at a former nuclear fuel reprocessing facility in West Valley, NY. Bear River Zeolite reported that it provided almost 2,000 t of zeolite for the project. The zeolite was placed in a trench to contain strontium-90 (a radioactive isotope of strontium that is a byproduct of nuclear reactions) in groundwater that was migrating away from the former nuclear processing site. The purpose of the zeolites was to filter out the strontium-90 while allowing groundwater to pass through the trench wall (O'Driscoll, 2010; Bear River Zeolite Co., Inc., 2011).

Sales of natural zeolites declined for animal feed, fertilizer, fungicide and pesticide carriers, odor control, oil absorbent, and wastewater treatment applications. The largest tonnage decline was in animal feed use.

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 \$40 to \$900 per metric ton. The bulk of the tonnage sold was between \$99 and \$170 per ton, which was typical of large, bulk shipments. Eyde (2010) reported that the average price for clinoptilolite granules was about \$145 per ton and that modified clinoptilolite and activated chabazite products sold for as much as \$8 per kilogram. For such products as fish tank media, odor control, or pet litter 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 were not available for natural zeolites. In 2010, exports of natural zeolites (other than gem-quality specimens) were estimated to be less than 400 t, and imports were estimated to be less than 150 t. The bulk of the U.S. zeolite trade was in synthetic zeolite products.

World Review

World production of natural zeolites was in the range of 2.8 to 3.3 Mt in 2010 based on reported production by some countries, world market trends, and production estimates published in trade journals. World production probably declined slightly in 2010 because sales to pozzolanic cement markets were likely to have been affected by the recent recession.

Natural zeolite production data were 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 were probably the most important factors for its large-scale use. It was also likely that a significant percentage of the material sold as zeolites in some countries was ground or sawn volcanic tuff that contained only a small amount of zeolites. Some examples of such usage are dimension stone (as an altered volcanic tuff), lightweight aggregate, pozzolanic cement, and soil conditioners.

Estimates for individual countries were: China (including pozzolanic cement applications), 1.7 to 2.2 Mt; Jordan (nearly all for pozzolanic applications), 380,000 to 430,000 t; the Republic of Korea, 235,000 t; Turkey, 150,000 t (excluding pozzolanic cement applications); Japan (including pozzolanic cement applications), 130,000 to 150,000 t; Slovakia, 80,000 t; the United States, 61,300 t; Cuba, 27,000 t; Hungary, 20,000 to 25,000 t; Ukraine (including pozzolanic cement applications), 15,000 to 35,000 t; New Zealand, 22,000 t; Bulgaria (excluding pozzolanic cement applications), 17,000 t; South Africa, 10,000 to 15,000 t; Australia, Russia, and Spain, 5,000 to 10,000 t each; Canada, Greece, Italy, and the Philippines, 3,000 to 5,000 t each; Mexico, 1,000 t; and Indonesia (excluding pozzolanic cement applications), 400 to 500 t. Small amounts of natural zeolites (probably less than 1,000 to 2,000 t) also were produced in Argentina, Armenia, Georgia, Germany (excluding pozzolanic cement applications), Serbia, and Slovenia.

Outlook

U.S. production and sales of natural zeolites increased slightly in 2010 from those of 2009. The annual rate of increase in U.S. consumption of natural zeolites was lower between 2006 and 2010 than in most of the prior 20 years, but it still increased slightly each year. Annual growth of 1% to 3% is likely to continue for the next 3 to 4 years. Any large changes in domestic consumption that may take place during this time would likely be the result of one or two special projects that have limited life spans, such as the West Valley remediation project discussed in the Consumption section above.

World demand continued to be affected by the global economic recession because sales in many countries were linked to construction activities, where natural zeolites and (or) zeolitic tuffs were sold were dimension stone, lightweight aggregate, and pozzolanic cement. Although the economies of many nations were recovering in 2010, world consumption was likely to remain unchanged through 2013.

References Cited

- Bear River Zeolite Co., Inc., 2011, West Valley demonstration project: Preston, ID, Bear River Zeolite Co., Inc., October 13, 9 p. (Accessed May 23, 2011, at http://www.bearriverzeolite.com/images_new/BRZWVDP.pdf.)
- Daleco Resources Corp., 2011, Form 10-K—2010: Securities and Exchange Commission, 64 p.
- Eyde, T.H., 2010, Zeolites: Mining Engineering, v. 62, no. 6, June, p. 86.
- International Agency for Research on Cancer, 1998, Erionite: Geneva, Switzerland, International Agency for Research on Cancer, April 23. (Accessed May 23, 2011, at <http://monographs.iarc.fr/ENG/Monographs/vol42/volume42.pdf>.)
- Lowers, H.A., Adams, D.T., Meeker, G.P., and Nutt, C.J., 2010, Chemical and morphological comparison of erionite from Oregon, North Dakota, and Turkey: U.S. Geological Survey Open File Report 2010–1286, 13 p.

O'Driscoll, Mike, 2010, Zeolite in nuclear waste barrier: Industrial Minerals, March 11. (Accessed March 11, 2010, via <http://www.indmin.com>.)

U.S. Environmental Protection Agency Region 8 and North Dakota Department of Health, 2010, Radiographic changes associated with exposure to erionite in road gravel in North Dakota: Bismark, ND, U.S. Environmental Protection Agency Region 8 and North Dakota Department of Health, October 4, 34 p. (Accessed May 23, 2011, at <http://www.ndhealth.gov/EHS/erionite/MedicalStudy/ErioniteMedicalStudyFinalReport-10-04-2010.pdf>.)

United States Antimony Corp., 2011, Form 10-K—2010: Securities and Exchange Commission, March 29, 30 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Zeolites (Natural). Ch. in Mineral Commodity Summaries, annual.

Zeolites in Sedimentary Rocks. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

British Zeolite Association.

Economics of Zeolites, The (6th ed.). Roskill Information Services Ltd., 2003.

European Zeolite Producers Association.

Federation of European Zeolite Associations.

Industrial Minerals, monthly.

International Natural Zeolite Association.

International Zeolite Association.

Natural and Synthetic Zeolites. U.S. Bureau of Mines Information Circular 9140, 1987.

Zeolites. Ch. in Industrial Minerals and Rocks (7th ed.), Society for Mining, Metallurgy, and Explorations, Inc., 2006.

TABLE 1
DOMESTIC ZEOLITE PRODUCERS IN 2010¹

| State and company | Type of zeolite |
|---|-----------------|
| Arizona: | |
| GSA Resources, Inc. | Chabazite. |
| UOP LLC | Do. |
| California: | |
| Ash Meadows, LLC | Clinoptilolite. |
| KMI Zeolite Inc. | Do. |
| Idaho: | |
| Bear River Zeolite Co., Inc. (United States Antimony Corp.) | Do. |
| Steelhead Specialty Minerals, Inc. | Do. |
| Teague Mineral Products Co. | Do. |
| Nevada, Moltan Co., L.P. | Do. |
| New Mexico, St. Cloud Mining, Inc. | Do. |
| Texas, Zeotech Corp. | Do. |
| Do. Ditto. | |

¹Addwest Minerals International Ltd. worked from stocks or purchased zeolites from other producers for resale.