Asbestos in the Environment - A Review of the Science

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Asbestos - A Review of the Science

- El Dorado Science Meetings, Aug 2004
  - Asbestos in California – Calif GS & USGS
  - Asbestos & Health – ATSDR & Region 8
  - Measurement & Monitoring of Asbestos Exposures – Region 8
- U.S. EPA's concern re: El Dorado

What is Asbestos?

- Naturally occurring mineral with thin, separable fibers.
- “Asbestos” = fibrous form of the minerals
- Resistant to heat, fire, and chemical & biological breakdown

What is NOA?
Naturally Occurring Asbestos

- NOA = natural geologic occurrence of asbestos-bearing minerals/rocks:
  - Calif state rock (serpentine) contains NOA
- Asbestos fibers are released from NOA-containing rock when disturbed:
  - Mining, Residential Construction

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- **Asbestos in California**

John Clinkenbeard

California Geological Survey

Gregg Swayze, Ph.D.

U.S. Geological Survey

NOA Occurrence in California

- NOA present in many (44/58) Calif counties
  - Present in foothills & fault zones
- Sierra Nevada foothills
  - Western El Dorado County
- Coastal Range foothills
- Northwest California

www.conservation.ca.gov/CGS/index.htm

http://pubs.usgs.gov/of/2004/1304

Types of Asbestos

Serpentine

- 95% of commercial use
- Fibers flexible & curved
- Less persistent in lungs & other biological tissue

Amphibole

- Little commercial use
- Rigid spears or needles
- More persistent in lungs & other biological tissue

Types of Asbestos Fibers

- Serpentine
  - Chrysotile *
- Amphiboles
  - Actinolite *
  - Tremolite *
  - Anthophyllite
  - Crocidolite
  - Amosite

* Common types in California NOA

Potential Problem with NOA

- NOT A PROBLEM: If NOA left alone and not disturbed and there is minimal release of fibers

- POSSIBLE PROBLEM: If human activity causes release of asbestos fibers in the air
  - Commercial Activities - mining, construction
  - Personal Activities - sports, gardening

Once airborne, asbestos poses an exposure risk (from both commercial and NOA sources)

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- **Asbestos & Health**

Jill Dyken, Ph.D., P.E.

Agency for Toxic Substances & Disease Registry (ATSDR)

Aubrey Miller, M.D.

U.S. EPA, Region 8

Asbestos Related Diseases

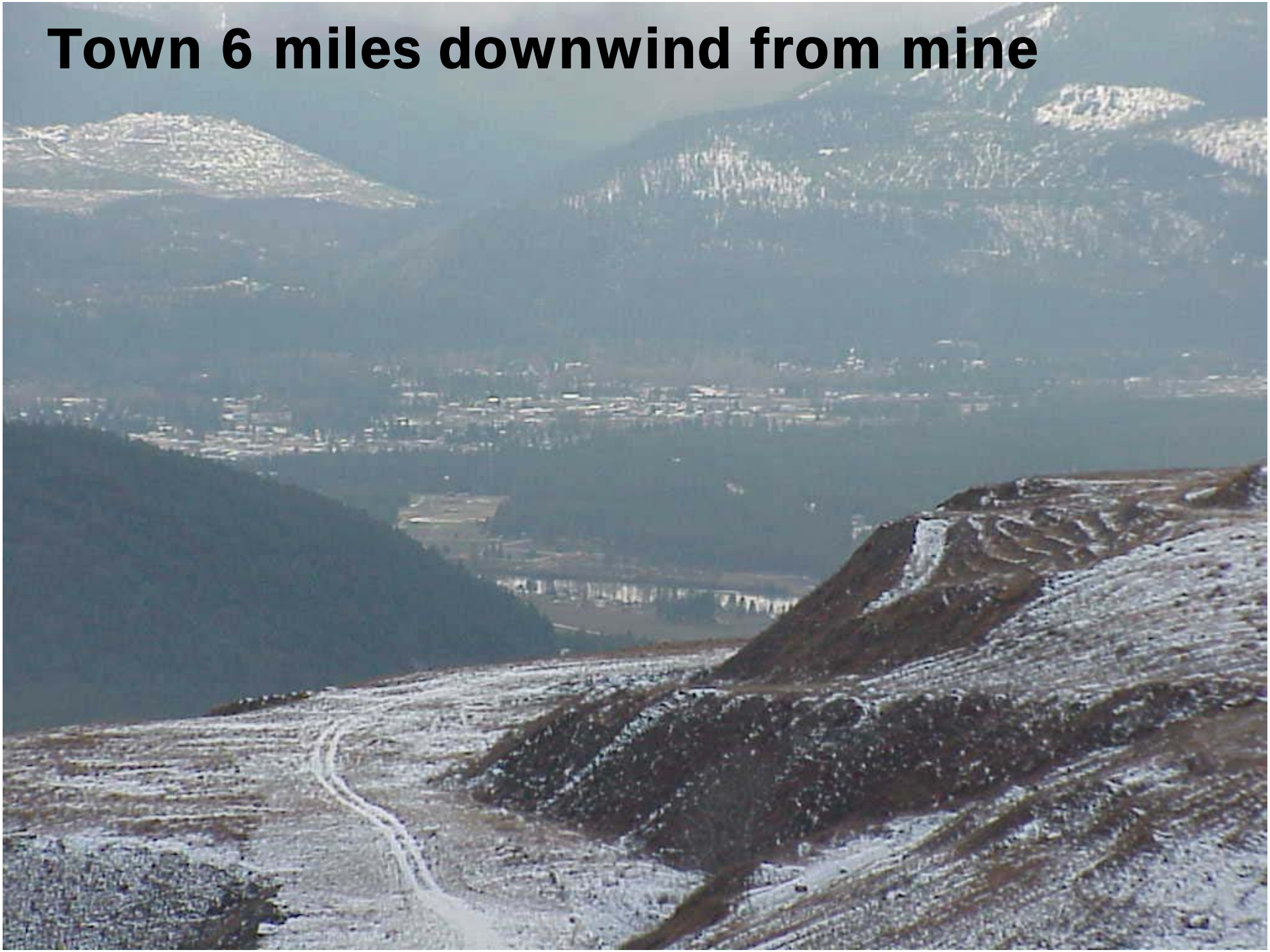
- NON-CANCER:
  - Asbestosis
  - Pleural Changes
- CANCERS:
  - Mesothelioma
  - Lung Cancer

Libby, MT - Zonolite Mine

- Vermiculite mine started 1920's
- Produced up to 80% of worlds vermiculite
- Vermiculite contained amphibole asbestos
- WR Grace bought 1963 & closed in 1990

<u>EXPOSURES</u>
Earlier up to 130 f/cc depending on job; later reduced (OSHA PEL 0.1 f/cc)

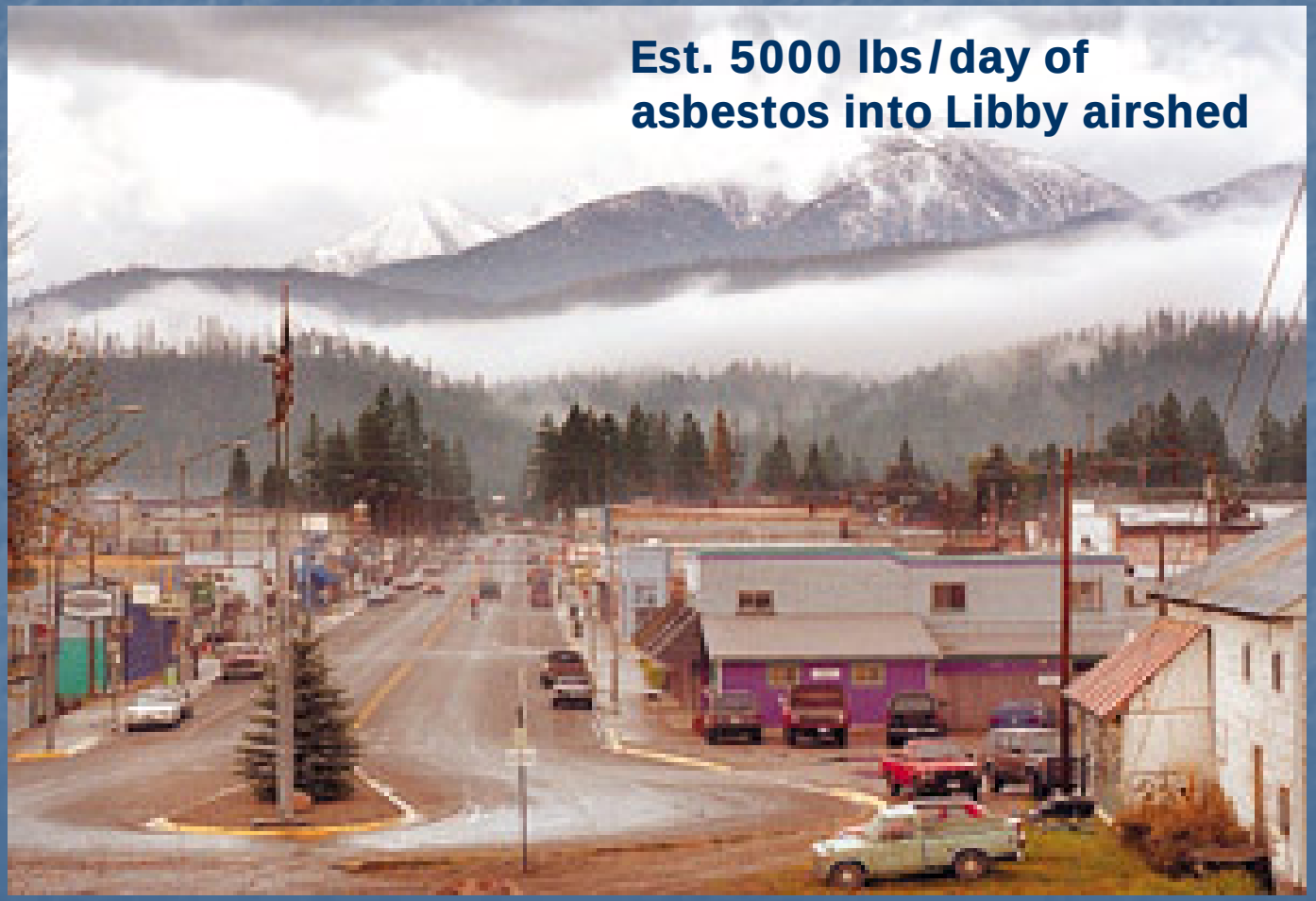
Town 6 miles downwind from mine



Libby: Historical Exposure Information

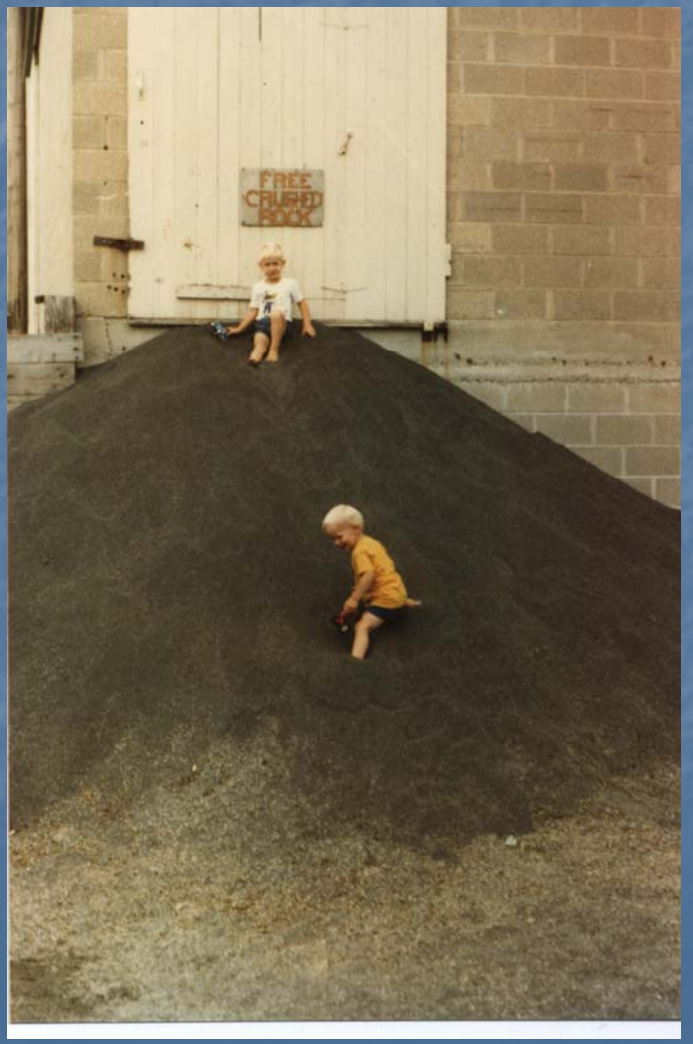
Ambient Air

- Grace records 1975: 0.7 to 1.5 f/cc (PCM) downtown
- EPA 1982: 0.5 f/cc (PCM) in Libby



Libby Non-occupational Exposures Historical & Present

- Family Contact with workers
- Other
  - Playing in vermiculite piles
  - School Areas
  - Garden use



Vermiculite Attic Insulation

Insulation made from Libby ore

Since 1999 Libby Health Data
Mortality Studies

- **NIOSH:***
  - **County asbestosis rate ~ 40X US rate;**
  - **Age-adjusted rate 1988-1997 was highest in the US**

- **ATSDR: (20 year study period: 1979 – 1998)**
  - **Increased risk compared to MT & US populations**
    - Asbestosis: 40-80x higher
    - Lung CA: 20-30% higher
    - Mesothelioma: marked increase (rate not quantifiable)
      - **Observed 3 / ~ 2500 (deaths outside county not counted)**
      - **Expected: typically estimated <10 / million**

***Evaluation NCHS data per R. Castellan, MD NIOSH / DRDS**

What is Asbestosis?

- Scarring of lungs caused by high exposure to asbestos => difficulty in breathing;
- Smoking decreases ability to clear asbestos fibers from the lungs:
  - Smoking may increase risk of asbestosis;
- A disease that progresses slowly; it takes decades to develop signs and symptoms.

What are Pleural Changes?

- Pleura = lining of the lungs & lung cavity;
- Thickening & hardening of the pleura;
- Potential higher risk of cancer;
- Role of smoking – not clear;
- Usually, no early symptoms;

  Sometimes observe decreased lung function

Asbestos: Non-Cancer Diseases

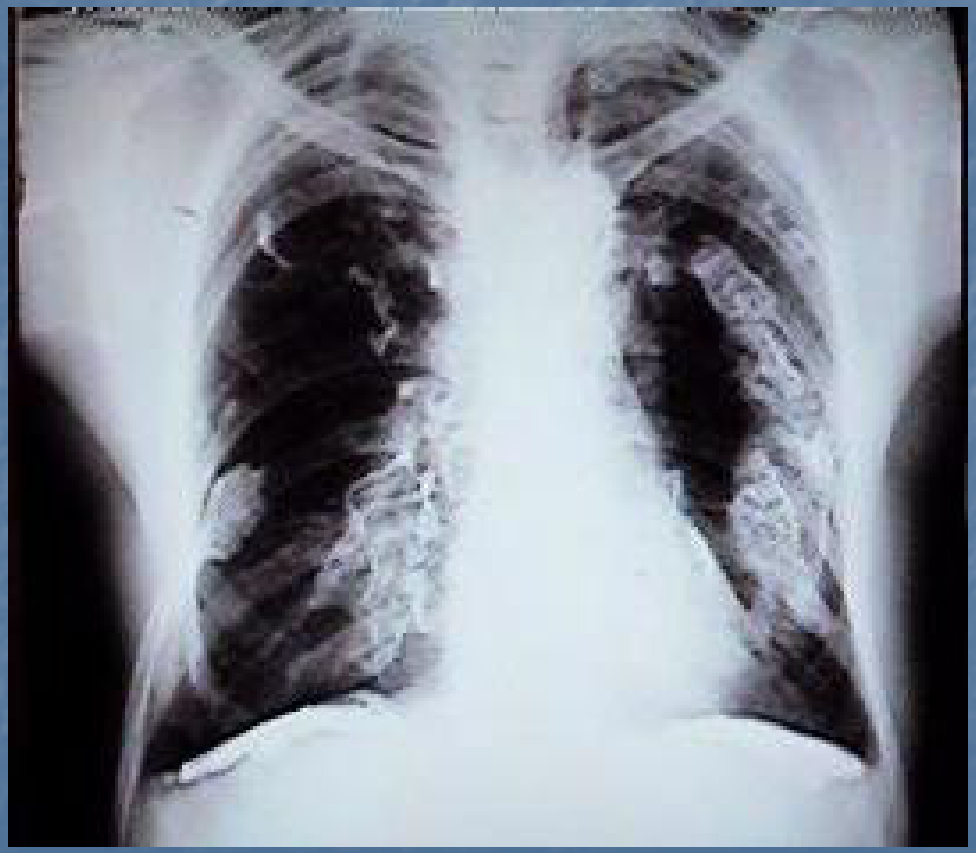
Asbestosis: (reported in workers in 1906)

Interstitial fibrosis of lung parenchyma (air sacs)

Pleural Fibrosis: Scarring / thickening lining around lung

- All types of asbestos
- Mortality
  - Under-reported
- Severity
  - Dose, Duration, Personal Factors
- Usually 10+ yrs to develop (Latency Period)
- Clinical: No impairment to severe disease & death

Macroscopic Lung Pathology Caused by fibers Pleural Disease



Prevalence of pleural abnormalities

Asbestos-related x-ray changes

- **Libby MT Site: >18 % of population**
  - 5 % with no apparent exposure - 24% with 6+ pathways
  - No control group but internal dose-response associations clear

- **Other US Studies:**
  - 0.2%: 1422 blue-collar workers in North Carolina (Castellan 1985)
  - 0.9%: 693 loggers in Washington and Oregon (Stibolt 1991)
  - 1.8%: 326 New Jersey residents (Anderson 1979)
  - 2.3%: 1212 patients at VA hospitals in NJ (Miller JA 1996)
  - 3.9%: cross-sectional 1060 US adults, workers included (Rogan 2002)

Implication of Pleural Disease
Cancer Risk

- Lung Cancer ?

- Mesothelioma Risk Appears Increased
  - 1588 (84% low exp.) Swedish Men (Hillerdal 1994)
    - Those with pleural plaques alone had risk of 1/1700 per year.
  - 2420 Croat patients with positive x-rays (Cvitanovic 2003)
    - Correlations intensity & duration of exposure.; but not smoking
    - Progressive changes related to increased risk

Hillerdal et al. Chest 1994; 105; 144-50.; Edge et al. Env Res. 1976; 11; 244-7.

Cvitanovic S et al , **Croat Med J. 2003 Oct;44(5):618-25;**

Asbestos: Carcinogenic Disease

- **Lung Cancer**
- **Mesothelioma**

Clearly associated

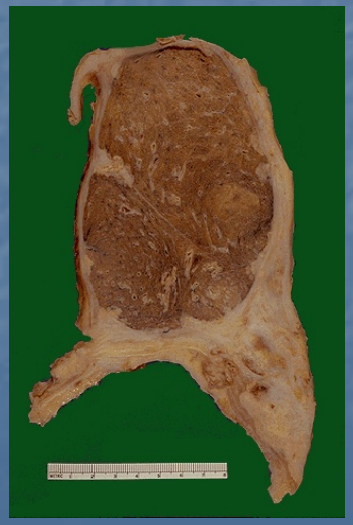
- GI Cancer — Most studies
- Other Cancers — Some studies
  - Laryngeal, Kidney, Ovaries

What is Mesothelioma?

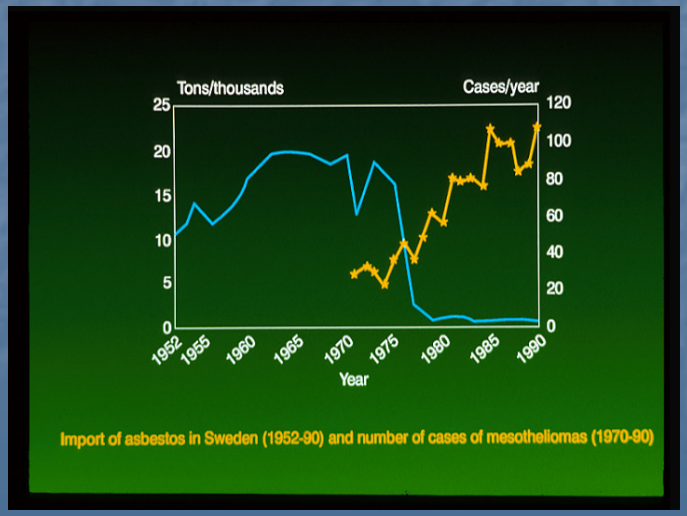
- A rare cancer - affects the lining of the lungs or lung cavity or the lining of the abdominal cavity;
- Known asbestos exposure is primary cause of mesothelioma;
- Most cases develop many decades after known exposure;
- Poor prognosis.

Mesothelioma

- Rare cancer of lining of lung & abdomen
  - Typically occur 20-40 years after exposure
  - 75% die within a year of diagnosis
- Strongly related to asbestos exposure



Rates Still Rising

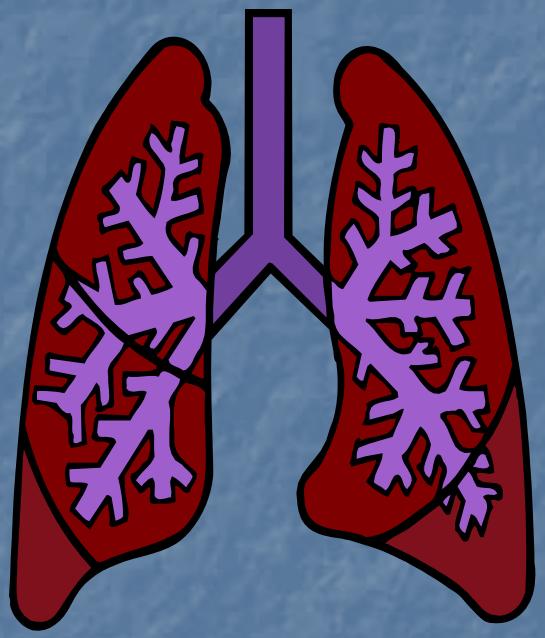


Mesothelioma & Environmental Exposures

- (Hansen, 1993) Wittenoon Crocidolite Mine, Australia
  - Residents with mesothelioma
    - Exposures ranged from 6 weeks to 11 years (5 cases < 1yr)
    - Estimated cumulative exposure as low as 0.53 f/ml
    - 1 case in a person who did not move there until after mine closed
- Other studies also show significantly increased risks
  - Soil exposures in Greece, Turkey, & China
  - Living near mines: South Africa, Canada, Italy
  - Living near processing facilities: Manville, NJ; Casale, Italy

What is Lung Cancer?

- Cancer that invades and blocks the lung's air passages.
- Cigarette smoking greatly increases the likelihood of lung cancer.
- Lung cancer caused by smoking or asbestos looks the same



Asbestos - A Review of the Science

- **Measurement & Monitoring of Asbestos Exposures**

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U.S. Environmental Protection Agency
Region 8

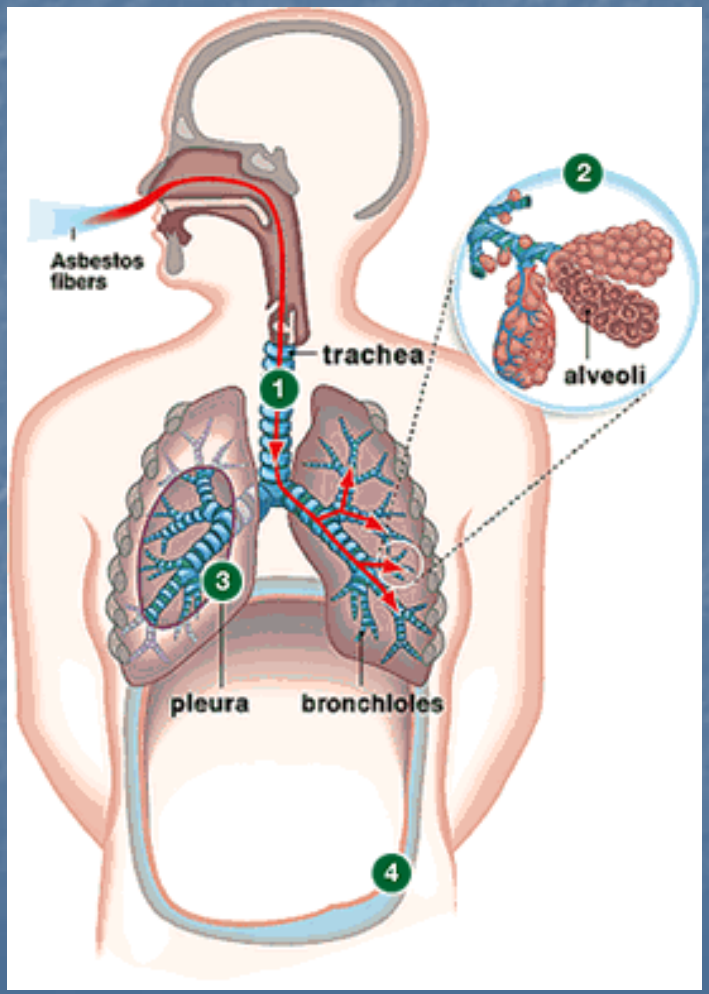
Exposure Pathway Components

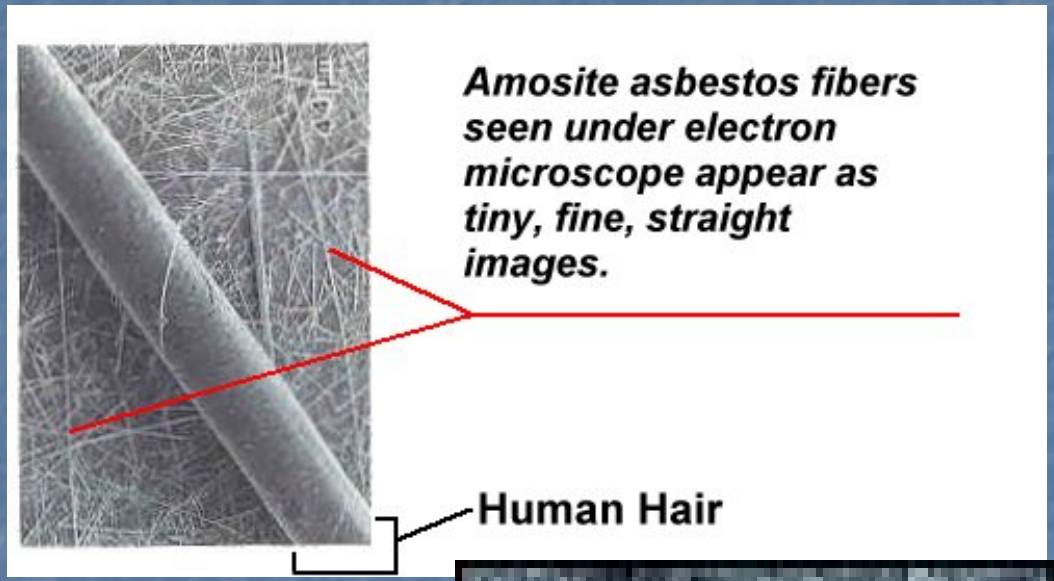
Source	Release Mechanism	Transport Mechanism	Exposure Route	Receptor
• drums • USTs	• spill • leak	• airborne • groundwater	• inhalation • ingestion	• residents • workers
Naturally Occurring Asbestos				
➢ soils ➢ rock	➢ construction ➢ mining	➢ airborne dust	➢ inhalation	➢ residents ➢ children

How Can a Person Become Exposed to Asbestos?

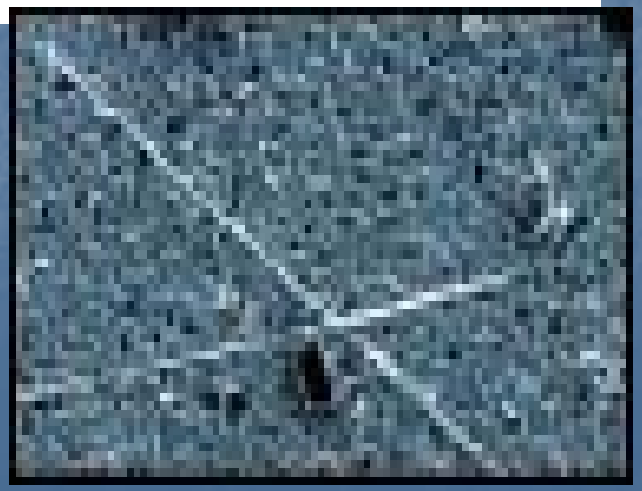
- Fibers become airborne and can be breathed into the lungs;
- Not a problem if:
  - Asbestos-containing minerals in soil are left undisturbed.

Fiber Deposition in the Lung





Tremolite



Phagocytosis of asbestos fibers

pulmonary alveolar macrophage cell attempting to engulf and ingest several long crocidolite asbestos fibers

incomplete ingestion of asbestos fibers can lead to extensive 'selective release' of proteolytic enzymes and ROS from the 'frustrated' PAMs

What is the Risk of Illness from Asbestos?

- People are more likely to experience health effects when they are exposed:
  - to higher concentrations,
  - for longer periods of time, and/or
  - are exposed more often.
- Not everyone who is exposed will develop asbestos-related disease.
  - We all have asbestos fibers in our lungs
  - Exactly how much asbestos exposure is needed to cause illness is not known precisely.

How to Measure Exposure

- Air sampling needed for meaningful exposure assessment;
  - exposure modeling from soil measurements not useful
- Must sample air during dust-generating activities (ambient air measurements do not reflect exposure potential);
- Must characterize all fiber sizes and fiber types.

U.S. EPA's Concern - El Dorado

- Dust-generating activities by children that create a "personal dust cloud"
- "Pig Pen" effect

Why is U.S. EPA Concerned?

- Asbestos is a Known Human Carcinogen that also causes serious non-cancer disease;
- Children are at higher risk;
- Much of El Dorado asbestos is amphibole type (more potent form; chrysotile also toxic);
- Air testing at Oak Ridge H.S. showed elevated exposure potential at sports venues (now clean).

Does the same potential exist at other places where children play in El Dorado?

Summary - EPA Concerns

- What we know:
  - NOA is present in El Dorado Hills
  - Amphiboles are present
  - Elevated asbestos exposure potential existed at ORHS (now cleaned up)
- What we DIDN'T know:
  - Potential for elevated exposure at other schools, playgrounds and sports venues?

Questions

Take Home Concepts

- Asbestos is a risk when airborne;
- Amphiboles are more toxic than chrysotile;
- Children are at higher risk than adults;
- Dusty activities create higher exposures;
- Dust suppression can limit exposure.

What can you do now?
Limit Exposure

- Stay on pavement; avoid mud and exposed soil
- Wipe shoes before coming inside
- Immediately clean up mud and soil tracked indoors
- Wet-mop and wet-wipe surfaces and dispose of the water down the drain
- Avoid dry-sweeping, indoors and out
- Steam-clean carpets if you believe they might hold asbestos-contaminated dust
- Replace carpets with hard surfaces if possible
- Avoid smoking tobacco

What should I do to reduce my risk from asbestos exposure?
THE KEY: PREVENTION

- Minimize / avoid further exposure to any form of asbestos
- STOP smoking / AVOID second-hand smoke
- Get regular medical care

When is Asbestos a Concern in the Environment?

- Exposure concern:
  - When fibers become airborne
  - Risk of breathing in fibers
  - Continued exposure increases the amount of fibers that remain in the lung

- No immediate exposure concern:
  - When left undisturbed or encased in building materials (tiles, insulation) or behind barriers
  - Not able to breath in fibers