Discovery Guides

Asbestos in the United States: Occurrences, Use and Control

by Andreas Saldivar & Vicki Soto

Introduction

Asbestos – the word itself connotes harm or danger. "Asbestos" is actually a collective term used to describe six naturally occurring fibrous minerals that have specific physical/chemical properties. These properties make them resistant to heat and acid and also give the material a high tensile strength, which makes it ideal for use in many industrial materials – everything from brake linings to building insulation.

Picture 1: Chrysotile, or white asbestos. Smithsonian National Museum of Natural History

Smithsonian National Museum of Natural History

Asbestos minerals fall into two mineralogical groups, the serpentines and the amphiboles. Chrysotile is the only member of the serpentine group. The remaining minerals, amosite (grunerite), crocidolite (riebeckite), anthophyllite, actinolite, and tremolite are all amphiboles.

Asbestos Mining and Use

Asbestos has been used for thousands of years, including in items such as lamp wicks and various textiles like cremation cloths, napkins and tablecloths (Ross & Nolan, 2003) (Ells, 1890). There is a story of Charlemagne who would throw his dirtied asbestos tablecloth into the fire to clean it of debris (Ells, 1890). The Smithsonian Museum of Natural History even has a newspaper printed on paper made of chrysotile asbestos.

The first large scale mining and industrial use of asbestos was not until the early 1800s (Virta, 2002). Production generally increased over the next 150 years, peaking with a world production of 4,970,000 metric tons in 1977 (Kelly, Matos (comps.), Historical statistics for mineral and material commodities in the United States, 2005). Products manufactured with some asbestos content included construction materials such as insulation, ceiling tiles, floor tiles, mastics; friction materials such as brakes; and textiles. Faced with the growing evidence of the harmful effects of asbestos on humans, production was decreased. However, world production was still 2,360,000 metric tons in 2004 (Kelly, Matos, (comps.), Historical statistics for mineral and material commodities in the United States, 2005).

Domestic asbestos mining occurred in numerous states throughout most of the twentieth century. There are sixty former asbestos mines in the Eastern U.S. alone. (http://pubs.usgs.gov/of/2005/1189/). The largest operations were in Arizona, North Carolina, Vermont and California (Virta, 2006).

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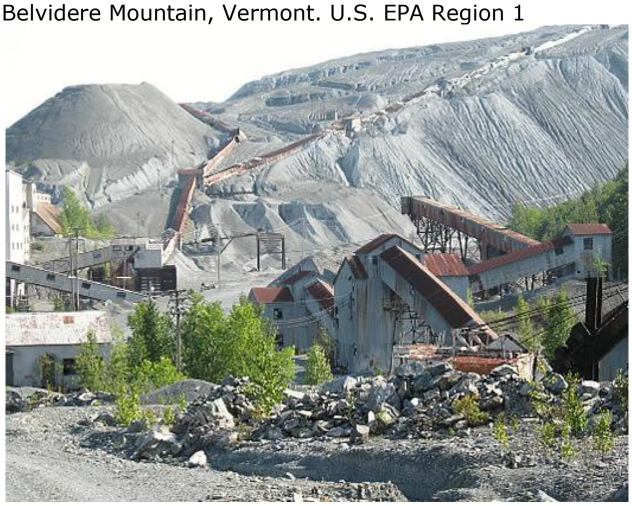
Picture 2: Vermont Asbestos Group mine site located on Belvidere Mountain, Vermont. U.S. EPA Region 1



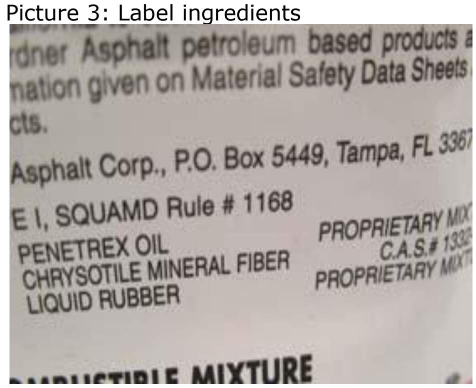
U.S. EPA Region 1

The first large scale operation in the U.S. was in Georgia in 1894 (Van Gosen, 2005). Domestic production continued for the next 100 years with the last mine closing in 1993 (Van Gosen, 2005). Domestic production peaked in 1973 at 136,000 metric tons (U.S. Geological Survey, 2005). Available statistics going back to 1910 show that domestic consumption far outpaced domestic production. In the 20th century the U.S. produced 3.3 million metric tons of asbestos but consumed 31 million metric tons. In 1973 when domestic production was at its peak, consumption was 803,000 metric tons. This resulted in the import of 718,000 metric tons. The vast majority, 94 percent, of asbestos imported into U.S. came from Canada, with additional imports from South Africa, Zimbabwe, and Swaziland (Ross & Nolan, 2003) (Virta, 2006).

Asbestos was used in numerous common building materials, including floor tiles, siding, roofing, ceiling tiles, insulation, fireproofing, gaskets, sealants, and many other products. It was also woven into cloths and used for heat resistant gloves and vibration insulation. A U.S. Environmental Protection Agency (U.S. EPA) sample list of products containing asbestos can be viewed at: http://www.epa.gov/Region06/6pd/asbestos/asbmatl.htm.

Many people think that newly manufactured products sold in the United States do not contain asbestos. This is not true. Asbestos can still be found in common household products and some toys purchased today. A recent study sponsored by the Asbestos Disease Awareness Organization found numerous products sold today that contain asbestos. Asbestos was found in the fingerprint powder of the CSI Fingerprint Examination Kit. Other products found to contain asbestos were a glazing, a spackle, a roof patching material, and even a variety of duct tape. The roof patching material even listed chrysotile as an ingredient (Asbestos Disease Awareness Organization, 2007).[1]

Picture 3: Label ingredients



Courtesy of the Asbestos Disease Awareness Organization.

[1] The entire report can be viewed at: http://www.asbestosdiseaseawareness.org/eLibrary/PressReleases/11.28.07.pressrelease.pdf

Asbestos Effects and Epidemiology

Because of its fibrous nature, asbestos can easily become airborne and can be breathed in. The most prevalent diseases associated with asbestos exposure are asbestosis, lung cancer, and mesothelioma – all lung or respiratory function related. Risk of developing asbestos related diseases varies with length of time, frequency and concentration of exposure to asbestos fibers (Agency for Toxic Substances and Disease Registry, 2007). Asbestos related disease can have a very long period to manifest after exposure. The report *Chemical-Specific Health Consultation: Tremolite Asbestos and Other Related Types of Asbestos*, ATSDR, 2001 (http://www.atsdr.cdc.gov/asbestos/more_about_asbestos/health_consultation/) lists the period of time after first occupational exposure to result in asbestosis or lung cancer as 15 years or more and 30 years or more for mesothelioma.

- Asbestosis: Scarring of the lungs and decreased respiratory function (Ross & Nolan, 2003).

- Lung Cancer: Exposure to asbestos correlates with a greatly increased risk of lung cancer, particularly in conjunction with smoking.

- Mesothelioma: A cancer of the tissues that surround the lungs, heart, or abdominal cavities. This form of cancer has been linked to exposure to amphibole asbestos (Ross & Nolan, 2003). There is still controversy over whether chrysotile asbestos causes mesothelioma (Osinubi, Gochfeld, & Kipen, 2000).

The first documented asbestos related death was in 1906. An autopsy of an asbestos worker showed lung fibrosis (asbestosis) (Chun, 2004). By the 1930s doctors were noticing a correlation between patients with asbestosis and lung cancer (Chun, 2004). In a 1939 Bureau of Mines report (Harrington, *Some Data on Dust in Industrial Work*, 1939) it is evident that people were beginning to think of the detrimental effects of exposure to occupational dust, including asbestos.

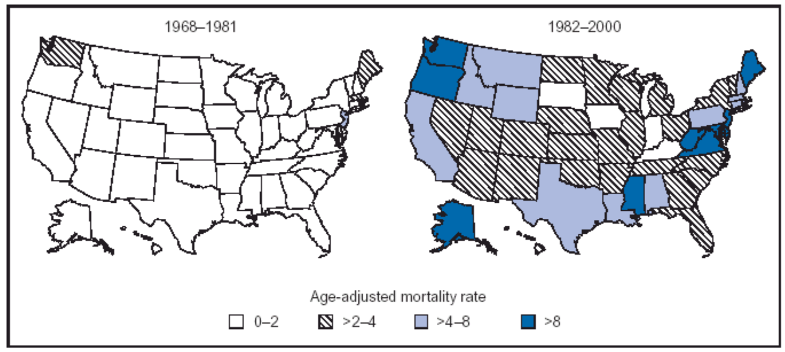
While other occupational respiratory disease mortality has been decreasing, asbestosis-related mortality has increased and was reported to be 1,493 in 2000 (Centers for Disease Control and Prevention, 2004).

Mesothelioma is the rarest of the asbestos related diseases, however, the incidence rate has increased over the past 20 years. Currently about 2,000 new cases are diagnosed each year (Mesothelioma: Questions and Answers, 2002). Research into the disease continues. In 2007 the U.S. Food and Drug Administration approved a blood test, known as Mesomark, to help with the early diagnosis of mesothelioma (CDRH Consumer Information, 2007).

For smokers exposure to asbestos can be exceptionally risky. Smokers are 50-84 times more likely to develop lung cancer than normal (Agency for Toxic Substances and Disease Registry, 2006). The data documenting asbestos as a human carcinogen is outlined in the U.S. Environmental Protection Agency Integrated Risk Information System. Asbestos is listed as a Class A human carcinogen. (U.S. Environmental Protection Agency, 2008)

Picture 4: (Centers for Disease Control and Prevention, 2004)

FIGURE 2. Mortality rates* for asbestosis, by state — United States, 1968–1981 and 1982–2000



* Per 1,000,000 population.

While there is no question about the correlation between asbestos exposure and disease, there is controversy over quantifying the risks of low-level asbestos exposure (Osinubi, Gochfeld, & Kipen, 2000). The Code of Federal Regulations Title 40 Section 61.141 defines Asbestos Containing Material (ACM) to be material with greater than 1% asbestos of any regulated type as identified by Polarized Light Microscopy (see Asbestos Structure/Analysis/Abatement). Current asbestos exposure limits set by the U.S. Occupational Safety and Health Administration are 0.1 fibers/cc for an 8 hour period (Occupational Safety and Health Administration, 2002).

Legislation

During the 1970s public awareness of the dangers of asbestos increased due to reporting of medical studies positively relating asbestos to lung disease. Demand for action resulted in legislation. The Asbestos Hazard Emergency Response Act (AHERA) was signed into law in October 1986. AHERA requires “schools to inspect their buildings for asbestos and take appropriate abatement actions using qualified, accredited persons for inspection and abatement.” AHERA also requires asbestos control professionals to take appropriate initial training with annual refresher training (U.S. Environmental Protection Agency, 2008).

In 1989 the U.S. EPA issued a ruling banning most asbestos containing products. This ban was overturned by the 5th Circuit Court of Appeals in 1991. However, under this ruling certain products remained banned, including flooring felt, rollboard, and corrugated, commercial, or specialty paper. The ruling also maintained the ban on asbestos in products that did not historically contain asbestos (U.S. Environmental Protection Agency, 2008).

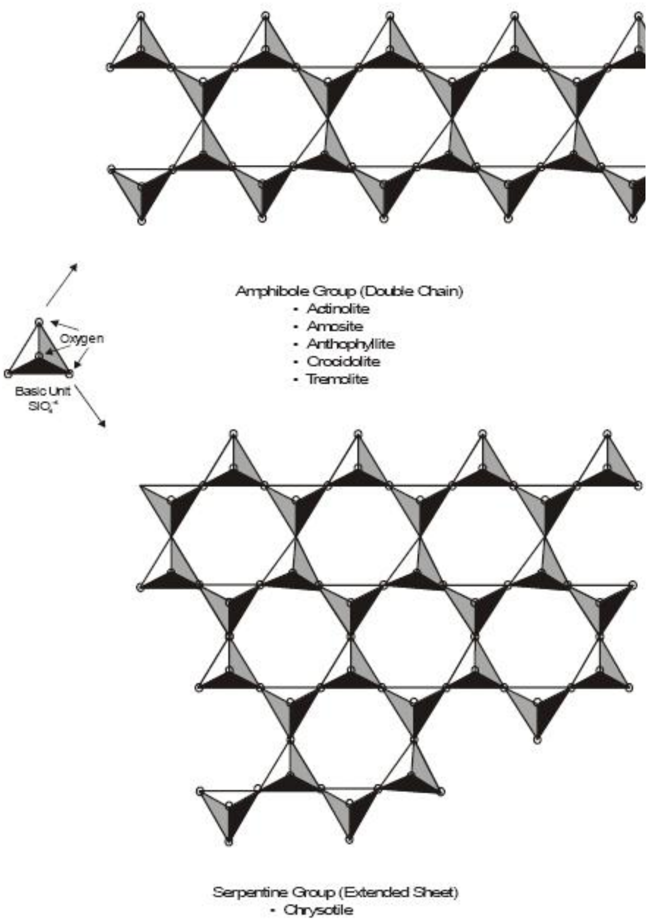
A new asbestos ban was introduced to congress in 2007. Senate bill S. 742, the "Ban Asbestos in America Act of 2007," was introduced on March 1, 2007 and passed unanimously on October 4, 2007 (GovTrack.us, 2007). The bill "Prohibits the importation, manufacture, processing and distribution of products containing asbestos." In addition to the six currently regulated asbestos minerals, it also defines asbestos as "any material formerly classified as tremolite, including winchite asbestos and richterite asbestos" plus "any fibrous amphibole mineral" (U.S. Senate, 2007). The House of Representatives version of the bill, H.R. 3285, was introduced on August 1, 2007. To date, the only action the House has taken on this bill was a hearing by a subcommittee on Environment and Hazardous Materials on February 28, 2008 (Committee on Energy and Commerce, 2008).

Asbestos Structure/Analysis/Abatement

Chemistry and Crystal Structure

All of the regulated asbestos minerals can crystallize in a massive habit (non-fibrous) or in the asbestiform habit (fibrous). When crystallizing in the asbestiform habit the mineral grows rapidly in thin, hair-like crystals. This structure is very strong and flexible, with tensile strength an order of magnitude higher than the massive habit. The surface structures are more resistant to acids than the same minerals in other habits.

Picture 5: Chemical structure of Amphibole and Serpentine Asbestos



Courtesy of Agency for Toxic Substances and Disease Registry

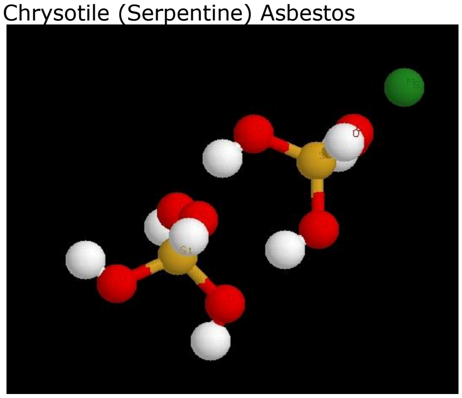
All the asbestos minerals are silicates, minerals with a silica tetrahedron structure that consists of one oxygen atom surrounded by four silicon atoms in a pyramid. The asbestos minerals are split into two groups: Serpentine and Amphibole. The Serpentine group has one member, chrysotile.

Chrysotile

The chemistry of chrysotile is $Mg_3Si_2O_5(OH)_4$. It belongs to the phyllosilicates (sheet or layer silicates), a mineral group that includes clays and micas. Phyllosilicates all have two basic layers. The first layer, or tetrahedral layer, is made up of a continuous sheet of silica tetrahedra. The second layer, or octahedral layer, consists of a cation surrounded by six oxygen atoms. This layer resembles two pyramids connected base to base.

The unit cell or basic structure of chrysotile is one tetrahedral layer linked with a single octahedral layer. The layers combine and share oxygen atoms. The spacing of the oxygen atoms in the tetrahedral layer is 0.305 nm. The spacing in the octahedral layer is 0.342 nm. The structure accommodates this mismatch in oxygen distances by curving and scrolling. The results are sheets that roll up into long scrolls. An easy visualization of this is to imagine rolling up a poster. When laid out flat the poster resembles a sheet; when rolled up it resembles a fiber.

Picture 6: Chemical Structure of Chrysotile (Serpentine) Asbestos



Courtesy of National Institutes of Health

Regulated Amphibole Asbestos

Amphiboles asbestos minerals are double chained inosilicates. The United States currently regulates five fibrous amphiboles: Amosite $(Fe,Mg)_7Si_8O_{22}(OH)_2$, Crocidolite $Na_2(Fe^{+2},Mg)_7Fe^{+3}{}_2Si_8O_{22}(OH)_2$, Anthophyllite $(Mg,Fe)_7Si_8O_{22}(OH)_2$, Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$, and Actinolite $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$. There are four groups of amphiboles: iron-magnesium-manganese, calcic, sodic-calcic, and alkali. Common to all the regulated amphiboles is $Si_8O_{22}(OH)_2$. The amount of magnesium, iron, sodium, and calcium determines which group the mineral belongs to.

Amphiboles also participate in solid solutions, minerals where the ratio of one element to another can vary without the crystal structure of the mineral changing. For example, Tremolite is in solid solution with Actinolite. The two possess the same crystal structure, but the ratio of magnesium to iron is different. Tremolite is all magnesium, while Actinolite is a mixture of magnesium and iron. And, finally, the non-regulated amphibole Ferroactinolite -- $Fe_2Mg_5Si_8O_{22}(OH)_2$ -- is all iron.

Abatement and Analysis

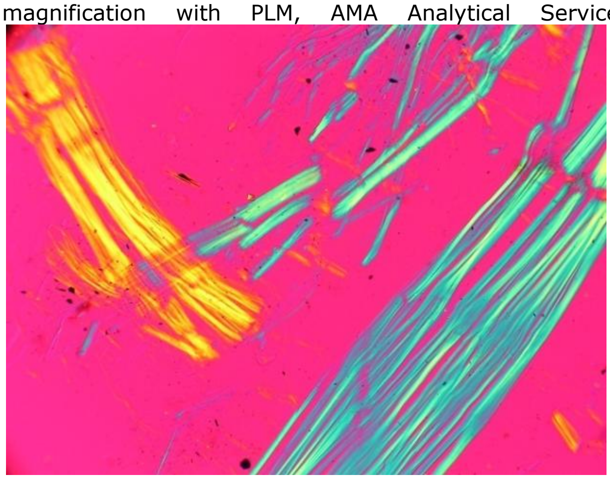
Asbestos was used for so long and in so many structures that today there is a thriving industry dedicated to identifying and removing asbestos-containing materials. AHERA mandates some institutions, such as schools, to "inspect their buildings for asbestos and take appropriate abatement actions using qualified, accredited persons for inspection and abatement." (U.S. Environmental Protection Agency, 2008). Other commercial structures, while not subject to AHERA, must follow Occupational Safety and Health Administration (OSHA) standards, which state that "Employee exposure to asbestos must not exceed 0.1 fibers per cubic centimeter (f/cc) of air, averaged over an 8-hour shift" (Occupational Safety and Health Administration, 2002). Accordingly, building owners, while not required to remove asbestos containing materials (ACM) from their structures find that, to stay in compliance with OSHA, they should.

The first step in this process is to identify all the ACM in a building. This process should be done by a trained asbestos industrial hygienist. Asbestos industry workers take training from state approved training facilities and receive a certification, and in some states, a license. The worker must also take an annual re-certification class (U.S. Environmental Protection Agency, 2008). In addition, some states go above and beyond the federal requirements (U.S. Environmental Protection Agency, 2008).

Once a qualified asbestos consulting company has been contracted, industrial hygienists will sample a large variety of building materials, typically including flooring and associated glue, ceiling tiles, wall systems, insulations, fireproofing, caulks, baseboards, roofs, siding, and pipe wraps. A typical sample size is about 1 square inch for a non-friable material and a few tablespoons for friable materials. The samples are sealed in airtight containers and shipped to an accredited laboratory. This type of sample is known as bulk sample.

Laboratories are accredited and licensed by the federal government and, in some cases, state governments. Most asbestos laboratories will possess accreditation though the National Voluntary Laboratory Accreditation Program (NVLAP), which is a part of the National Institute of Standards and Technology (NIST). Some states, such as New York and California, also have laboratory accreditation programs. Many other states have license programs.

Picture 7: Chrysotile Asbestos as seen under 100x magnification with PLM, AMA Analytical Service

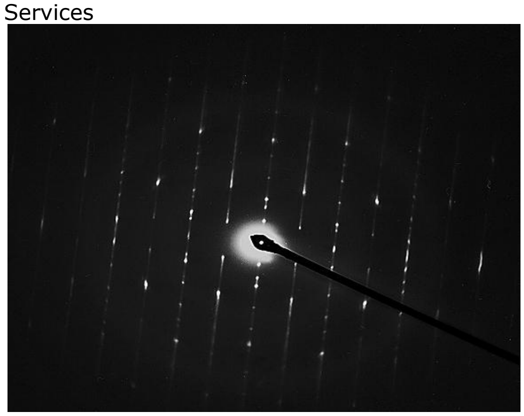


Typical bulk sample analysis is performed by polarized light microscopy (PLM), which uses an optical microscope to measure various optical properties of minerals/materials observed. All minerals possess certain uniquely identifying optical properties. A few examples of these are: refractive index, sign of elongation, and extinction angle. Two types of asbestos may possess the same sign of elongation and extinction angle but have differing refractive indexes. If the analyst measures enough of the optical properties they can positively identify whether a mineral is asbestos and what type of asbestos it is. For asbestos the most important optical property is refractive index. Refractive index is the measure of how much the speed of light is reduced as it enters a medium. A refractive index of 1.5 means that light is slowed down by 1.5 times. Refractive index can also be described as a measure of how much a light ray refracts or bends as it passes through a medium. An easy way to visualize this is how your feet appear distorted while standing in swimming pool. That is because water has a refractive index of approximately 1.34. As the light rays move from the air to the water they slow down by 1.34 times as they refract and bend.

Picture 8: Chrysotile fibers seen under19,000x magnification with TEM. Fibers are 1 to 4 microns long. AMA Analytical Services.

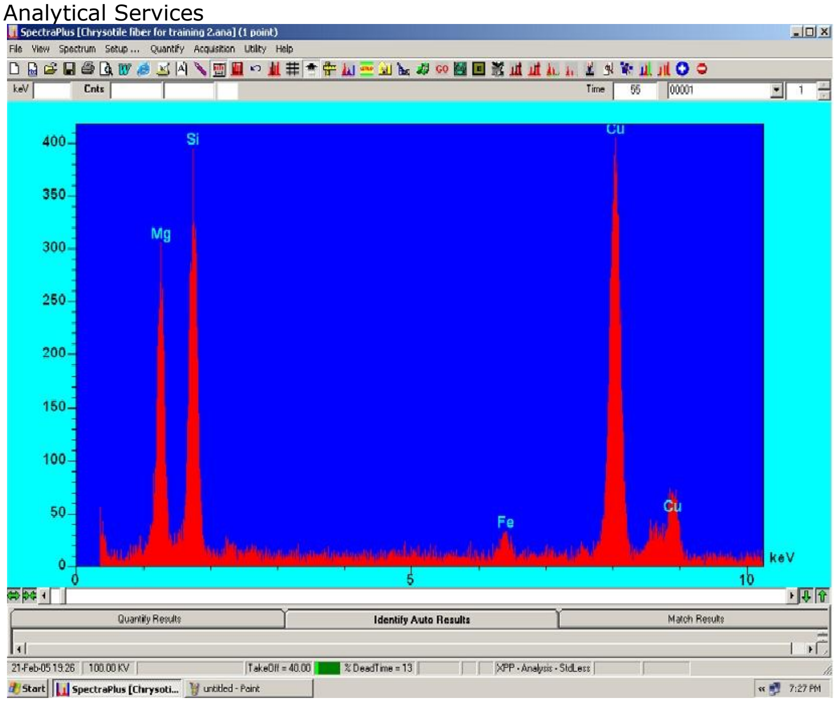
The optical microscopes used for asbestos analysis typically magnify the sample 40 to 400 times. While this sounds like a lot, in certain types of samples, such as floor tiles, the asbestos can be so small it is beyond the resolution of optical microscopy. For samples with asbestos too small to resolve with PLM a Transmission Electron Microscope (TEM) can be used. Typical TEMs can magnify a sample millions of times. The TEM offers the analyst more than just high magnification to help identify particles; it also can show the diffraction pattern, or atomic structure, of a mineral and the chemical composition. The chemistry of a mineral is checked by energy dispersive x-ray analysis (EDXA). As the stream of TEM electrons hits the particle it excites the electrons within the particle causing them to jump to other electron shells. This causes other higher energy electrons in the atom to fill the spots of the original lower energy electrons. As they do so, they give off a tiny packet of energy at a certain level that differs for all atoms. The EDXA can measure this packet of energy, thereby determining the chemical make up of the particle. EDXA combined with diffraction can positively identify any mineral.

Picture 9: Chrysotile Diffraction Pattern, or crystal structure, seen with TEM. AMA Analytical Services



When the laboratory completes the analysis, the results are reported to the consultant and the building owner. They then make the determination on how to remove or contain the asbestos containing material (ACM). Removal of the ACM is done by first building a containment barrier around the ACM to be removed. Then qualified asbestos workers, wearing special protective clothing and respirators to prevent exposure to asbestos, remove the ACM. The ACM waste must be disposed of following all local and federal guidelines and placed in special hazardous materials landfills. During removal, the industrial hygienist monitors the ambient air quality by taking air samples for analysis using phase contrast microscopy (PCM). This monitors the fiber in air concentration and to insure that workers are wearing the proper respirator. PCM does not identify asbestos but does give a relative total "fiber" count. These fibers can be anything: asbestos, fiberglass, mineral wool, cellulose, synthetic fibers, etc.

Picture 10: Chrysotile Asbestos chemical composition as measured with TEM showing Magnesium, Silica and Iron. The copper is equipment based. AMA Analytical Services



After the workers complete the final cleaning of the containment, the industrial hygienist takes a set of final air samples. Air samples are typically run for at least two hours to collect 1,200 or more liters of air. These samples are typically analyzed by TEM in order to positively identify if asbestos is present. If the samples are below predetermined clearance criteria, the abatement is complete and the containment can be torn down. If the samples fail, the area must be re-cleaned and new samples taken.

For large office buildings with a lot of asbestos this process can take years and cost millions of dollars.

CASE STUDY: Libby, Montana

Libby Montana, a small town located in the Kootenai National Forest, has become known as one of the worst asbestos contamination sites in U.S. history. The contamination is a direct result of the nearby Vermiculite mine that operated from the 1920s to 1990 (LibbyMT.com, 2004).

The first mining operations, in the Libby area, started in the 1860s with the discovery of gold, silver, and lead. Vermiculite was discovered by gold miners in 1881. In 1919, E.N. Alley bought the Rainy Creek Claim and shortly after opened the Zonolite Company, which marketed vermiculite as an insulation, an additive to plaster, and an additive to soil. Vermiculite from this mine that was used in insulation was marketed under the name Zonolite. In 1963, W.R. Grace bought the mine and operated it until it closed in 1990 (LibbyMT.com, 2004).

Unfortunately one of the by products of the vermiculite in Libby is asbestiform amphiboles, primarily winchite, richterite, and tremolite. The U.S. Geological Survey characterized the "respirable fraction of the abestiform minerals as 84% winchite, 11% richterite, and 6% tremolite." Raw ore was estimated to be 21-26% asbestos by weight and the mill feed was 3.5-6.4% asbestos. The vermiculite shipped to processing plants was 0.3-7.0 %. It is estimated that the airborne dust in the Libby mill was 40% asbestos. The mine produced as much as 80% of the world's vermiculite supply (Sullivan, 2007). (Note, winchite and richerite are not currently on the list of regulated asbestiform minerals; however the new Ban Asbestos in America Act of 2007 does list them as such.)

The mine was a significant employer of Libby and surrounding area residents. During the life of the mine it is estimated that employees were exposed to asbestos levels ranging from <1 f/cc to as high as 182 f/cc. Occupational exposure was dependent on what job the employee did and when in the life of the mine they were employed (Sullivan, 2007).

In 1999 dozens of asbestos related illnesses and deaths were blamed on the mine. The U.S. EPA then began investigating. The Agency for Toxic Substances & Disease Registry (ASTDR), an agency of the Department of Health and Human Services, released a report on mortality in Libby (Agency for Toxic Substances and Disease Registry (ATSDR), 2007).

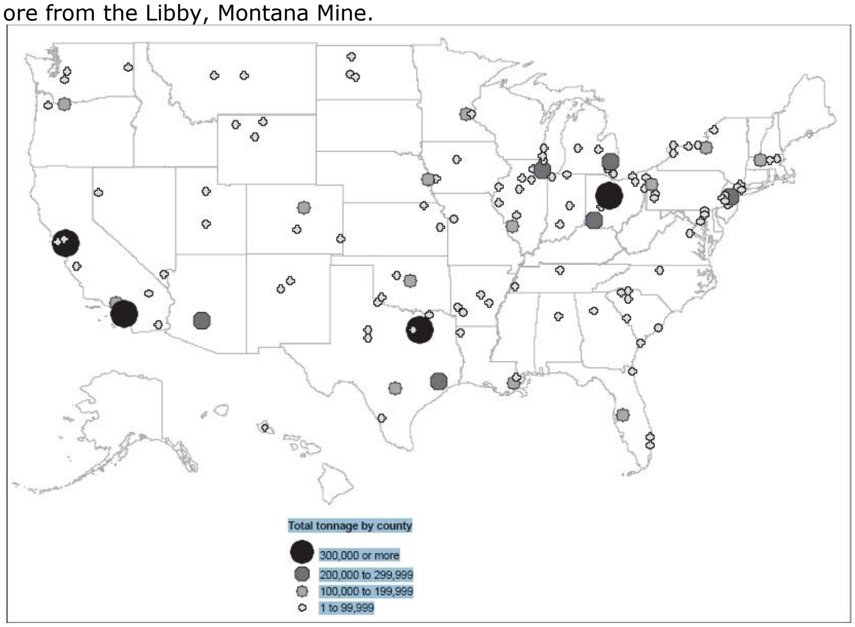
> The updated report concluded that for the 20-year period examined, mortality in Libby resulting from malignant and nonmalignant respiratory diseases was significantly elevated.

> The report showed that when compared to Montana and U.S. mortality, there was a 20 percent to 40 percent increase in malignant and nonmalignant respiratory deaths in Libby from 1979 to1998.
>
> Specifically, U mortality in Libby was 40 to 80 times higher than expected and lung cancer mortality was 1.2 to 1.3 times higher than expected when compared to Montana and the United States. U mortality was elevated but because statistics on this extremely rare cancer are not routinely collected, it was difficult to quantify the increase. Other non-malignant, noninfectious respiratory deaths also were significantly elevated. Most of the increase in respiratory mortality noted in the revised report likely can be associated with occupational exposures.
>
> Asbestosis and mesothelioma mortality were found almost exclusively in former workers. Some of the lung cancer mortality occurred in former employees of the vermiculite facility."(Agency for Toxic Substances and Disease Registry (ATSDR), 2007)

In February 2005 a Federal Grand Jury indicted seven executives from W.R. Grace for knowingly exposing residents of Libby, Montana to asbestos contamination (U.S. Department of Justice, 2005).

The vermiculite ore from the Libby mine was shipped to over 200 processing facilities around the country. Between 1964 and 1990 approximately 95% of the ore was shipped to exfoliation facilities.

Picture 11: This map shows the distribution of 195 facilities receiving vermiculite ore from the Libby, Montana Mine.



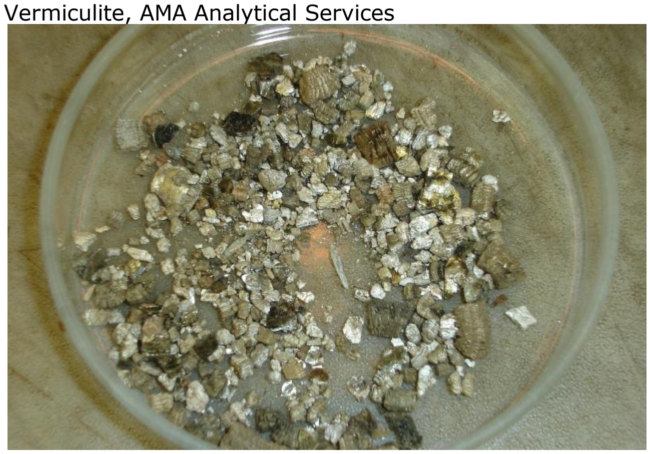
Courtesy of the Government Accounting Office.

Exfoliation is the process that expands the vermiculite into its commercially viable form. The process involves heating the ore to 2,000 ºF which causes the vermiculite to expand. The expanded vermiculite was marketed as an insulation product known as Zonolite (U.S. Government Accountability Office, 2007). Zonolite was an easily poured insulation ideal for walls and attics. In 1985 the U.S. EPA estimated that 940,000 homes contained or, had contained Zonolite attic fill (U.S. Environmental Protection Agency, 2008). If you suspect you have vermiculite insulation you should visit http://www.epa.gov/asbestos/pubs/verm.html.

Picture 12: Photo of Zonolite brand insulation

Courtesy of EPA

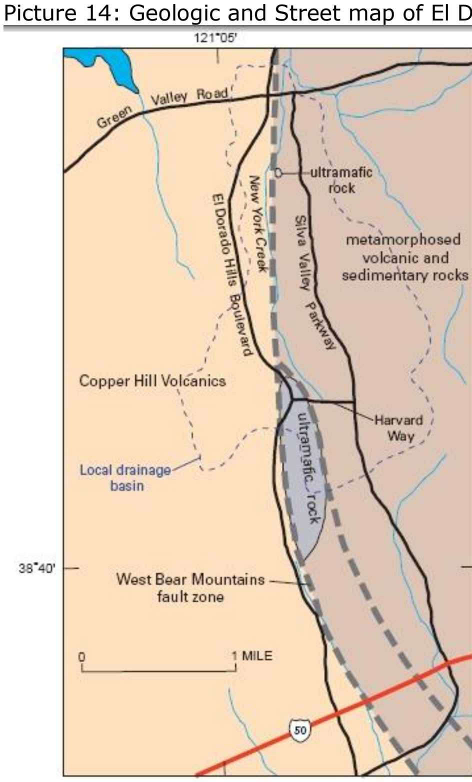
Picture 13: Amphibole Asbestos bundle in Libby Vermiculite, AMA Analytical Services



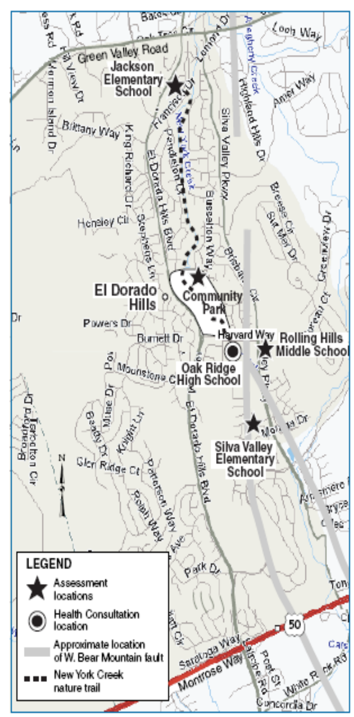
CASE STUDY: El Dorado Hills, California

While it has long been known that exposure to asbestos can cause disease, it has generally been thought that the exposure would come from working in a mine, living near a mine, manufacturing ACM products, or being exposed to ACM products. Another way to be exposed is to live in an area with naturally occurring asbestos. Asbestos is not man-made, it is a naturally occurring mineral. There are many places in the United States where veins of asbestos are part of the local geology. They may be exposed in surface outcrops of rocks, in road cuts, or occur just below

Picture 14: Geologic and Street map of El Dorado Hills, CA



Courtesy of USGS



Courtesy of EPA

the surface. In these areas the surface soil may contain asbestos weathered from the surrounding veins. If a town or community is built in area with naturally occurring asbestos, the residents run the risk of long-term exposure.

El Dorado Hills is a community of about 40,000 people located in the Sierra foothills 30 miles northeast of Sacramento. The local geology is primarily volcanic rock and some ultramafic rock. Ultramafic rock is iron and magnesium rich and can provide conditions where asbestos minerals can form within the rock (Meeker, Lowers, Swayze, Van Gosen, & Brownfield, 2006).

In 2002 during the construction of a vein of asbestos was disturbed at Oak Ridge High School during the construction of 2 soccer fields. In 2003 the U.S.EPA was asked to evaluate the asbestos exposure in public areas around the high school. The U.S.EPA collected over 400 air samples and about 180 soil samples. Air samples were collected as the U.S.EPA investigators participated in recreational and sport activities. Some of the samples were personal air samples in which the individual wears the sampling apparatus and some were ambient samples taken just outside the area of activity (U.S. Environmental Protection Agency, 2005).

Picture 15: Testing asbestos exposure during recreational activities

Courtesy of the U.S. EPA

"U.S. EPA found that asbestos fibers were present in almost all El Dorado Hills air samples, whether from sports and play activities or from samples collected nearby, but outside the areas of the activity sampling. The dominant fiber type for most air samples, especially for the longer PCME fibers, was amphibole (mainly actinolite and tremolite). However, short chrysotile fibers were also present at high levels from activities at the Community Park baseball fields and at the children's playground." (U.S. Environmental Protection Agency, 2005)

Generally the U.S.EPA found that the asbestos levels were higher on the personal air samples than on the ambient air samples (U.S. Environmental Protection Agency, 2005).

The findings generated concern in the community. Steps were taken to reduce the exposure. They included:

- "Mitigation of soccer fields, including grading and covering native soils with geotextile fabric, 24 inches of clean topsoil, and sod, was completed in 2003. Cut banks were also sprayed with materials to reduce erosion or other release of asbestos fibers.
- Mitigation of the baseball and softball fields, which included replacement of fill materials with clean fill, was completed in 2004.
- The track around the football field was paved in 2003.
- Paths and bare areas were paved or landscaped in the spring and summer of 2004.
- Mitigation of remaining areas (bare soil under bleachers, piles of removed soil) was completed in the summer of 2004." (Agency for Toxic Substances and Disease Registry, 2006)

The U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry further evaluated the site as to how it related to human exposure and risk. They concluded that current exposure had been minimized because of the steps taken. Future exposure would be dependent on maintaining of the installed barriers, proper cleaning, and not disturbing other veins. They concluded that based on past exposures the individuals most likely to have an increased risk of asbestos related disease were coaches, outdoor maintenance staff, and student athletes (Agency for Toxic Substances and Disease Registry, 2006). The entire ASTDR report can be viewed at http://www.atsdr.cdc.gov/HAC/PHA/OakRidgeHS-013106/OakRidgeHighSchoolHC013106.pdf.

Picture 16: El Dorado Hills, CA remediation strategies

Example of Geotextile Fabric installation

Courtesy of the California Department of Toxic Substance Control

It is likely, that as the populace becomes more aware of this type of exposure, more instances of exposure to naturally occurring asbestos will be identified and investigated. The United States Geological Survey (USGS) and the U.S. EPA have produced maps for historic asbestos mines and naturally occurring asbestos. An example of a map can be found at: http://pubs.usgs.gov/of/2006/1211/downloads/pdf/Plate.pdf

CONCLUSION

For thousands of years asbestos was the miracle fiber. Only recently have the harmful effects become known. Efforts to ban and remove asbestos in the United States have made progress but there are still a lot buildings containing ACM. Many countries still regularly mine and use asbestos in construction and products. In today's global economy with billions of dollars of imports into the U.S., many ACM products are still available. If the Ban Asbestos in America Act becomes law it will take great vigilance to find and remove all ACM.

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