
The Health Effects of Dusts
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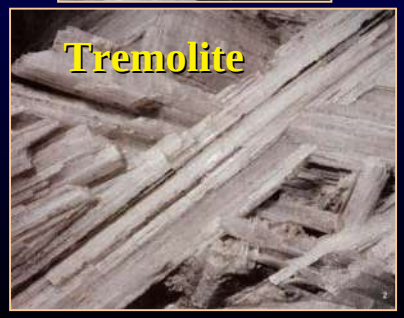
The Health Effects of Dusts

- Some aspects have been well known for decades
  - General effects of industrial / commercial asbestos
  - Silicosis (hard rock mining)
  - Black lung (coal mining)
- New issues and problems are arising
  - Effects of trace asbestos in other rocks, industrial products
  - Valley fever
  - Trans-oceanic dust transport

Why is asbestos toxic?

- Duration and magnitude of the exposure are important
- Needle-like crystals, when inhaled, lodge in and penetrate the alveoli of the lungs
- When ingested, can lodge in and penetrate the lining of the gastro-intestinal tract
- “Protocol” fibers of greatest concern:
  - > 1 micrometer length
  - < 0.5 micrometers long
- Acicular cleavage fragments of non-fibrous amphiboles, serpentine are apparently much less toxic



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Not all forms of asbestos are equally toxic

- Mac Ross of the USGS (Ross, 1999) was one of the first researchers to conclude that not all forms of asbestos are equally carcinogenic or deleterious to health
- Recent studies (i.e, van Oss et al., 1999; Churg et al., 1989): indicate that:
  - Chrysotile can break more easily into shorter fibers, and therefore can be cleared more easily by the lungs
  - The asbestos amphiboles are less soluble than chrysotile in bodily fluids, and therefore cannot be cleared as easily by the body

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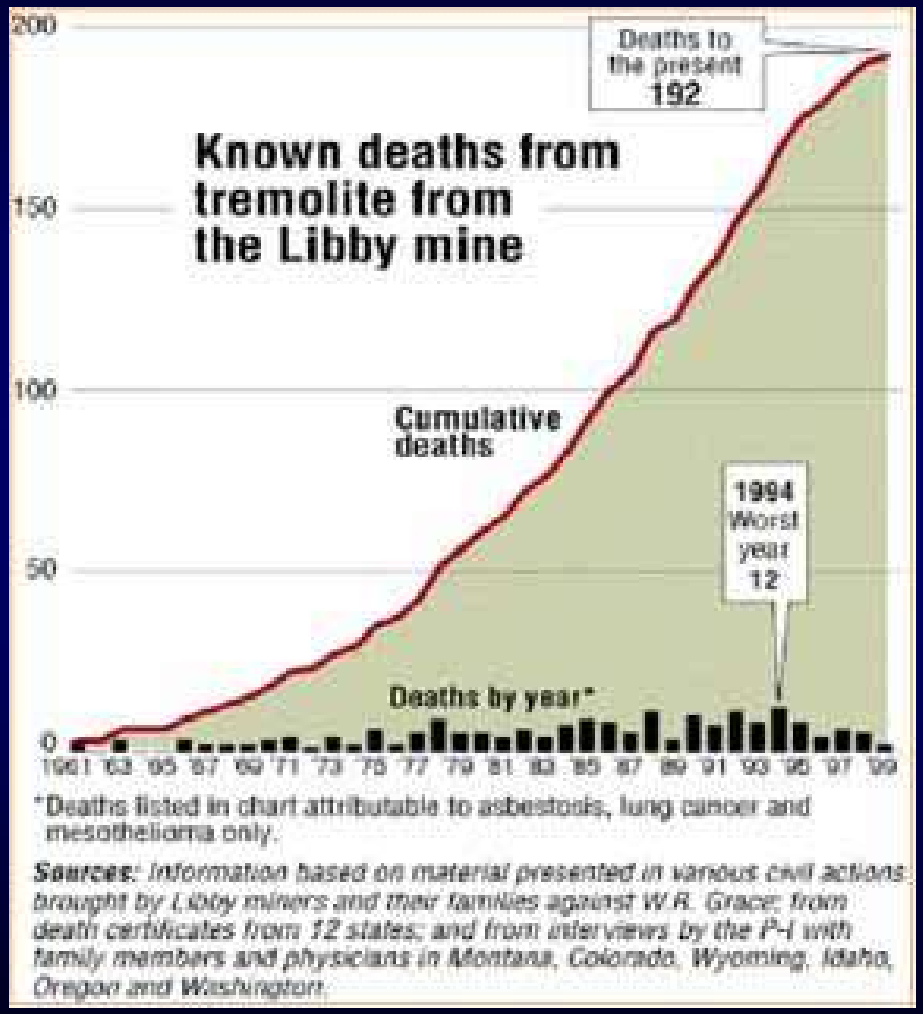
Libby, Montana (pop. ~2500)



- Since 1961 there has been nearly 200 deaths attributed to lung cancer and mesothelioma among vermiculite miners and mill workers, their families, and the general public.
- Another 300 residents currently have these diseases.
- Although known for several decades, the growing health problems at Libby have recently become the focus of intense action by EPA and other regulatory agencies.

Images from Seattle Post-Intelligencer

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Libby, Montana

- Libby provided the majority of the United States' vermiculite production for 80 years, until the mine was shut down in 1990.
- Libby ore was shipped to at least 315 locations around the U.S., Canada, and overseas for "popping", a process during which it is heated to 2000°F to cause the vermiculite to expand in thickness greatly, accordionlike, perpendicular to its plates.

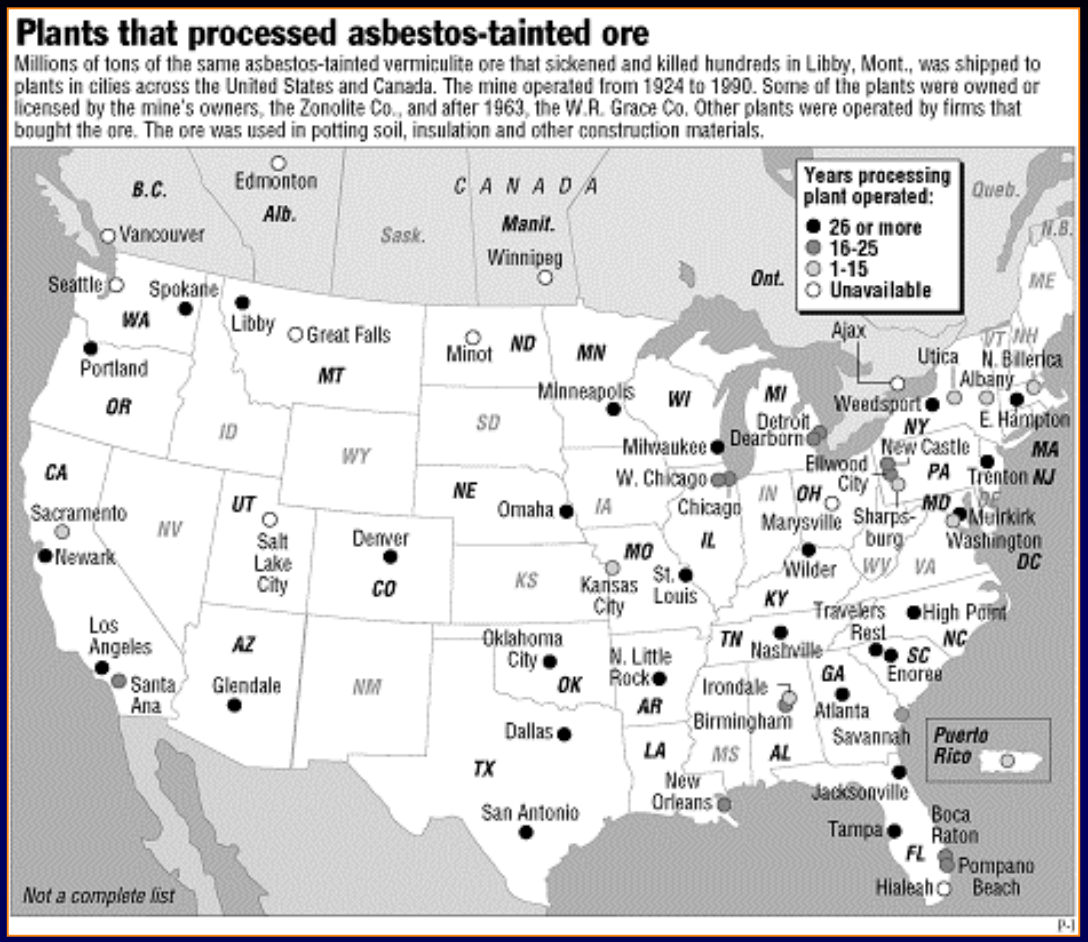
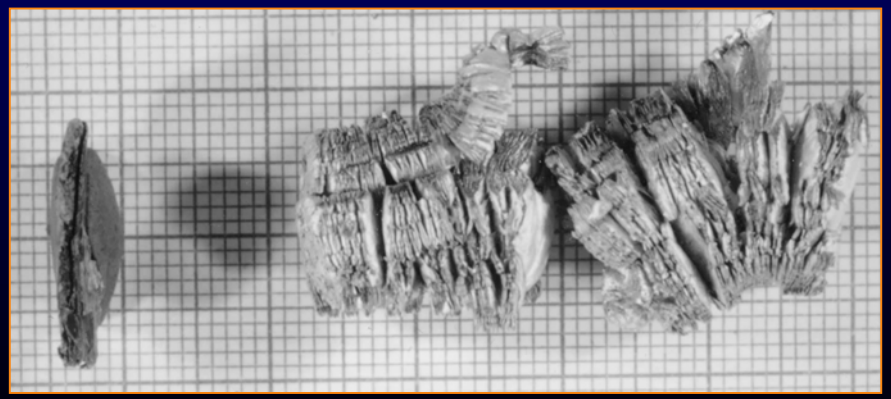


Image from Seattle Post-Intelligencer



Raw vermiculite ore (left); popped (exfoliated) vermiculite (right).
Photo by Al Bush

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Dusts and the origin of Valley Fever (Coccidiomycosis)

- Coccidiomycosis is a reemerging infectious disease
- *C. immitis* is the etiological agent of coccidiomycosis
- *C. immitis* is a soil inhabiting fungus found in North, Central, and South America.
  - Given proper conditions, infectious spores are released when soil is disturbed
    - ie, storms, construction, earthquakes
- Acknowledgments to
  - Mark Bultman (mbultman@usgs.gov); Randy Jibson (rjibson@usgs.gov)

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Valley Fever-Clinical Presentation

- 7,500 new cases of Valley Fever occur annually in the U.S.A, with a cost in excess of $60 million a year.

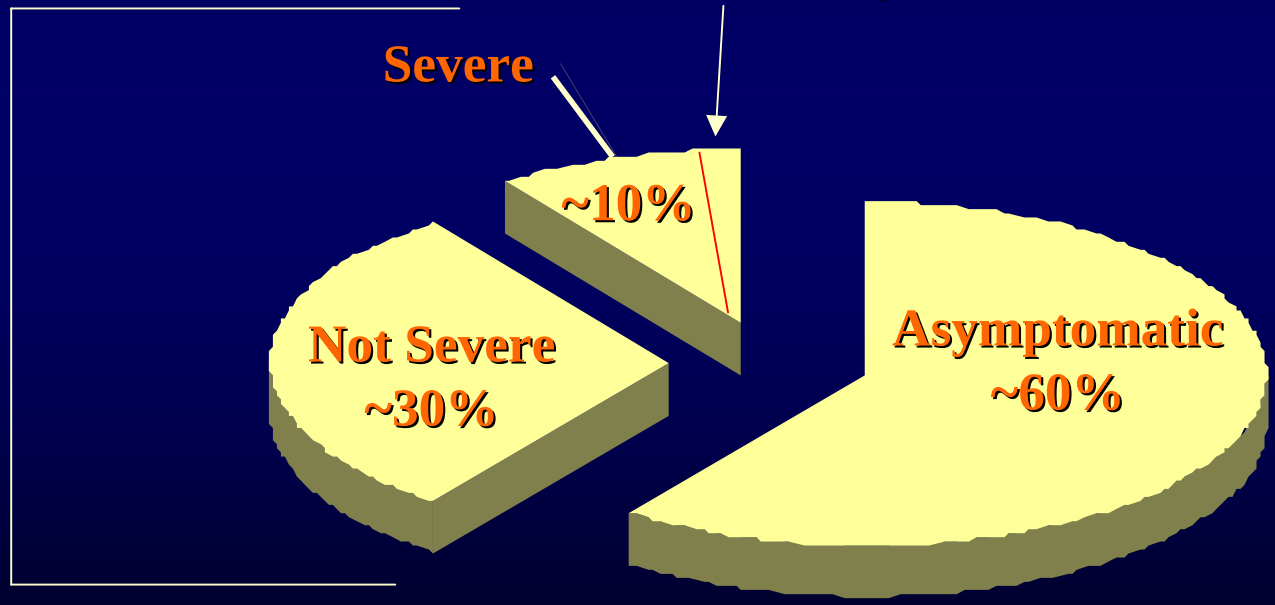
Valley Fever (Coccidioidomycosis)

- Clinical manifestations occur in ~40% of infected persons

In ~1% to 2% of cases the disease becomes disseminated, and affects skin, bones, or joints, or develops into meningitis (<1 % fatal)

self -limited influenza-like illness to pneumonia

fatigue
cough
chest pain
fever
rash
headache
joint ache



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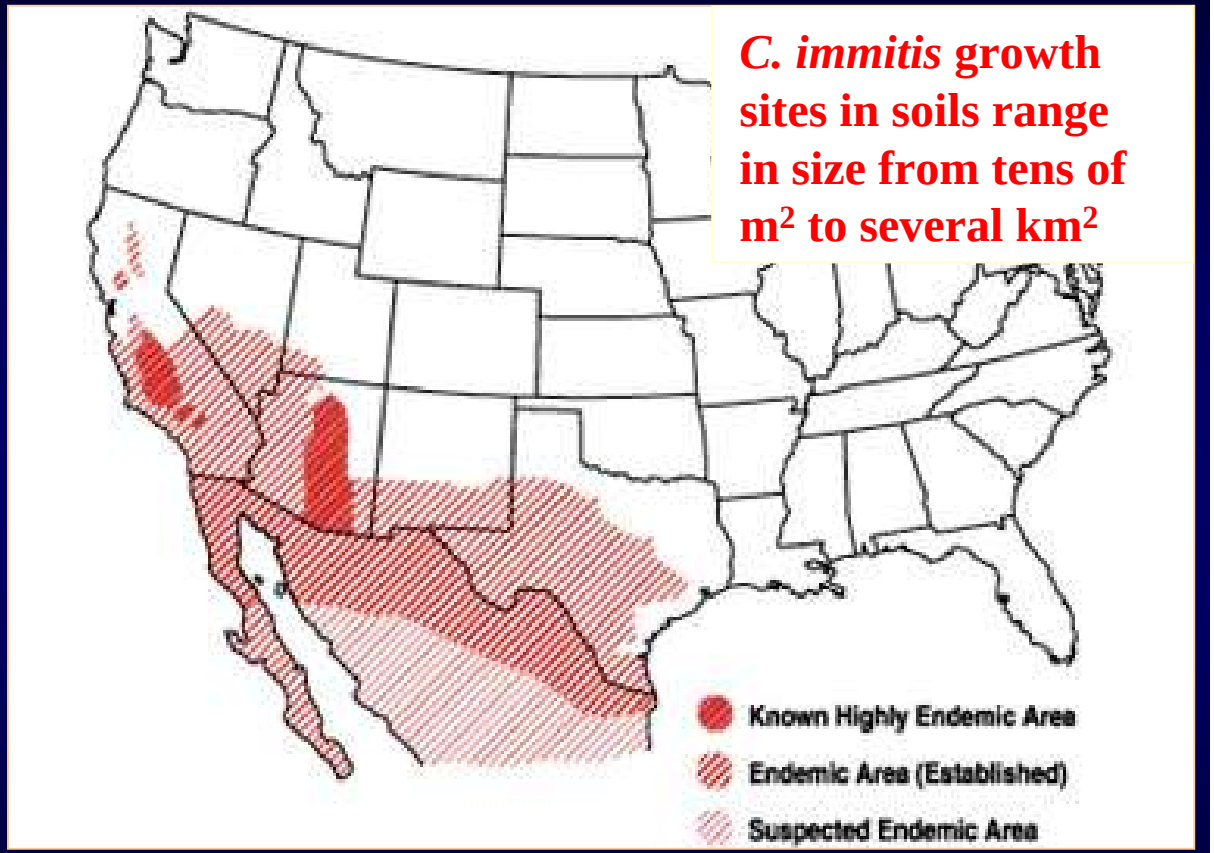
Dusts and the origin of Valley Fever (Coccidioidomycosis)

Coccidioidomycosis epidemiology

- Common in parts of desert southwest, but...
- Persons receiving packages and clothing from endemic regions have been infected by the aerosols created by handling
- Travelers passing even briefly through endemic areas can be infected and develop the illness well away from endemic areas



***C. immitis* growth sites in soils range in size from tens of m^2 to several km^2**

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Dusts and the origin of Valley Fever (Coccidioidomycosis)

- Geologic links to Valley Fever
  - Boron-rich, alkaline soils?
  - Marine shale parent rocks?
  - Evaporative alkaline salts?
  - Slope, shape of topography
- Dust storms have been shown to carry spore laden dirt as far as 700 km, causing outbreaks

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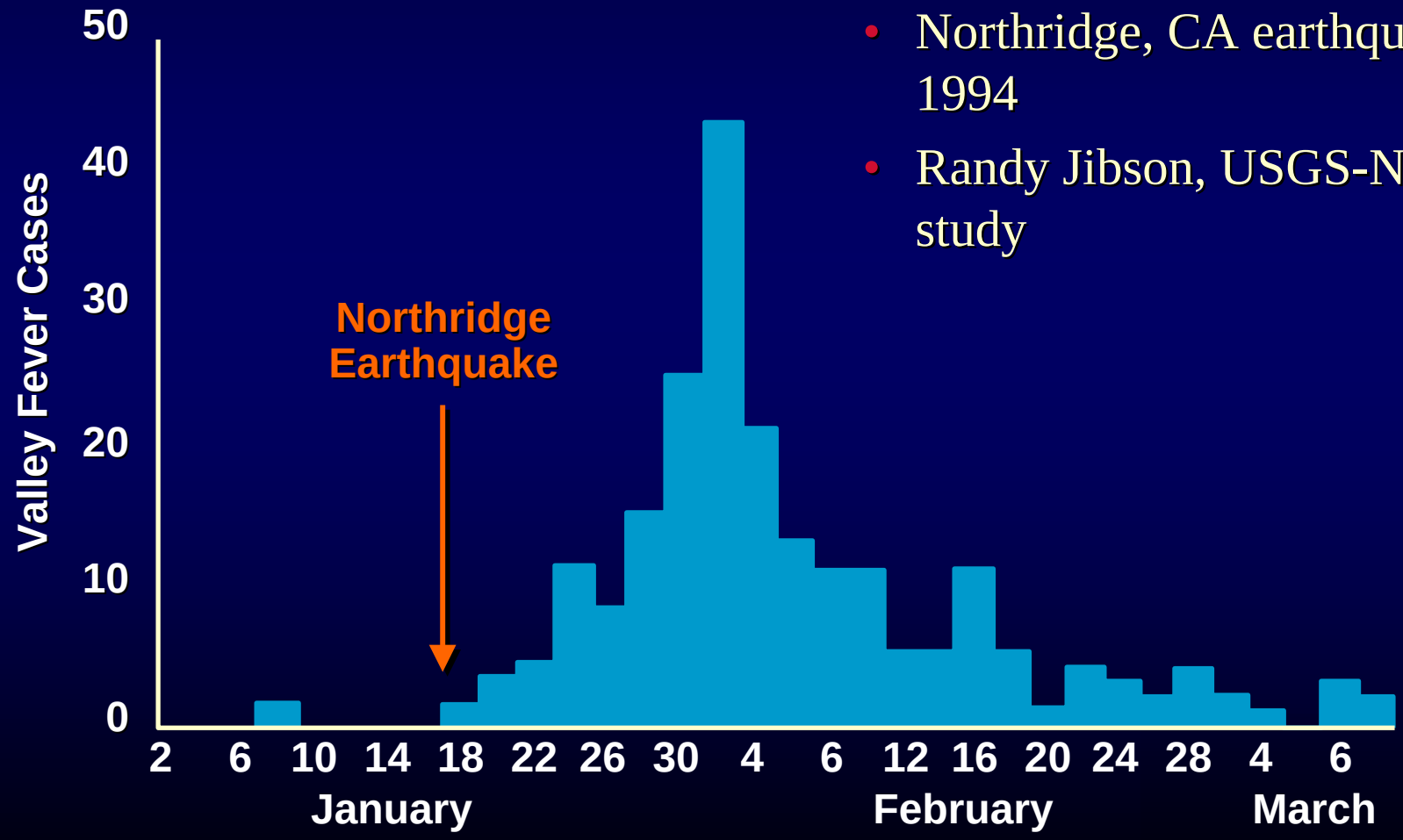
Geologic links to Valley Fever

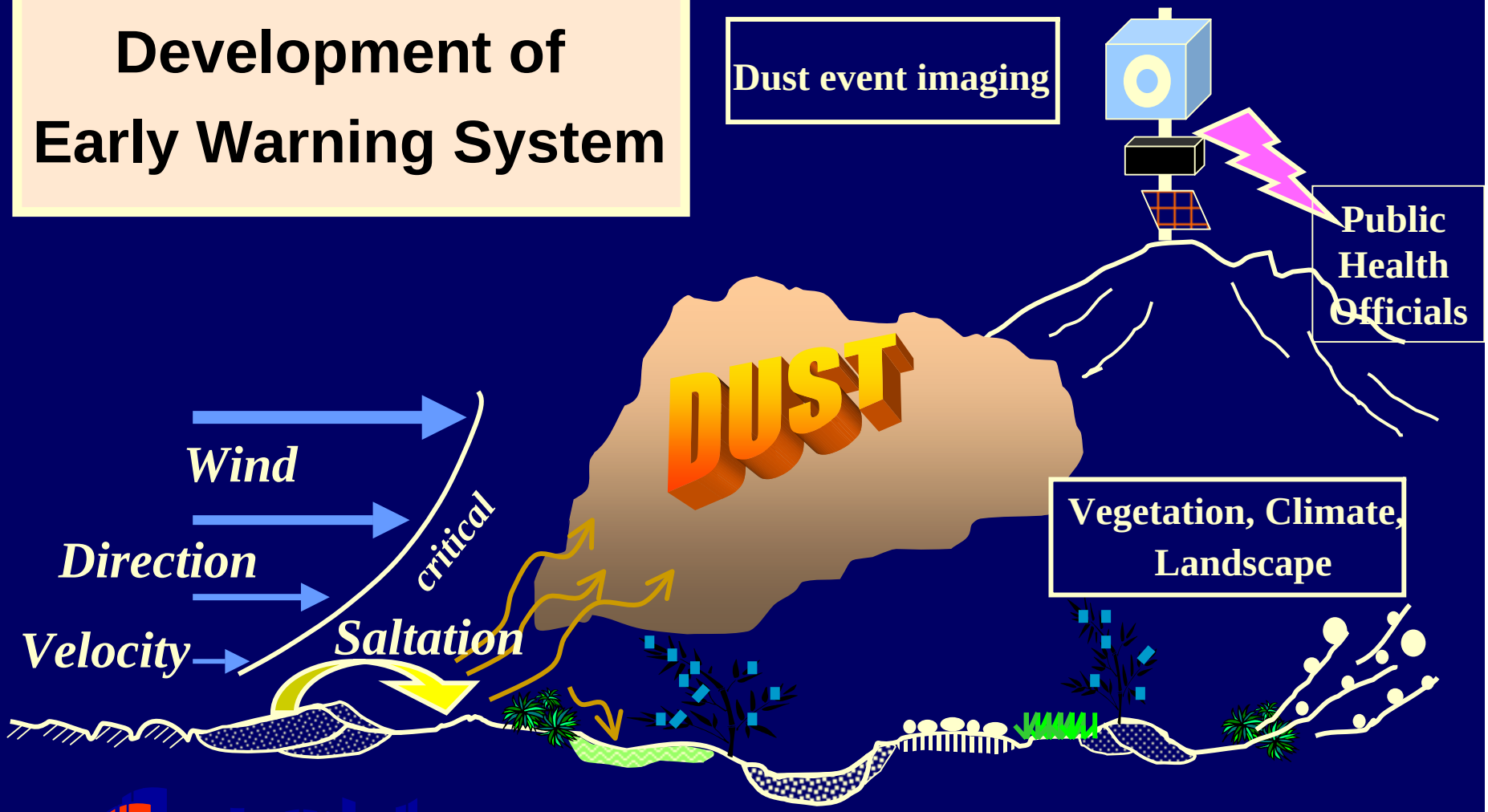
Valley Fever cases after Northridge earthquake

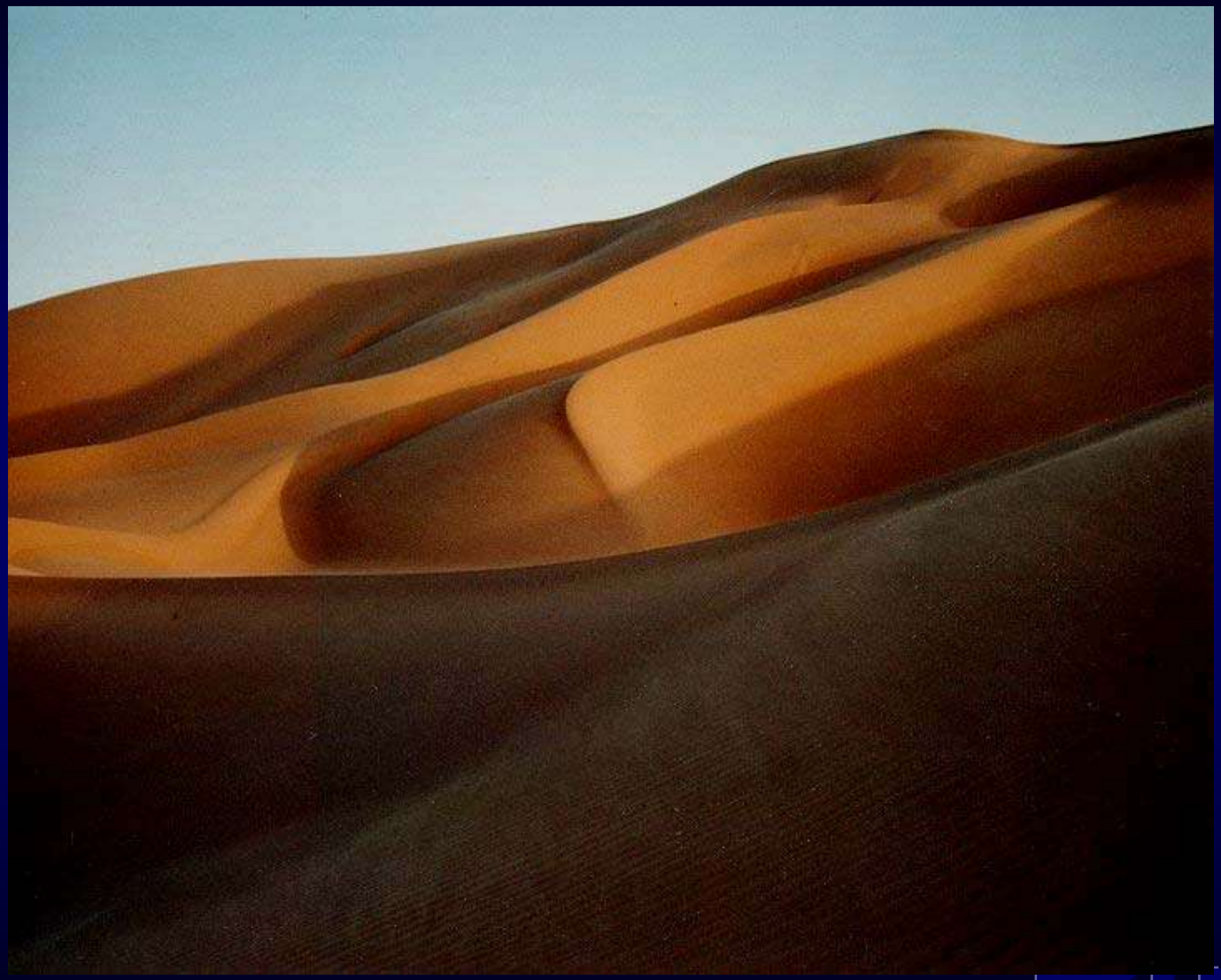
From Jibson et al., 1998



- Earthquakes can trigger VF epidemics by generating landslides and their resulting dust clouds
  - Northridge, CA earthquake, 1994
  - Randy Jibson, USGS-NIH study

Development of Early Warning System





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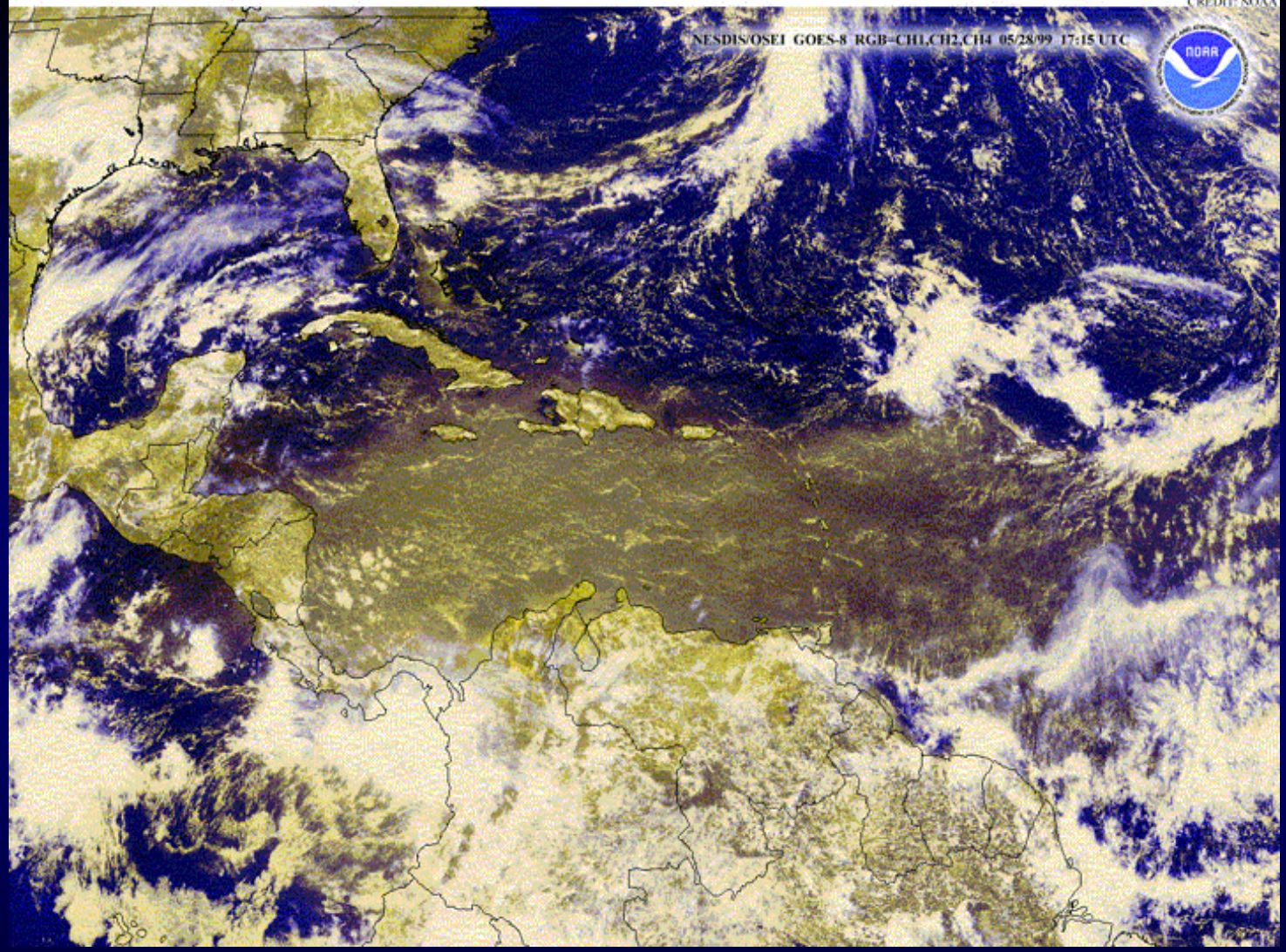
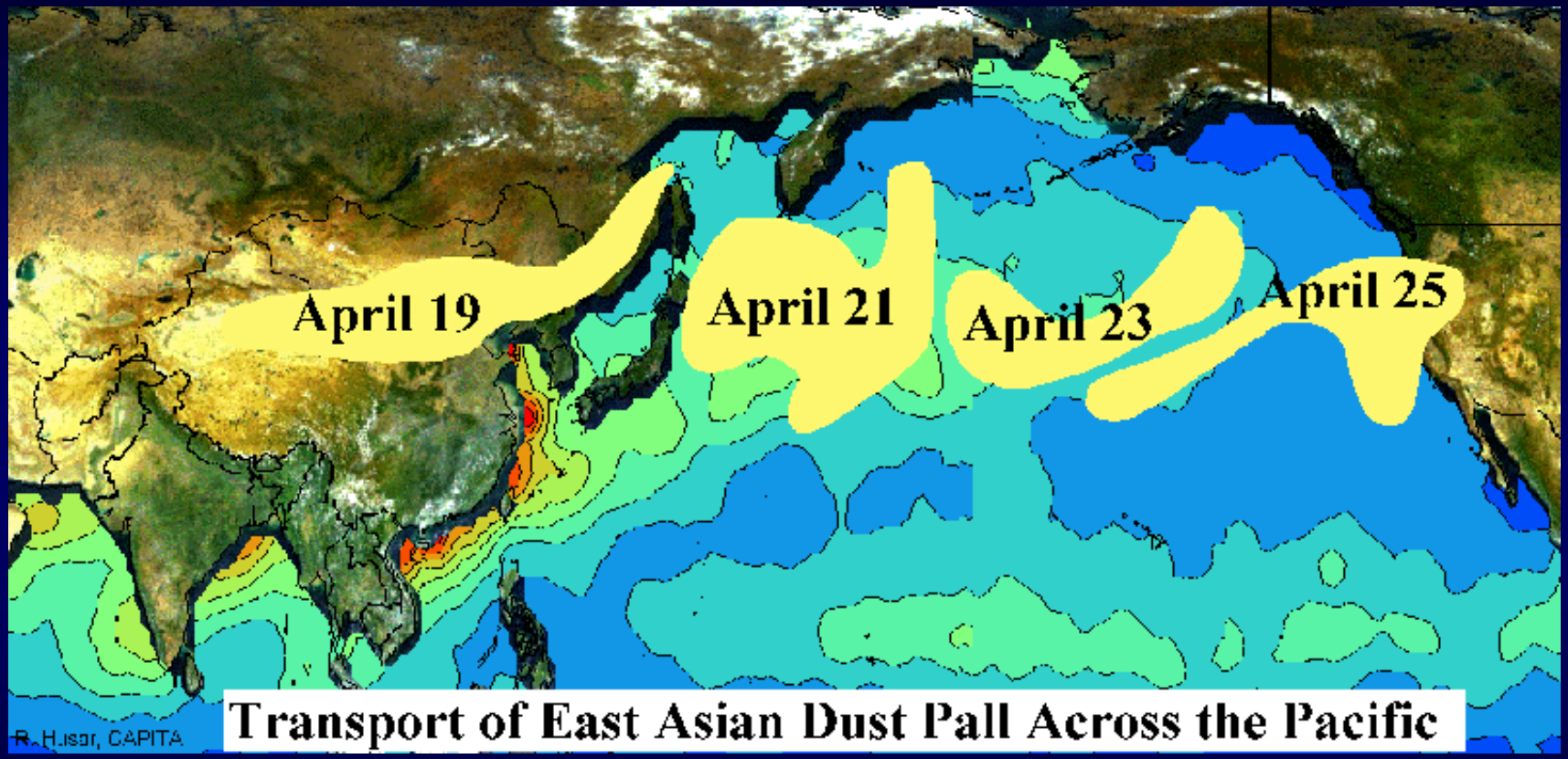
Airborne dust (brown haze) over the Caribbean Sea. This dust originated in the Sahara Desert of western Africa where it was lifted and carried off the coast by strong winds.

CREDIT: NOAA



- 100’s of millions of tons of intercontinental dust is deposited annually.
- This dust is increasingly viewed as a key component of some terrestrial and marine ecosystems, as well as a potentially significant source of pathogens and environmental contaminants.

Location of 1998 dust cloud based on SeaWiFS, GMS5, GOES9, GOES10, TOMS satellite data



R.B. Husar and 28 others

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Coal Miners “Black Lung Disease”

National Museum of Health and Medicine, Washington, DC

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Trans-Atlantic transport of African dust

African dust may be responsible for a number of environmental hazards;

- Demise of Caribbean corals
- Red tides, amphibian diseases
- Increased occurrence of asthma, lung diseases in humans
- Decrease of oxygen (eutrophication) in estuaries.

- New studies at the University of South Carolina Aiken have identified several species of a soil fungus, *Aspergillus*, in dusts samples collected in the Carribbean

- Lung infections caused by several species of *Aspergillus* are a leading cause of mortality in AIDS victims.

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The Health Effects of Dusts - Summary

- Some aspects have been well known for decades
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- New issues and problems are arising
  - Effects of trace asbestos in other rocks, industrial products
  - Valley fever
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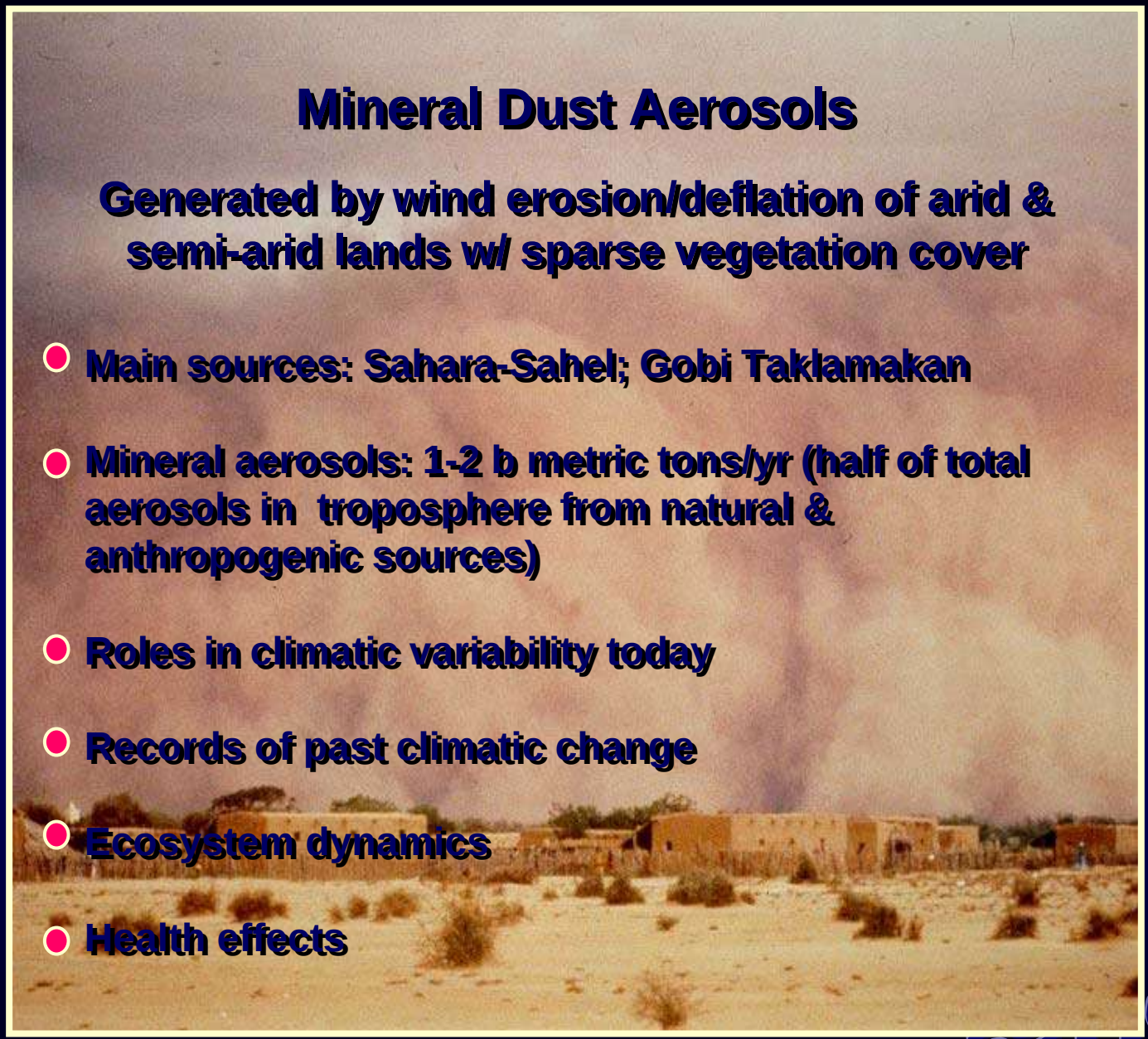
Mineral Dust Aerosols

Generated by wind erosion/deflation of arid & semi-arid lands w/ sparse vegetation cover

- Main sources: Sahara-Sahel; Gobi Taklamakan
- Mineral aerosols: 1-2 b metric tons/yr (half of total aerosols in troposphere from natural & anthropogenic sources)
- Roles in climatic variability today
- Records of past climatic change
- Ecosystem dynamics
- Health effects



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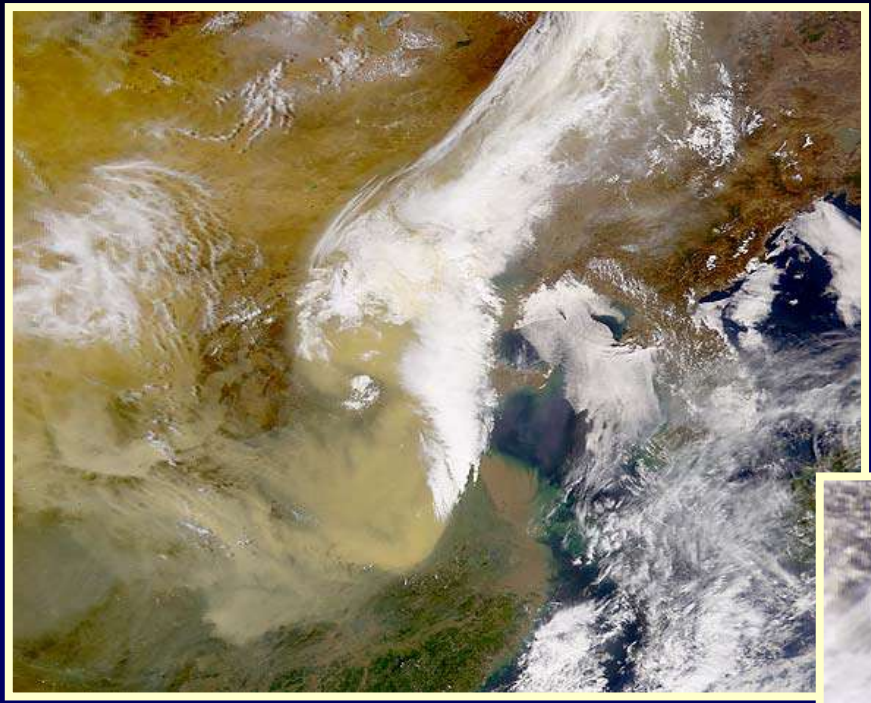

Dust storm forming over the Gobi

April 16, 1998

Dust arriving at North America

April 25, 1998

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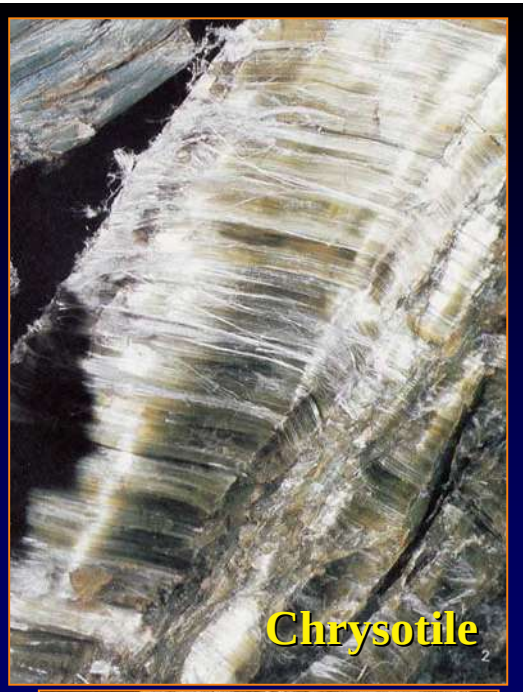
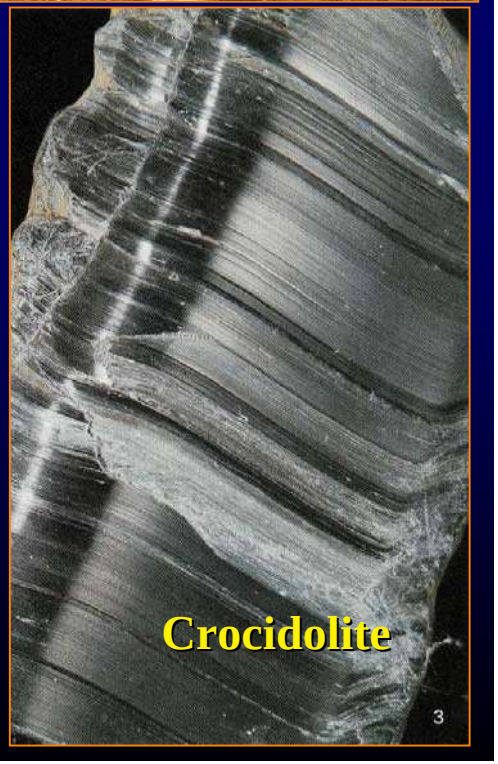
Asbestos: an evolving health issue

- Asbestos is a generic commercial term originally applied to mineral products that are fibrous and flexible, with high tensile strength, resistance to chemical and thermal degradation, large surface area and weavability. The term includes a variety of minerals:
  - Chrysotile - a fibrous variety of serpentine
  - Crocidolite - a fibrous variety of the amphibole riebeckite
  - Fibrous anthophyllite - a fibrous amphibole
  - Amosite - fibrous grunerite amphibole
  - Fibrous tremolite and actinolite - fibrous amphiboles
- Asbestos was used in many different industrial applications and commercial products prior to the 1980's, because of its heat resistance and flexibility
  - Insulation; auto brake linings; roofing; linoleum backing; fire-proof clothing; sewer and water pipes; spray-on ceilings





Asbestos: an evolving health issue

- The deleterious health effects of asbestiform minerals have been recognized for decades, and were widespread among people employed in some asbestos mining and processing, or in manufacturing making use of asbestos:
  - mesothelioma cancers, other cancers of the lung, asbestosis, cancers of stomach
  - asbestosis-induced heart failure
- Multiple decades between exposure, disease
- Mac Ross of the USGS was one of the first researchers to conclude that not all forms of asbestos are equally carcinogenic or deleterious to health:
  - Chrysotile is much less carcinogenic than amosite, crocidolite, asbestiform anthophyllite, asbestiform tremolite / actinolite, asbestiform erionite (a zeolite)

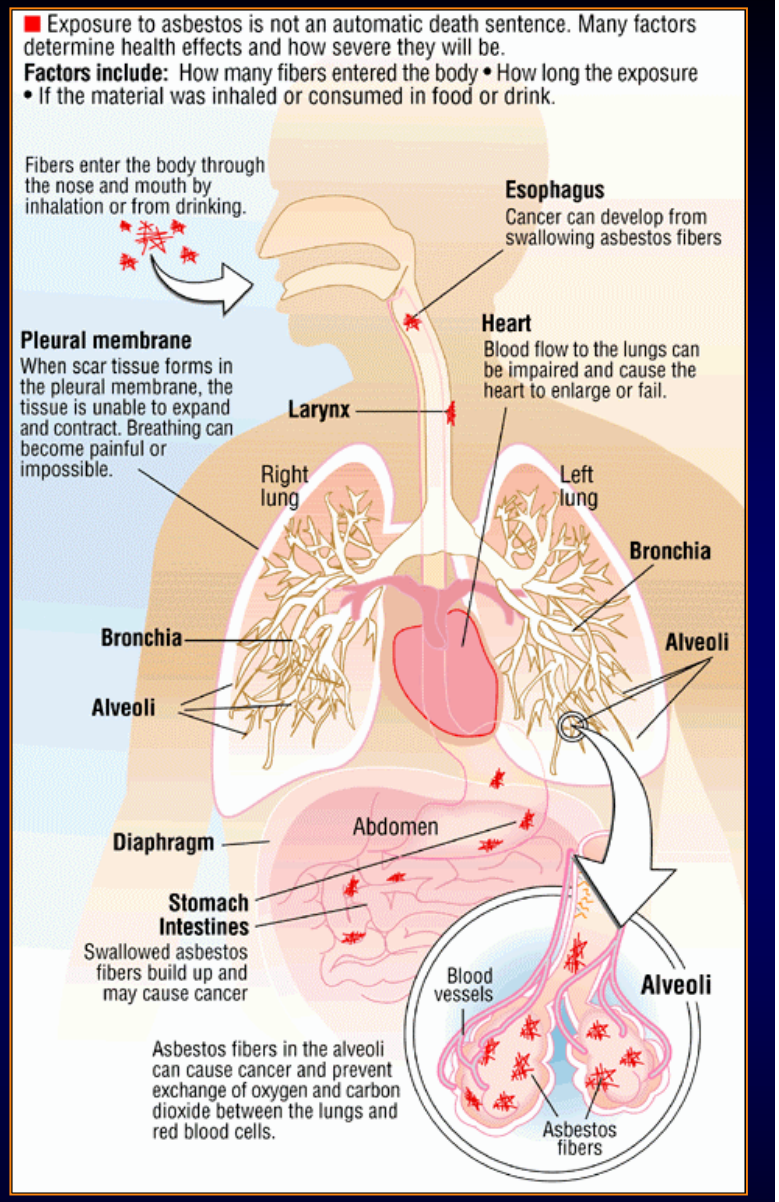


Image from Seattle Post-Intelligencer

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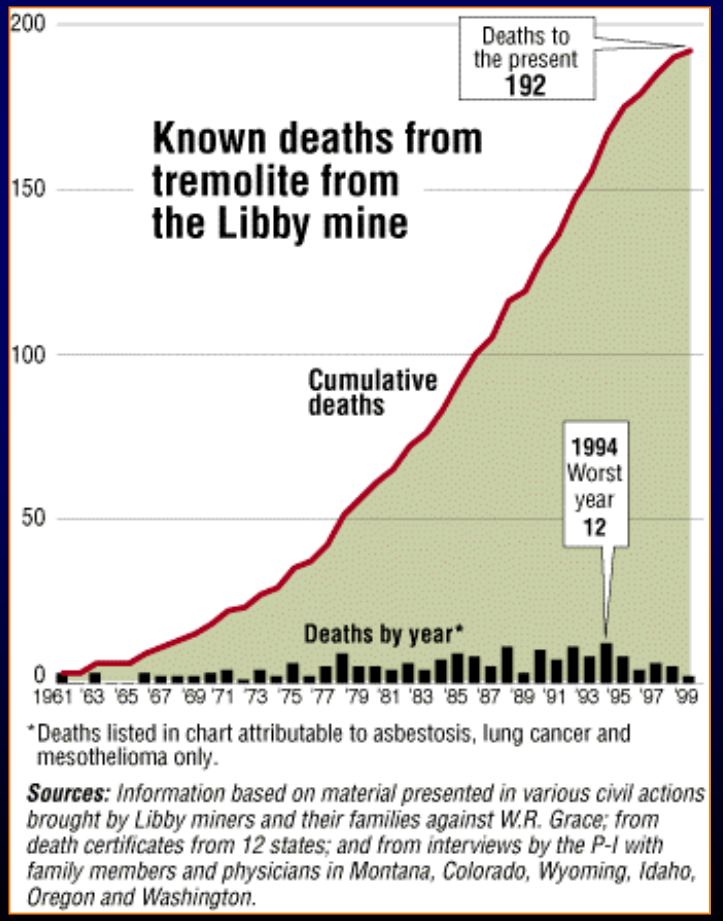
Libby, Montana

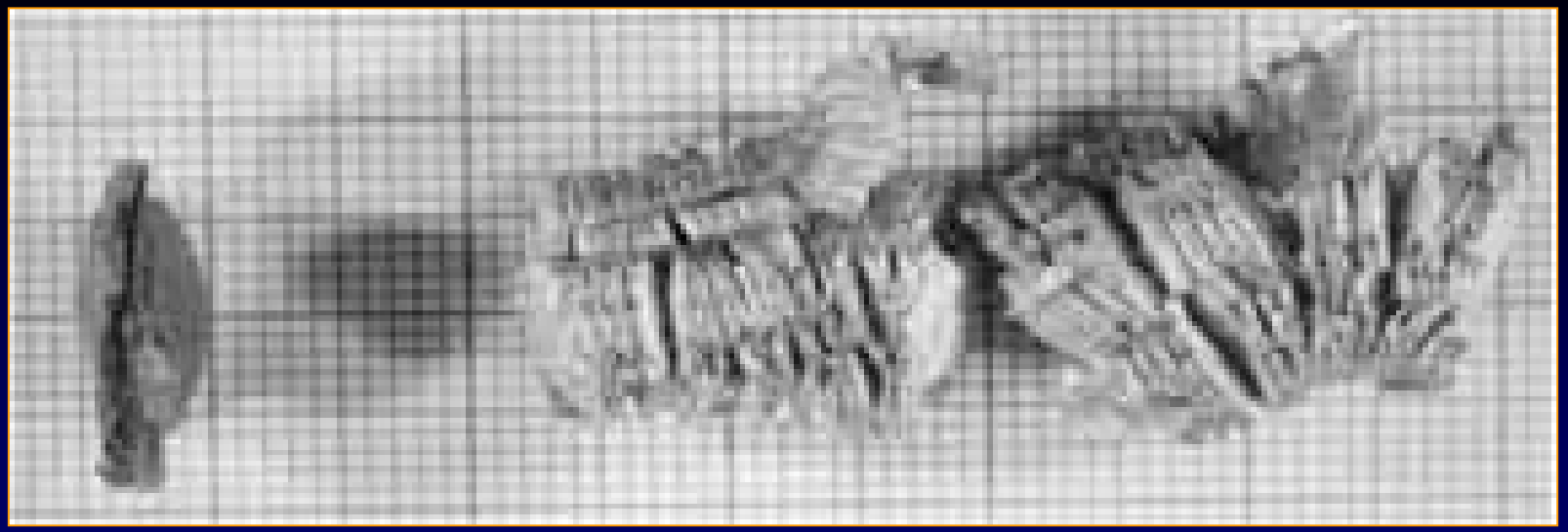
- In late 1999, the Seattle Post-Intelligencer (http://www.seattlep-i.com) ran a series of articles highlighting very high incidences of mesothemlioma, other cancers, and asbestosis among vermiculite miners and mill workers, their families, and the general public in Libby, Montana (pop. ~2500).
  - Nearly 200 deaths “attributable to asbestosis, lung cancer, and mesothelioma”
  - Reportedly another 300 residents currently have these diseases
- Fibrous tremolite, a potentially highly toxic form of asbestos, is a common trace mineral in the vermiculite mined at Libby.
- Although known for several decades, the growing health problems at Libby have recently become the focus of intense action by EPA and other regulatory agencies.

Images from Seattle Post-Intelligencer



Libby, Montana

- Vermiculite puffing leads to the liberation of asbestos fibers contained within the vermiculite
- EPA has estimated that the Libby puffing plant was discharging over 5 tons of asbestos-rich dust each day into the air
- Unusually high clusters of mesothelioma, lung cancer, and asbestosis are now being identified in workers at an residents around a number of the puffing plants around the US to which Libby vermiculite was shipped



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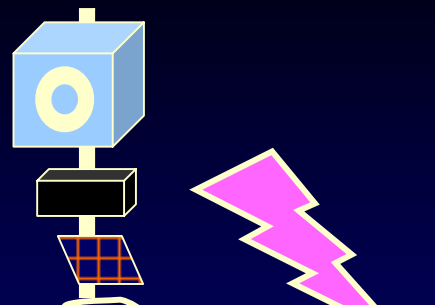
Development of Wind Erosion Model

Calibration
Dust event imaging



Atmospheric boundary layer

Change monitoring

Vegetation, Climate, Landscape

Surface

Armor, roughness RS extrapolation	Sediment availability Soil characteristics

Surface response

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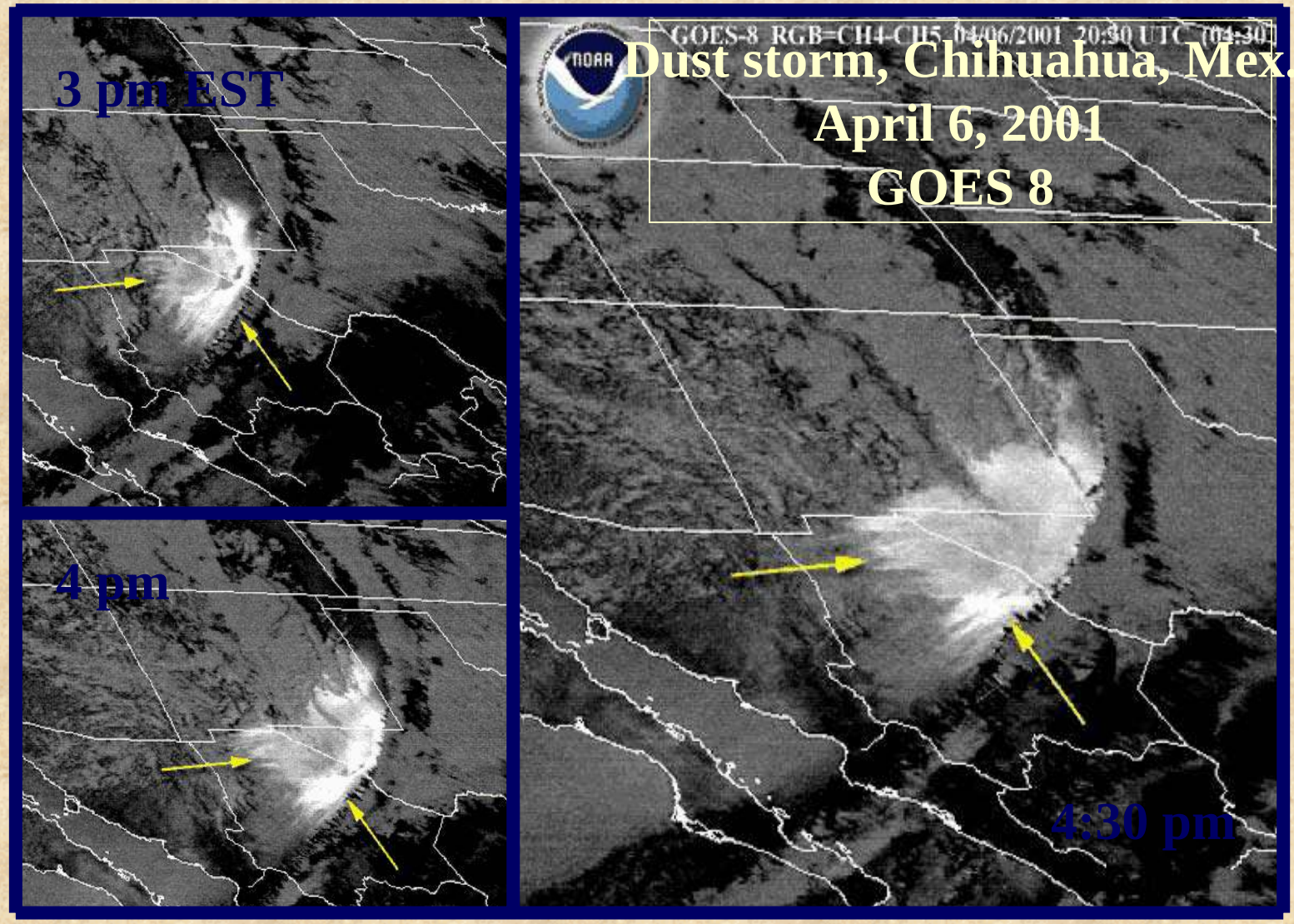
Trans-Atlantic transport of African dust

- Agriculture in the Bahamas depends significantly on accumulation of African dust to form the red soils often referred to as pineapple loam

- The dust also transports significant amounts of iron, phosphorous, and sulfate, key nutrients for ecosystems

The satellite image at left, acquired by NASA/Goddard Spaceflight Center's SeaWiFS Project and ORBIMAGE on February 26, 2000, shows one of the largest Saharan dust storms ever observed by SeaWiFS as it moves out over the eastern Atlantic Ocean. Spain and Portugal are at upper right, Morocco is at lower right.


3 pm EST
4 pm
GOES-8 RGB=CH4-CH5 04/06/2001 20:30 UTC (04:30
Dust storm, Chihuahua, Mex.
April 6, 2001
GOES 8
4:30 pm

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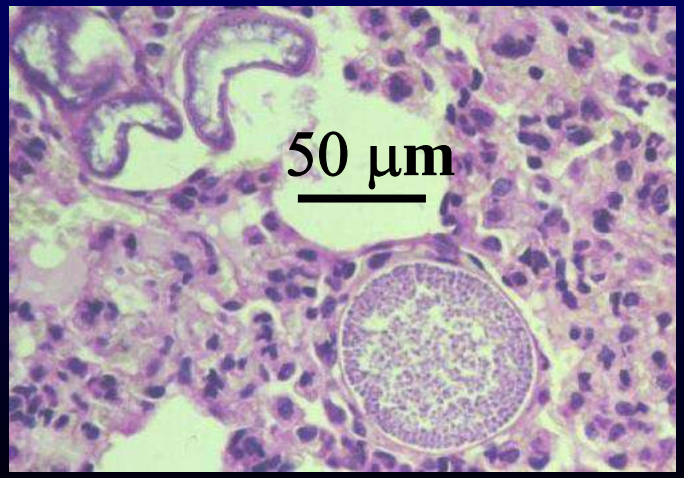
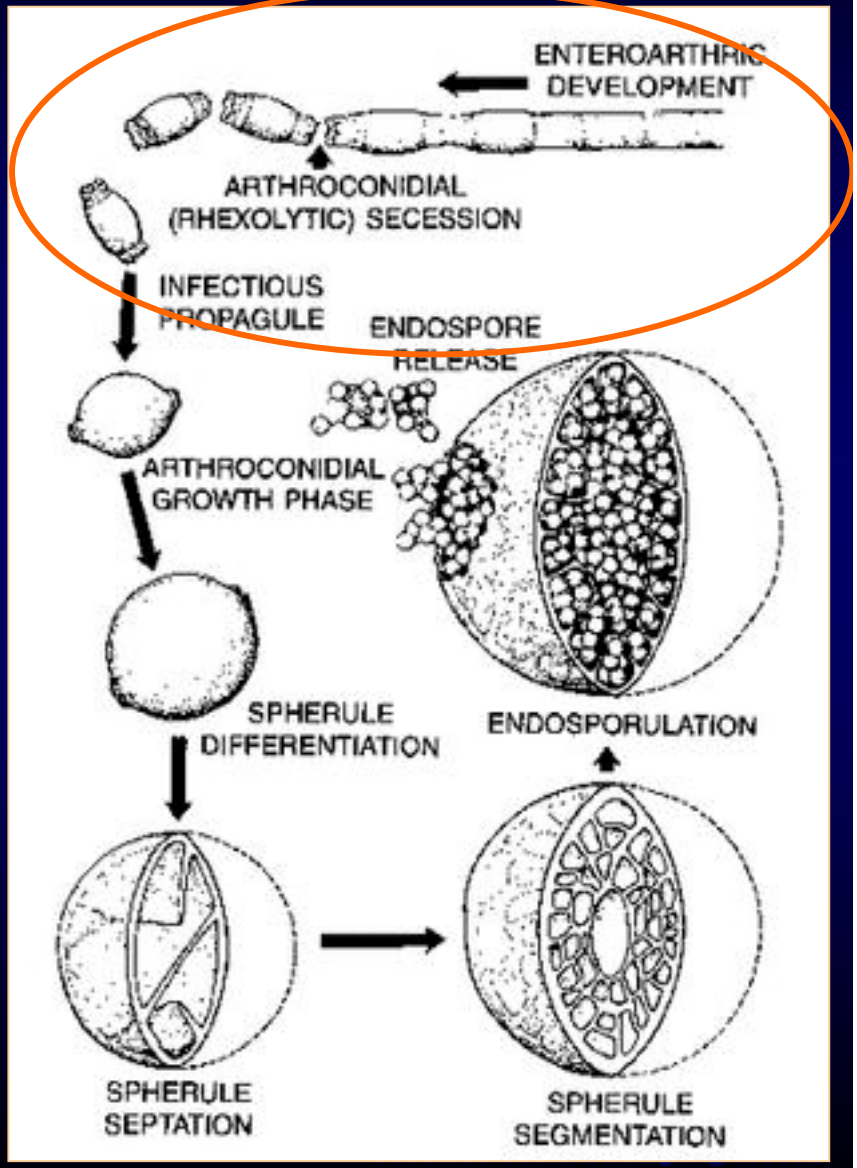
Valley Fever (Coccidiomycosis)

- A systemic infection caused by the inhalation of airborne spores of *Coccidioides immitis*

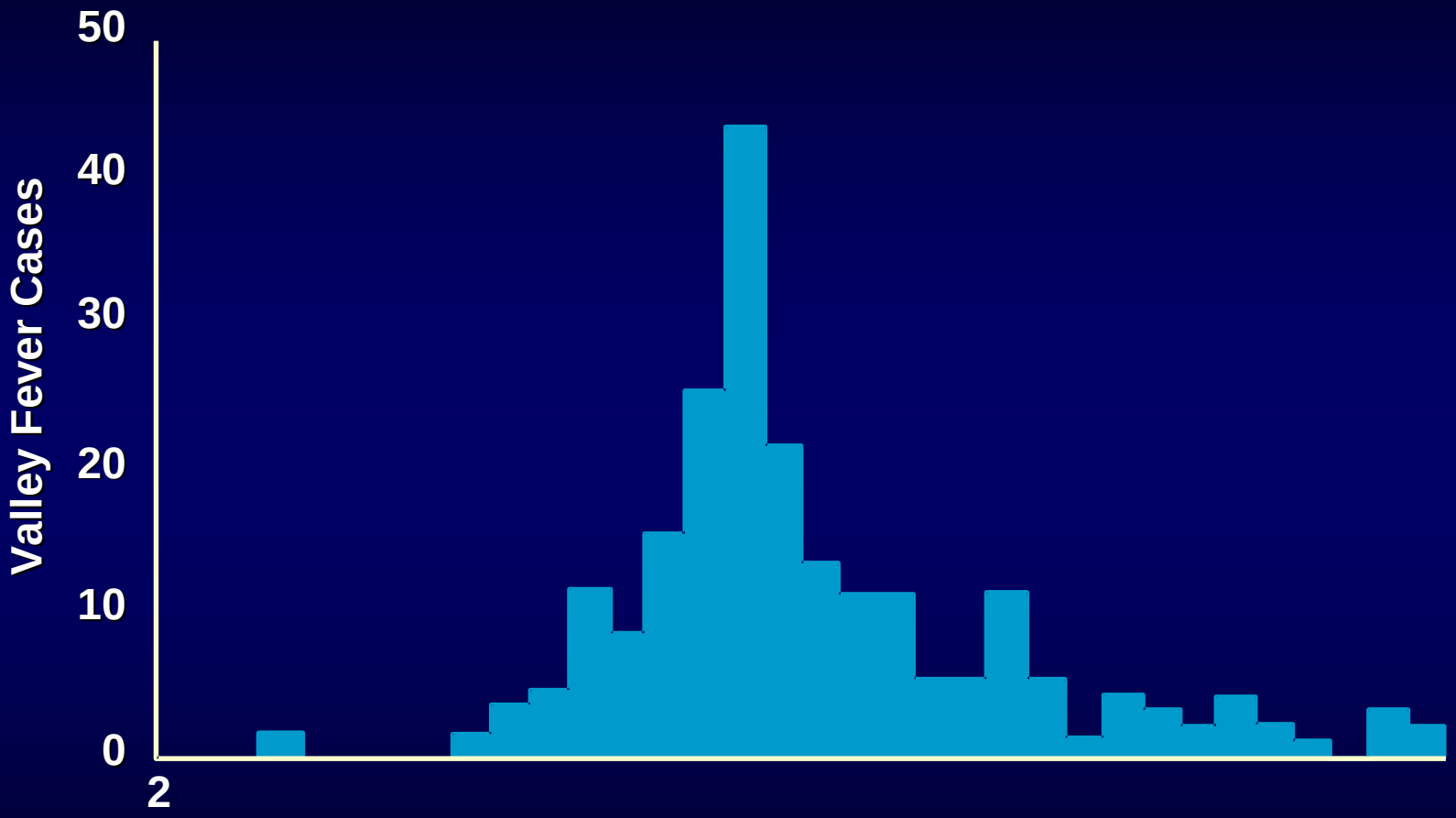


C. immitis life cycle

Occurs in soil



Incidence of Valley Fever



Valley Fever (Coccidioidomycosis)

- 7,500 new cases of Cocci annually in the U.S.A. alone. This translates to a cost that may exceed $60 million a year.
- *"The medical and indirect costs for people with the most benign illness range from $3,000 to $5,000 per case. For those who experience a more severe illness, costs climb from $30,000 to $300,000 - especially for those who get meningitis or who are hospitalized for a long time. The average is $8,000 per case overall."* John Caldwell, Director of Clinical Research
  Kern Medical Center

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