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 from studies in humans.

Cancer Studies in Humans

Descriptive studies have reported an excess of mortality from mesothelioma (cancer of body cavity linings) in individuals living in three villages in Turkey where there was chronic exposure to erionite (IARC 1987a,b, Baris 1991). 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 contaminated villages, and lung tissue samples collected from individuals with mesothelioma contained erionite fibers. In another study, a higher proportion of ferruginous (iron-containing) bodies with a zeolite core were found in inhabitants of two contaminated villages than in inhabitants of two control villages.

Cancer Studies in Experimental Animals

There is sufficient evidence for the carcinogenicity of erionite from studies in experimental animals. High incidences of mesothelioma were observed in rats exposed to erionite by inhalation or by intrapleural or intraperitoneal injection and in mice exposed by intraperitoneal injection (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 (e.g., in pet litter, soil conditioners, animal feed, wastewater treatment, or gas absorbents) 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 United States, 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 promise for 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 (8.8 billion pounds), and the market was projected to grow to 5.5 million metric tons (12.1 billion pounds) per year by 2010 (Frost and Sullivan 2000). Most commercial uses of natural zeolites are based on their ability to selectively adsorb molecules from air or liquids (IARC 1987a). Domestic uses for natural zeolites 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 (Virta 2002). Pet litter, animal feed, and horticultural applications accounted for more than 65% of domestic sales tonnage. The largest increases in tonnage sales were for use in animal feed and pet litter.

Production

Commercial mining of ores containing erionite by two U.S. companies began in the 1960s and continued through the 1970s (IARC 1987a). During that time, erionite was one of four commercially important zeolites (Mumpton 1978, Kresge and Dhinga 2004). By 2002, nine companies were mining natural zeolites in the United States (Virta, 2002). Zeolite minerals are associated with the alteration of volcanic tuffs in 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 normally is associated with other zeolite minerals. In several locations, however, 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). U.S. production then started to increase, peaking 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, up from 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; there are 10 trillion tons of reserves, and 120 million 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 potentially be exposed to fibrous erionite in ambient air (Rom *et al*. 1983, IARC 1987a).

Potential occupational exposure to erionite occurs during the production and mining of other zeolites. In the past, occupational exposure occurred from erionite mining and production operations. Erionite was also reported to be a minor component in some other commercial zeolites (Mondale *et al.* 1978). Therefore, the use of other zeolites may result in potential exposure to erionite for workers and members of 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

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

References

Baris YI. 1991. Fibrous zeolite (erionite)-related diseases in Turkey. *Am J Ind Med* 19(3): 374-378.

Clifton RA. 1985. Other non-metals. In *Minerals Yearbook, Vol. 1, Metals and Minerals.* Washington, DC: U.S. Geological Survey.

Frost and Sullivan. 2000. *Zeolites—Industry Trends and Worldwide Markets in 2010*. Frost and Sullivan Research Service. Technical Insights, Inc.

IARC. 1987a. Erionite. In *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. pp. 225-239.

IARC. 1987b. Erionite. In *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. p. 203.

Kresge T, Dhinga SS. 2004. Molecular sieves. In *Kirk-Othmer Encyclopedia of Chemical Technology,* vol 16. Online edition. New York: John Wiley & Sons. pp. 811-853.

Mondale KD, Mumpton FA, Aplan FF. 1978. Beneficiation of natural zeolites from Bowie, Arizona: a preliminary report. In *Natural Zeolites: Occurrences, Properties, Uses*. Sand LB, Mumpton FA, eds. New York: Pergamon Press. pp. 527-537.

Mumpton FA. 1978. Natural zeolites: a new industrial mineral commodity. In *Natural Zeolites: Occurrences, Properties, Uses*. Sand LB, Mumpton FA, eds. New York: Pergamon Press. pp. 3-27.

Mumpton FA. 1999. La roca magica: uses of natural zeolites in agriculture and industry. *Proc Natl Acad Sci U S A* 96(7): 3463-3470.

Rom WN, Casey KR, Parry WT, Mjaatvedt CH, Moatamed F. 1983. Health implications of natural fibrous zeolites for the Intermountain West. *Environ Res* 30(1): 1-8.

Vaughan DEW. 1978. Properties of natural zeolites. In *Natural Zeolites: Occurrence, Properties, Use*. Sand LB, Mumpton FA, eds. New York: Pergamon Press. pp. 353-371.

Virta RL. 2000. Zeolites. In *Minerals Yearbook, Vol. I, Metals and Minerals.* U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/zeolites/zeomyb00.pdf.

Virta RL. 2002. Zeolites. In *Minerals Yearbook*, *Vol. I, Metals and Minerals.* U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/zeolites/zeolmyb02.pdf.