Erionite
CAS No. 66733-21-9

Known to be a human carcinogen
First Listed in the *Seventh Annual Report on Carcinogens* (1994)

Carcinogenicity

Erionite is *known to be a human carcinogen* based on sufficient evidence of carcinogenicity in humans. Descriptive studies have reported an excess of mortality from mesothelioma in individuals living in three Turkish villages where there was chronic exposure to erionite. No cases of mesothelioma occurred in a control village without exposure to erionite. An excess of lung cancer also was reported in two of the three villages contaminated with erionite. Respirable erionite fibers were detected in air samples collected from the affected villages, and lung tissue samples collected from mesothelioma cases contained erionite fibers. A higher proportion of ferruginous (iron-containing) bodies with a zeolite core were found in inhabitants of the contaminated villages than of those from the two control villages (IARC 1987a,b, Baris 1991).

There is sufficient evidence of carcinogenicity of erionite in experimental animals. Rats exposed to erionite by inhalation or injection (intrapleural or intraperitoneal) and mice exposed by intraperitoneal injection had high incidences of mesotheliomas (IARC 1987a,b).

Properties

Erionite is a naturally occurring fibrous mineral that belongs to a group of minerals called zeolites. Zeolites are hydrated aluminosilicates of the alkaline and alkaline-earth metals, and erionite is one of the more common of the approximately 40 natural types identified (Virta 2002). It has a hexagonal, cage-like structure composed of a framework of linked $(Si,Al)O_4$ tetrahedra. The structure is chainlike, with six tetrahedra on each edge of the unit forming part of a chain of indefinite length. It consists of white prismatic crystals in radiating groups and occurs in a fibrous form. Erionite absorbs up to 20% of its weight in water, has a specific gravity of 2.02 to 2.08, and has gas absorption, ion exchange, and catalytic properties that are highly selective and depend on the molecular size of the sorbed compounds (IARC 1987a). Zeolites, in general, have good thermal stability, rehydration kinetics, and water vapor adsorption capacity (Clifton 1985).

Use

Erionite is no longer mined or marketed for commercial purposes. Although other natural zeolites have many commercial uses (pet litter, soil conditioners, animal feed, waste-water treatment, gas absorbents, etc.) because of their unique properties, very few data are available specifically for erionite. It reportedly was used in the past as a noble metal-impregnated catalyst in a hydrocarbon-cracking process and was studied for use in fertilizers and to control odors in livestock production. Erionite-rich blocks have been used to build houses in parts of the western U.S., but this was a minor and unintentional use of the mineral (IARC 1987a).

In 1999, natural zeolites were described as "full-fledged mineral commodities" with a promise of expanded use in the future (Mumpton 1999). In 2001 the global annual consumption of natural zeolites was estimated to be 3.98 million metric tons, and the market was projected to grow to 5.5 million metric tons per year by 2010 (TechInsight 2001). Most commercial uses of natural zeolites are based on their ability to selectively adsorb molecules from air or liquids (IARC 1987). According to Virta (2002), domestic uses for natural zeolite in 2002 were, in decreasing order by tonnage, pet litter, animal feed, horticultural applications (use as soil conditioners and growth media), miscellaneous applications, oil absorbent, odor control, desiccant, pesticide carrier, water purification, aquaculture, wastewater cleanup, gas absorbent, and catalyst. Pet litter, animal feed, and horticultural applications accounted for more than 65% of domestic sales tonnage. The largest increases in tonnage sales were in animal feed and pet litter.

Production

Commercial mining of ores containing erionite began in the 1960s and continued through the 1970s by two U.S. companies (IARC 1987a). During that time, erionite was one of four commercially important zeolites (Mumpton 1978, Kirk-Othmer 1981). By 2002, nine companies were mining natural zeolites in the United States (Virta, 2002). Zeolite minerals are associated with the alteration of volcanic tuffs with saline lake water. Several hundred occurrences of zeolite deposits have been recorded in over 40 countries. Commercial deposits in the United States are in Arizona, California, Idaho, Nevada, New Mexico, Oregon, Texas, Utah, and Wyoming. Erionite occurs in rocks of many types and in many geologic settings; however, it rarely occurs in pure form and is normally associated with other zeolite minerals. There are, however, several locations where erionite exists in deposits exceeding millions of tons (IARC, 1987).

No production data specifically for erionite were available; however, commercial mining of other natural zeolites continues. Only a few hundred tons of zeolites were mined annually in the United States through the 1970s, and by the mid 1980s, annual production was still less than 10,000 metric tons (22 million pounds). Production then started to increase and peaked in the United States in 1994 at 52,800 metric tons (116 million pounds) (Virta 2000). In 2002, nine companies reported mining 46,000 metric tons (101 million pounds) of zeolites, which was up from the 36,400 metric tons (80 million pounds) reported in 2001 (Virta 2002).

Exposure

Zeolites are one of the most extensive mineral families in the earth's crust (Vaughan 1978). Fibrous and nonfibrous zeolites are common minerals in the western United States; 10 trillion tons (9 trillion metric tons) of reserves and 120 million tons (109 million metric tons) exist near the surface of the ground (Rom *et al.* 1983). The zeolite beds may be up to 15 feet thick and may lie in surface outcroppings. Deposits of fibrous erionite are located in Arizona, Nevada, Oregon, and Utah. Erionite fibers have been detected in samples of road dust in Nevada. U.S. residents of the Intermountain West may be potentially exposed to fibrous erionite in ambient air (Rom *et al.* 1983, IARC 1987a).

Potential cccupational exposure to erionite occurs during the production and mining of other zeolites. In the past, occupational exposure occurred from erionite mining and production operation. Erionite also was reported to be a minor component in some commercial zeolites (Mondale *et al.* 1978). Therefore, the use of other zeolites may result in potential exposure to erionite for the workers and the general population who use the zeolites in a variety of processes and products. Total dust exposures for miners in an open-pit zeolite mine that contained some erionite in Arizona ranged from 0.01 to 13.7 mg/m^3; respirable dust in the mining area was 0.01 to 1.4 mg/m^3 (IARC 1987a).

Regulations and Guidelines

No specific regulations or guidelines relevant to reduction of exposure to erionite were identified.

References

Baris, Y. I. 1991. Fibrous zeolite (erionite)-related diseases in Turkey. Am J Ind Med 19(3): 374-8.
Clifton, R. A. 1985. Other Non-metals. In Minerals Yearbook, Vol. 1 Metals and Minerals. Washington, D.C.: U.S. Government Printing Office.
IARC. 1987b. Overall Evaluations of Carcinogenicity. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, Supplement 7. Lyon, France: International Agency for Research on Cancer. 440 pp.
IARC. 1987a. Silica and Some Silicates. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 42. Lyon, France: International Agency for Research on Cancer. 289 pp.
Kirk-Othmer. 1981. Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed., vol. 13. New York, NY: Jon Wiley and Sons.
Mondale, K. D., F. A. Mumpton and F. F. Aplan. 1978. Beneficiation of Natural Zeolites from Bowie,

Arizona: A Preliminary Report. In Natural Zeolites: Occurrences, Properties, Uses. L. B. Sand and F. A. Mumpton, eds. New York: Pergamon Press. p. 527-537.

Mumpton, F. A. 1978. Natural Zeolites: A New Industrial Mineral Commodity. In Natural Zeolites: Occurrences, Properties, Uses. L. B. Sand and F. A. Mumpton, eds. New York: Pergamon Press. p. 3-27.

Mumpton, F. A. 1999. La roca magica: uses of natural zeolites in agriculture and industry. Proc Natl Acad Sci U S A 96(7): 3463-70.

Rom, W. N., K. R. Casey, W. T. Parry, C. H. Mjaatvedt and F. Moatamed. 1983. Health implications of natural fibrous zeolites for the Intermountain West. Environ Res 30(1): 1-8.

TechInsight. 2001. Zeolites: Industry Trends and Worldwide Markets in 2010. Technical Insights, Inc. Last updated: 9/01. http://the-infoshop.com/study/ti7686_zeolites_industry.html. Last accessed: 2/18/04.

Vaughan, D. E. W. 1978. Properties of Natural Zeolites. In Natural Zeolites: Occurrence, Properties, Use. L. B. Sand and F. A. Mumpton, eds. Oxford, England: Pergamon Press. pp. 353-371.

Virta, R. L. 2000. Zeolites. U.S. Geological Society Minerals Yearbook. U.S. Geological Society. Last updated: 10/28/03. http://minerals.usgs.gov/minerals/pubs/commodity/zeolites/index.html#myb. Last accessed: 2/18/04.

Virta, R. L. 2002. Zeolites. U.S. Geological Society Minerals Yearbook. U.S. Geological Society. Last updated: 10/28/03. http://minerals.usgs.gov/minerals/pubs/commodity/zeolites/index.html#myb. Last accessed: 2/18/04.