Other Medical Geology Issues

Robert B. Finkelman
U.S. Geological Survey
rbf@usgs.gov

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Medical Geology-Range of Issue

- Trace Element Exposure- As, Hg, F, Se, Zn, Al
- Dust- Asbestos, African, Valley Fever, Silicosis, CWP,VOG
- Radionuclides - Radon, Radium, Uranium
- Organics - VOCs, MTBE, PAHs, Antibiotics, Pesticides
- Microbes, Pathogens - West Nile Encephalitis, LaCrosse Encephalitis, Plague, Hantavirus, Rift Valley Fever, Lyme disease, etc.

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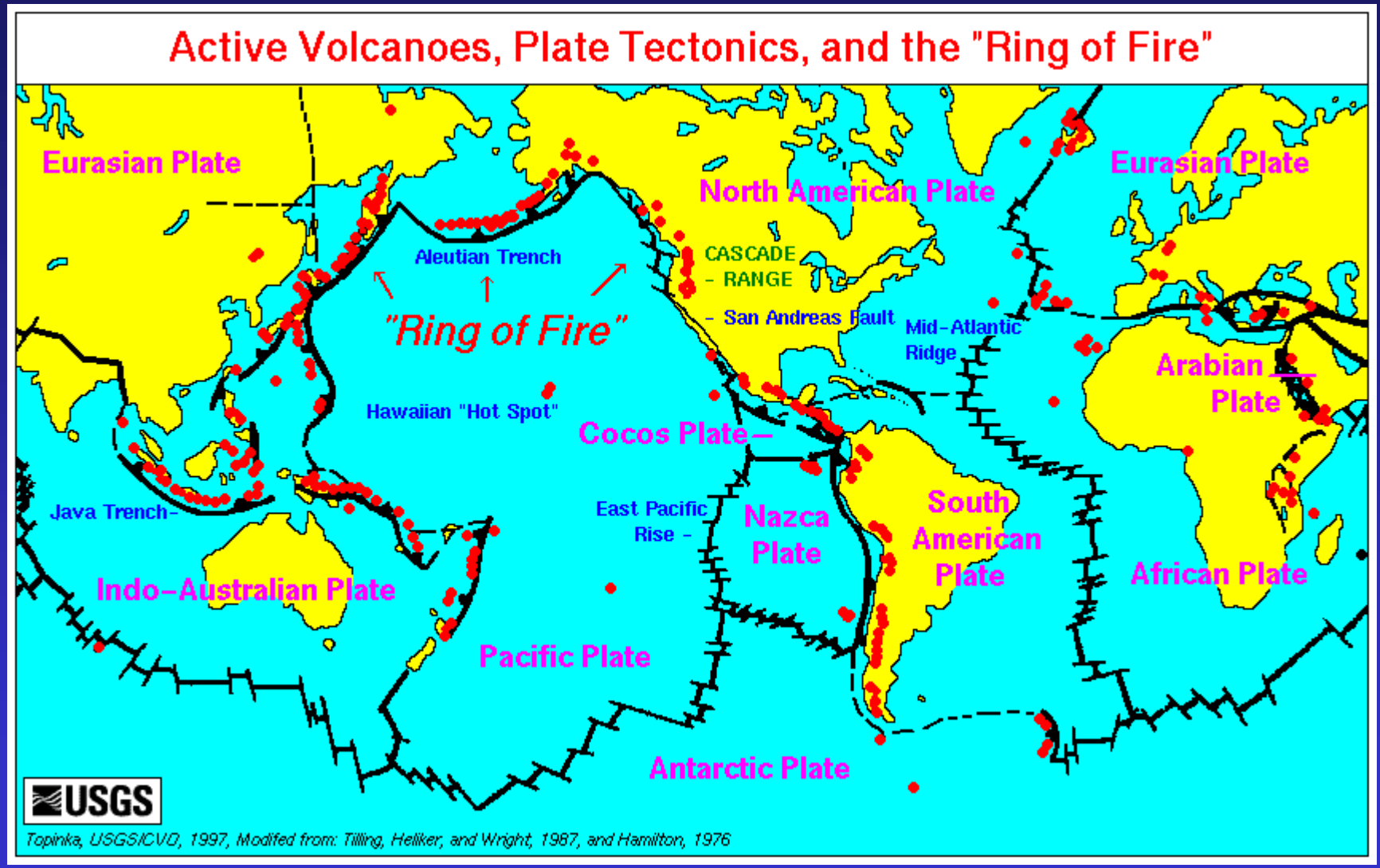
Other Medical Geology Issues – Outline

- Volcanism
- Organics (BEN)
- Radioactivity
- Pathogens and Microbes
- Mseleni Joint Disease
- Occupational Health


Active Volcanoes, Plate Tectonics, and the "Ring of Fire"
Eurasian Plate
North American Plate
Eurasian Plate
Aleutian Trench
CASCADE
- RANGE
- San Andreas Fault
"Ring of Fire"
Mid-Atlantic
Ridge
Arabian
Plate
Hawaiian "Hot Spot"
Cocos Plate
Java Trench
East Pacific
Rise
Nazca
Plate
South
American
Plate
African Plate
Indo-Australian Plate
Pacific Plate
Antarctic Plate
USGS
Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

Health effects of other eruptive events

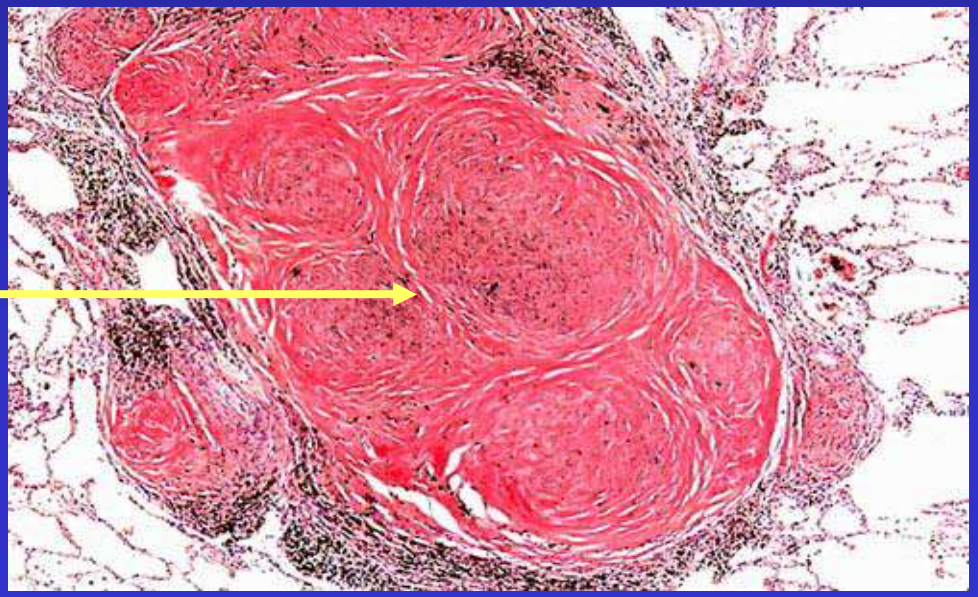
- **Lava flows**
- **Pyroclastic flows**
- **Volcanic activity and aquatic environments**

The health effects of tephra dispersal

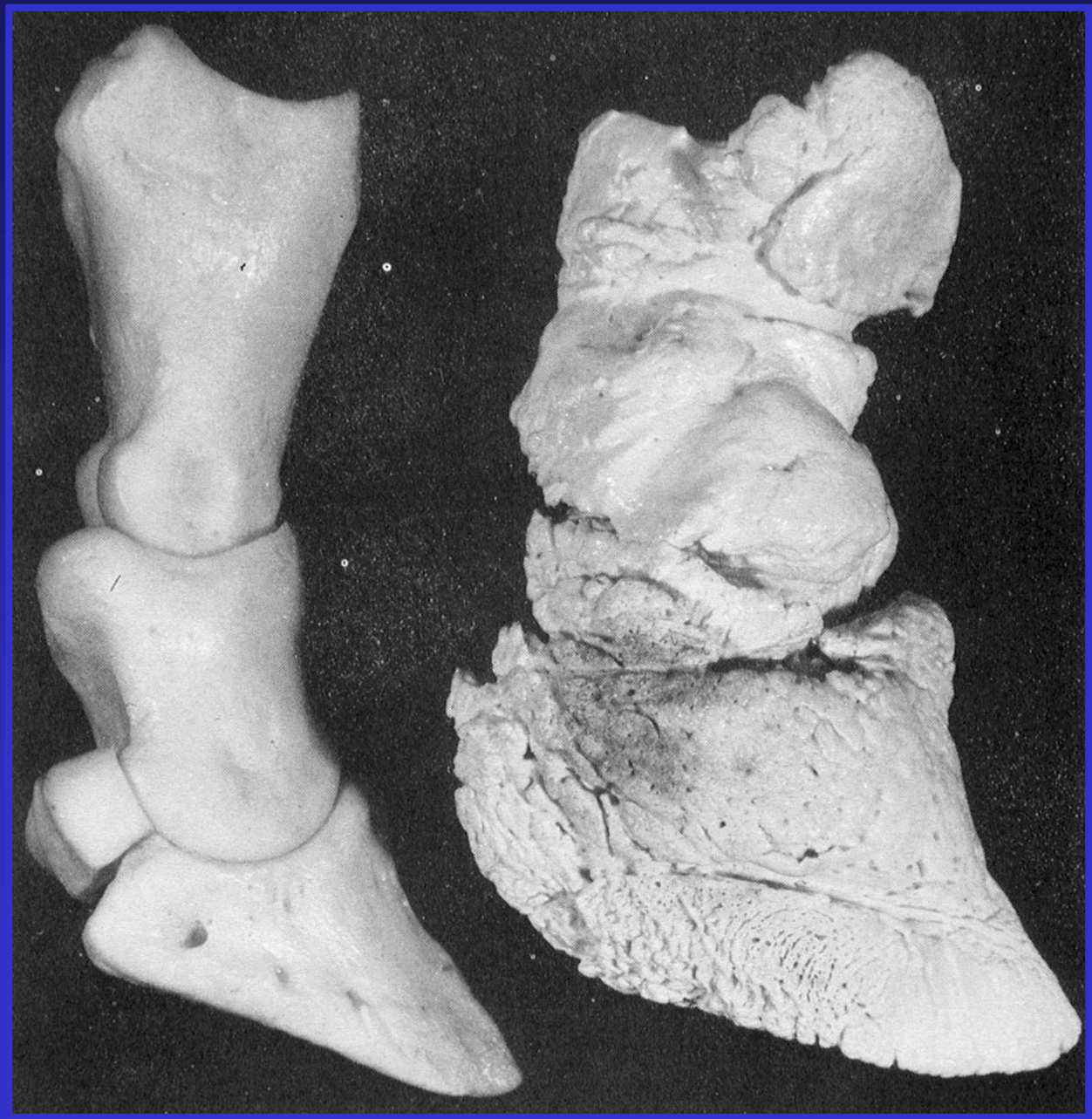
Volcanic tephra dispersal

- Mucous membrane irritation
- Silicosis
- Adsorbed toxins

Silicotic nodule in the lung tissue with disruption of surrounding alveoli



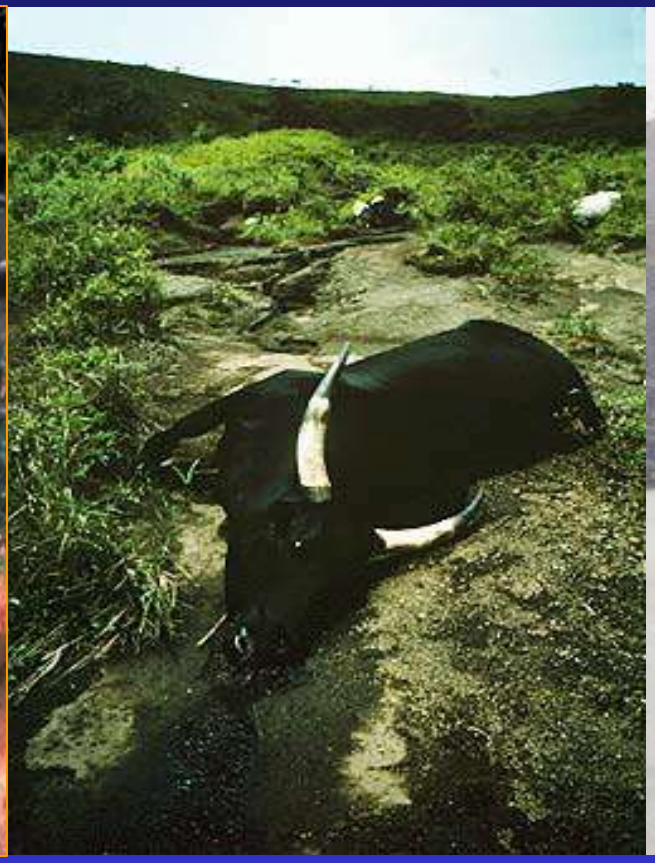
Calcium fluorosilicate ($CaSiF_6$)



The health effects of volcanic gas emissions

Inert asphyxiants

Carbon dioxide, CO_2



Irritant gases

- **Hydrofluoric acid, HF /hydrochloric acid, HCl**
  - **Mucosal irritation**
  - **Cutaneous burns**
  - **Respiratory disease**

- **Sulphur dioxide, SO_2**
  - **Asthma**

- **Hydrogen sulphide, H_2S**

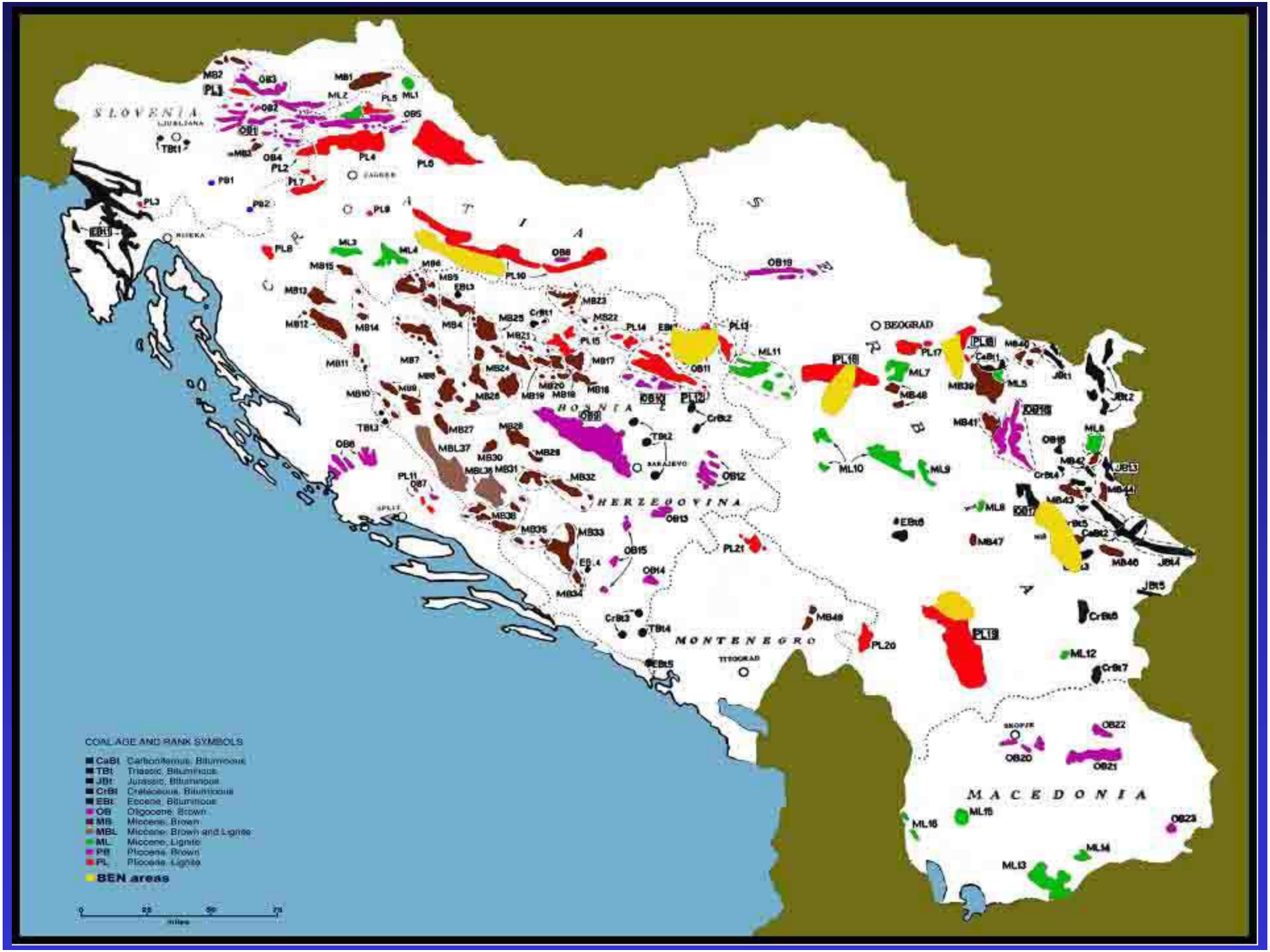
7 µg/m^3 – 'rotten egg' smell

15,000 µg/m^3 – eye irritation

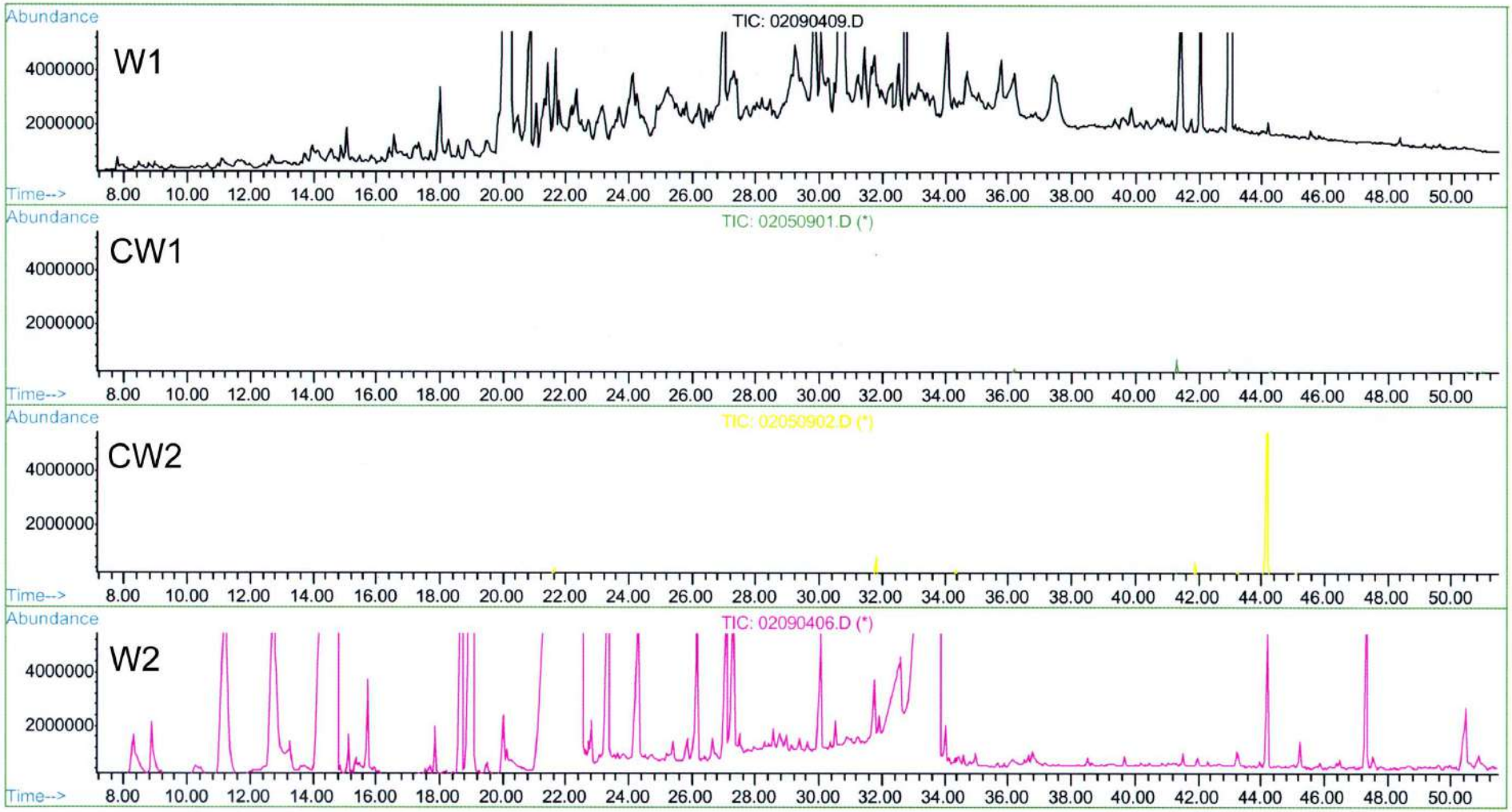
480,000 µg/m^3 – risk of pulmonary oedema

1,500,000 µg/m^3 – lethal

BALKAN ENDEMIC NEPHROPATHY (BEN)

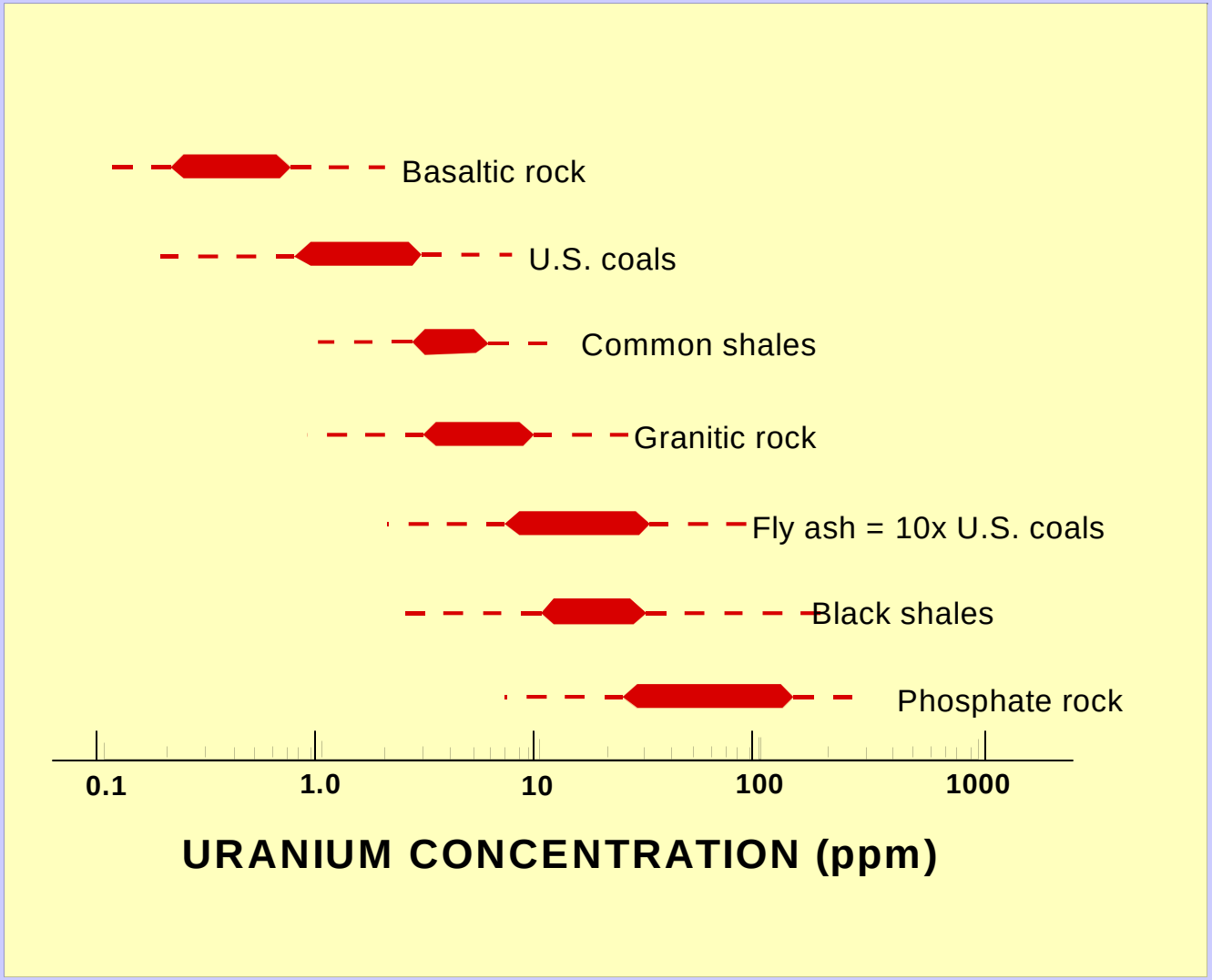

SLOVENIA
LJUBLJANA
ZAGREB
RIJEKA
SARAJEVO
SPLIT
BEOGRAD
TITOGRAD
SKOPJE
BOSNIA
HERZEGOVINA
MONTENEGRO
MACEDONIA
COAL AGE AND RANK SYMBOLS
CaBt Carboniferous, Bituminous
TBt Triassic, Bituminous
JBt Jurassic, Bituminous
CrBt Cretaceous, Bituminous
EBt Eocene, Bituminous
OB Oligocene, Brown
MB Miocene, Brown
MBL Miocene, Brown and Lignite
ML Miocene, Lignite
PB Pliocene, Brown
PL Pliocene, Lignite
BEN areas
0 25 50 75
miles

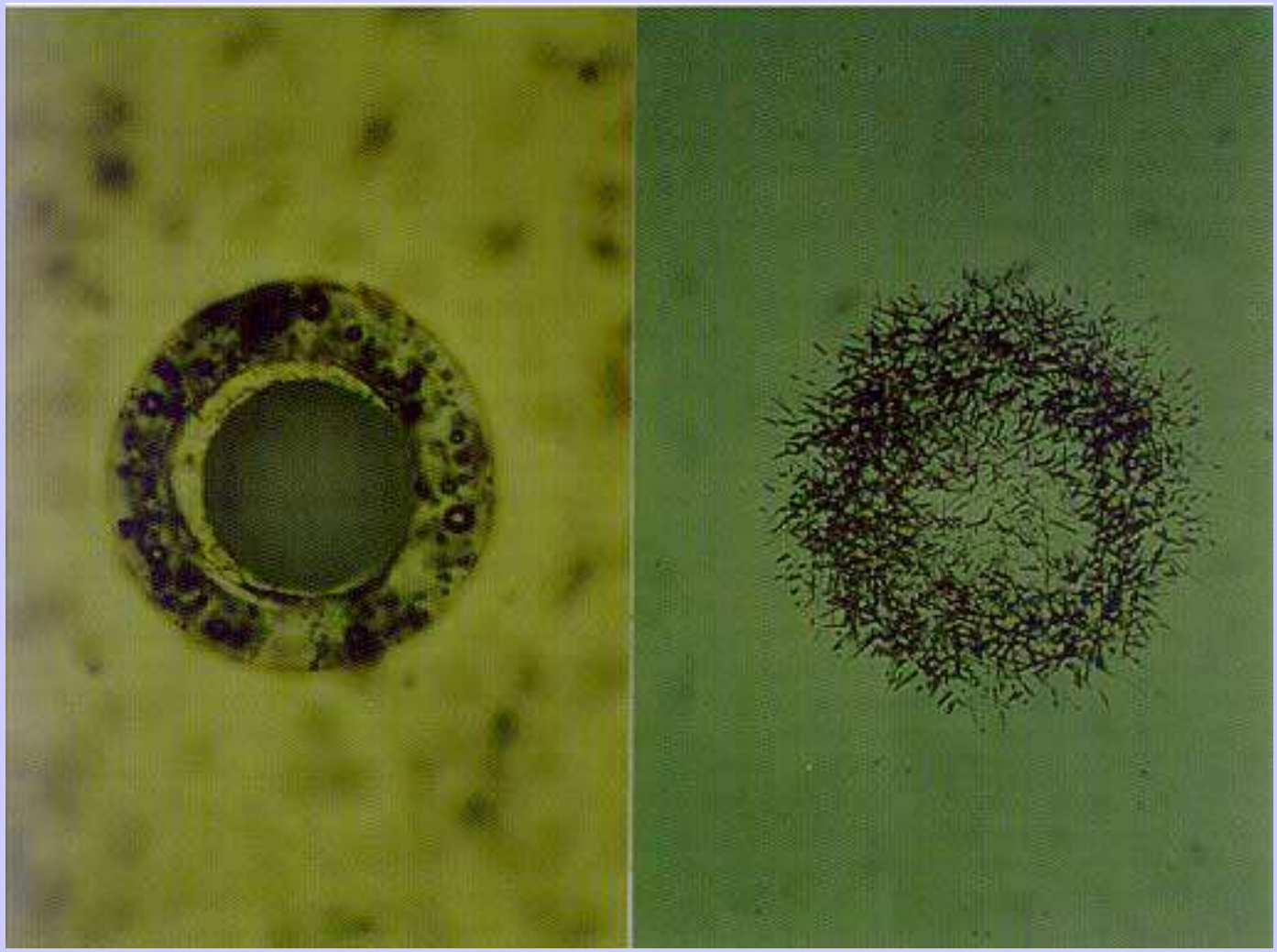
Water from wells in areas of Louisiana with high incidence of renal pelvic cancer and with lignite deposits (W1 and W2) have much higher levels of organic contaminants compared to control sites (CW1 and CW2)



Total ion currents (TICs) of Lousiana drinking well water samples collected from areas with high incidence of urinary tract cancer and underlying coal deposits (W1, W2) and control drinking well water samples from areas lacking coal deposits (CW1, CW2).

Typical Range of Uranium concentration in coal, fly ash, and a variety of common rocks





Photograph of hollow glassy fly ash particle (0.01 cm D)

Fission track radiograph of the same particle

Geographic Analysis of Disease Risk

- Where are the potential areas of disease?
- Who are the populations at risk now and in the future?
- When might an outbreak occur?
- How can outbreaks be mitigated?

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Locating Mosquito Breeding Sites

Use land characteristics, FEMA flood maps, and imagery to identify locations of potential *Culiseta melanura* habitat, but still accessible by roads or trails, where mosquito traps may be placed; determine risk to human health.

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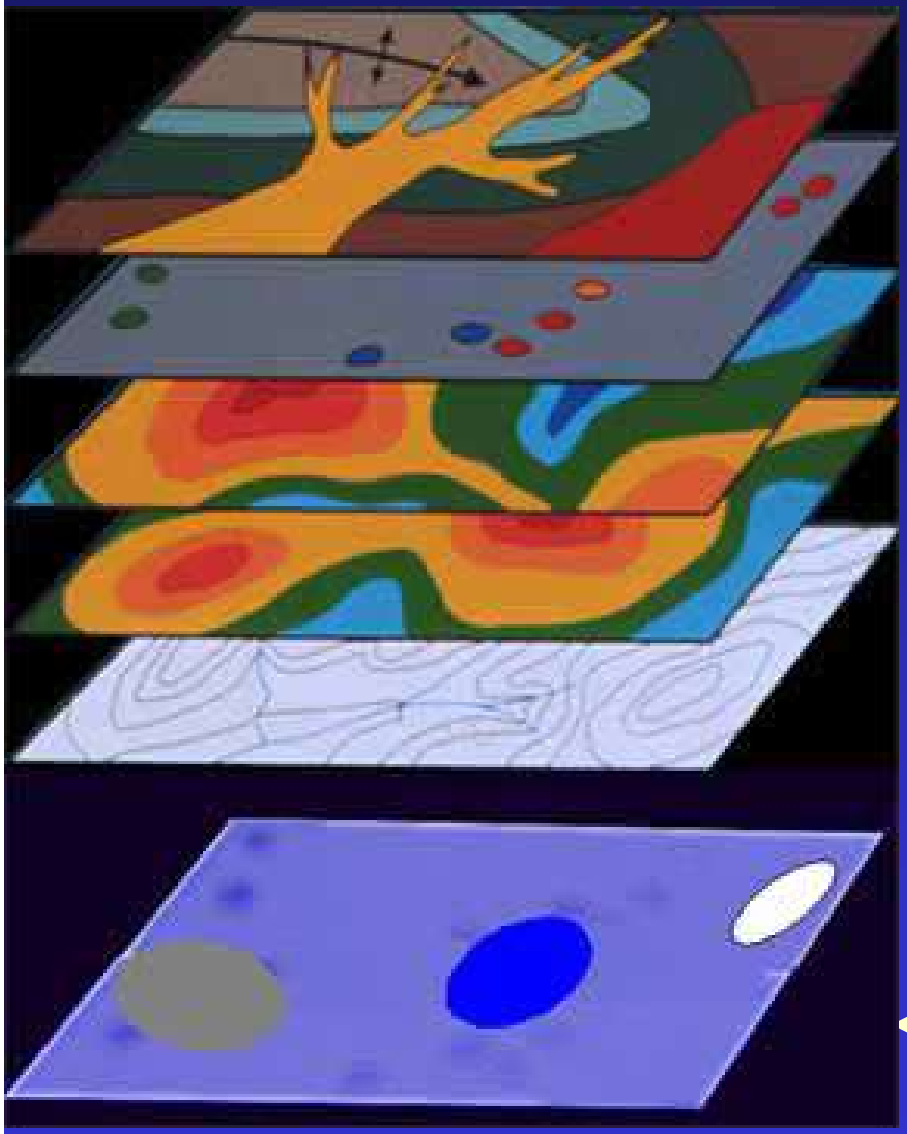
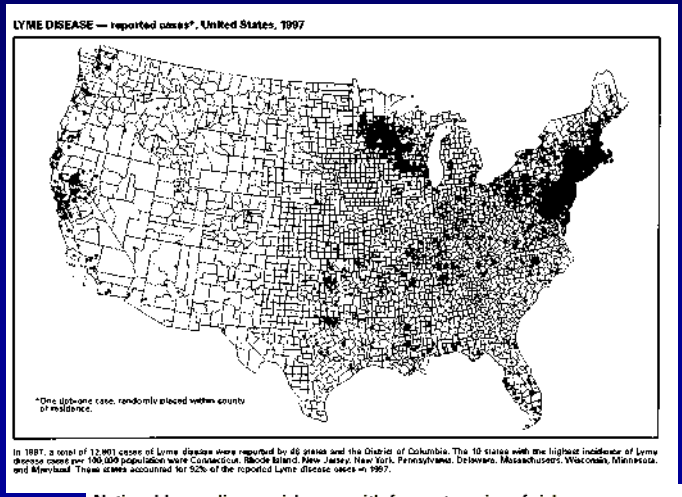
Valley Fever: ***Geological/Ecological occurrence modeling***



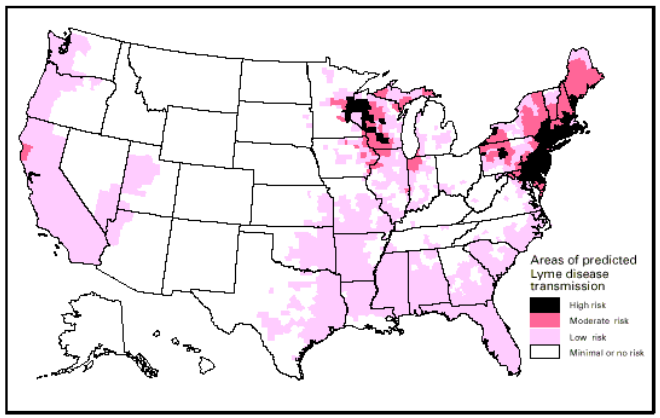
- geology
- geochemistry
- soils
- remote sensing interpretation
- elevation
- ….
- spatial data$_i$

→ *Valley Fever* favorableness

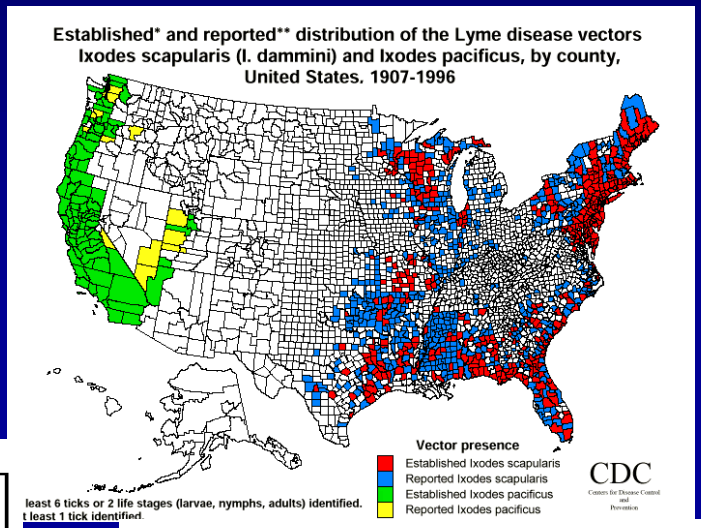
Analysis of Lyme Disease

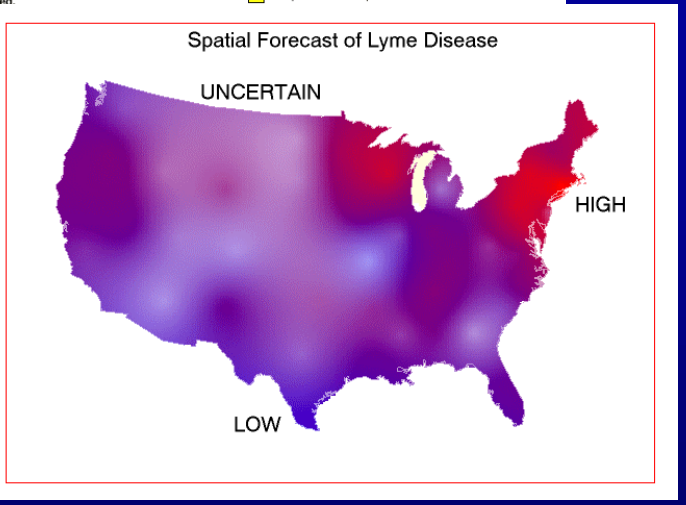


In 1997, a total of 12,801 cases of Lyme disease were reported by 46 states and the District of Columbia. The 10 states with the highest incidence of Lyme disease cases per 100,000 population were Connecticut, Rhode Island, New Jersey, New York, Pennsylvania, Delaware, Massachusetts, Wisconsin, Minnesota, and Maryland. These states accounted for 92% of the reported Lyme disease cases in 1997.



Note: This map demonstrates an approximate distribution of predicted Lyme disease risk in the United States. The true relative risk in any given county compared with other counties might differ from that shown here and might change from year to year. Risk categories are defined in the accompanying text. Information on risk distribution within states and counties is best obtained from state and local public health authorities.





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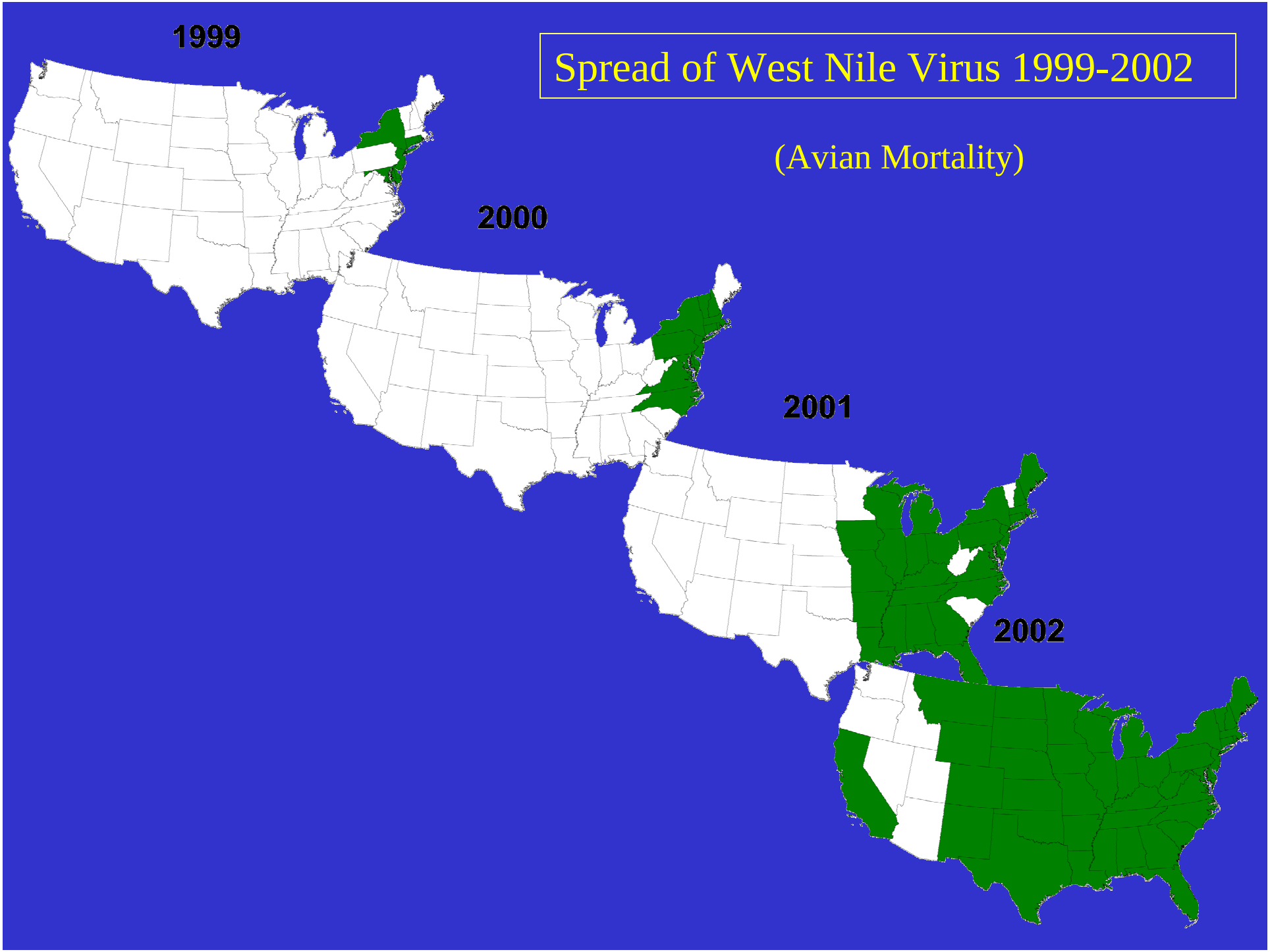

1999
Spread of West Nile Virus 1999-2002
(Avian Mortality)
2000
2001
2002

Mseleni Joint Disease

- Multiple epiphyseal displasia (long bones have malformed growth)
- Polyarticular osteoarthritis (arthritis of several joints)
- Protrusio acetabuli (hip disorder)
- Dwarfism

Disease Progression

Prevalence

- Onset unknown
- Overall 39% women, 11% men
- >19, 66% women, 25% men

Grey Fernwood Sand

- **Near neutral pH_{H_2O} 6.9**
- **< 4% clay (kaolinite and quartz)**
- **Low organic C ~1.6%**
- **CEC 2.0 $cmol_c\ kg^{-1}$**

Prior Geochemical Research

- Soils
  - Deficient: N, P, K, S, Ca, Zn, Cu, and B
  - Suspected: Mo
  - Not studied: F, I, V and Se

MINING AND OCCUPATIONAL HEALTH

Medical Geology and Occupational Health

- Hard Rock Mining
- Coal Mining
- Asbestos Mining and Processing
- Ore Processing
- Farming
- Power Plant Workers

Immediate and short term health effects

- **Trauma** eg cave-ins and other accidents, including explosions
- **Thermal injury**
- **Pressure effects**
- **Toxic gas inhalation**
- **Injury to sensory organs** (noise –induced hearing loss; ear, nose and throat and visual irritation)

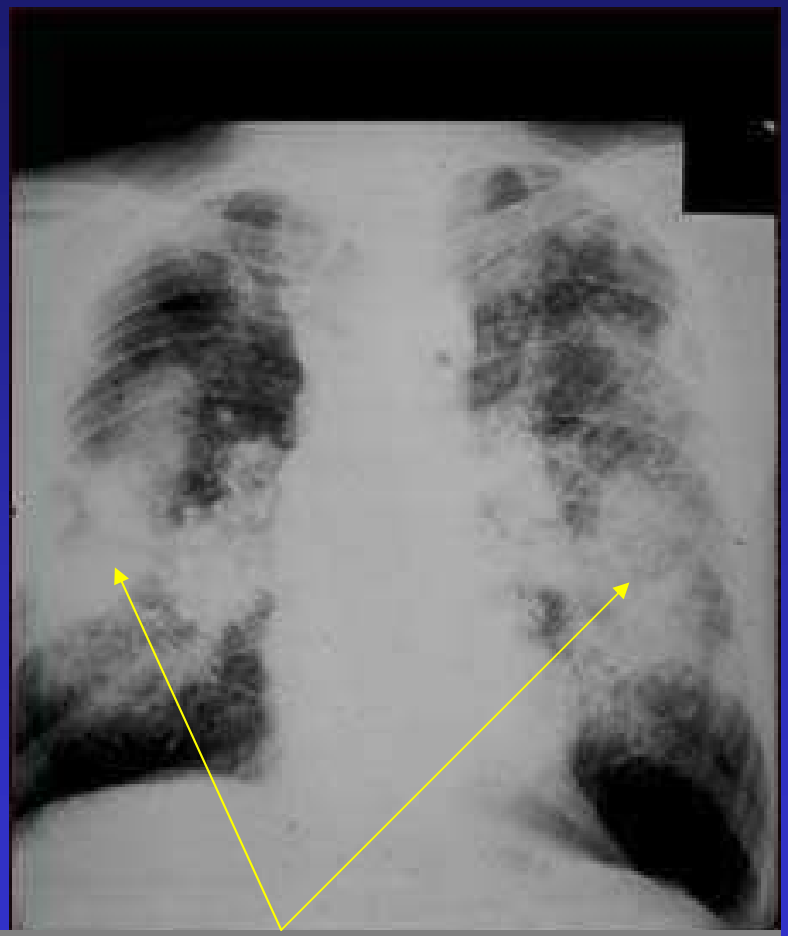
Delayed /chronic health effects

- Carcinogenicity
- Dermatological effects
- Respiratory effects

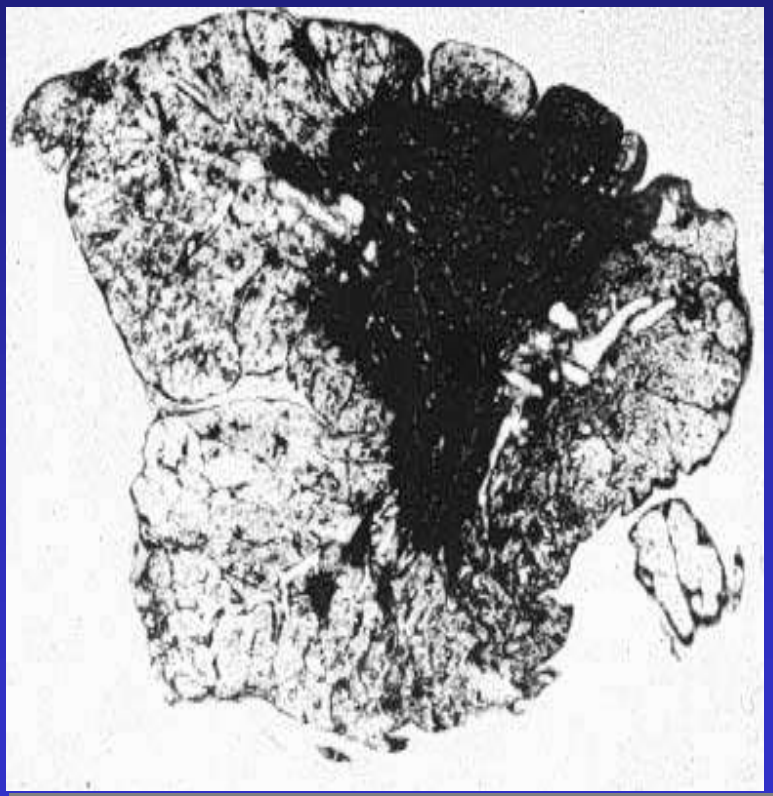
Carcinogenicity

EXAMPLES OF PROBABLE OR DEFINITE CARCINOGENS ASSOCIATED WITH MINING / SMELTING
Asbestos
Coke oven emissions
Uranium and radon
Benzene
Nickel
Arsenic
Chromium

Lung diseases associated with mining: exposure to coal dust

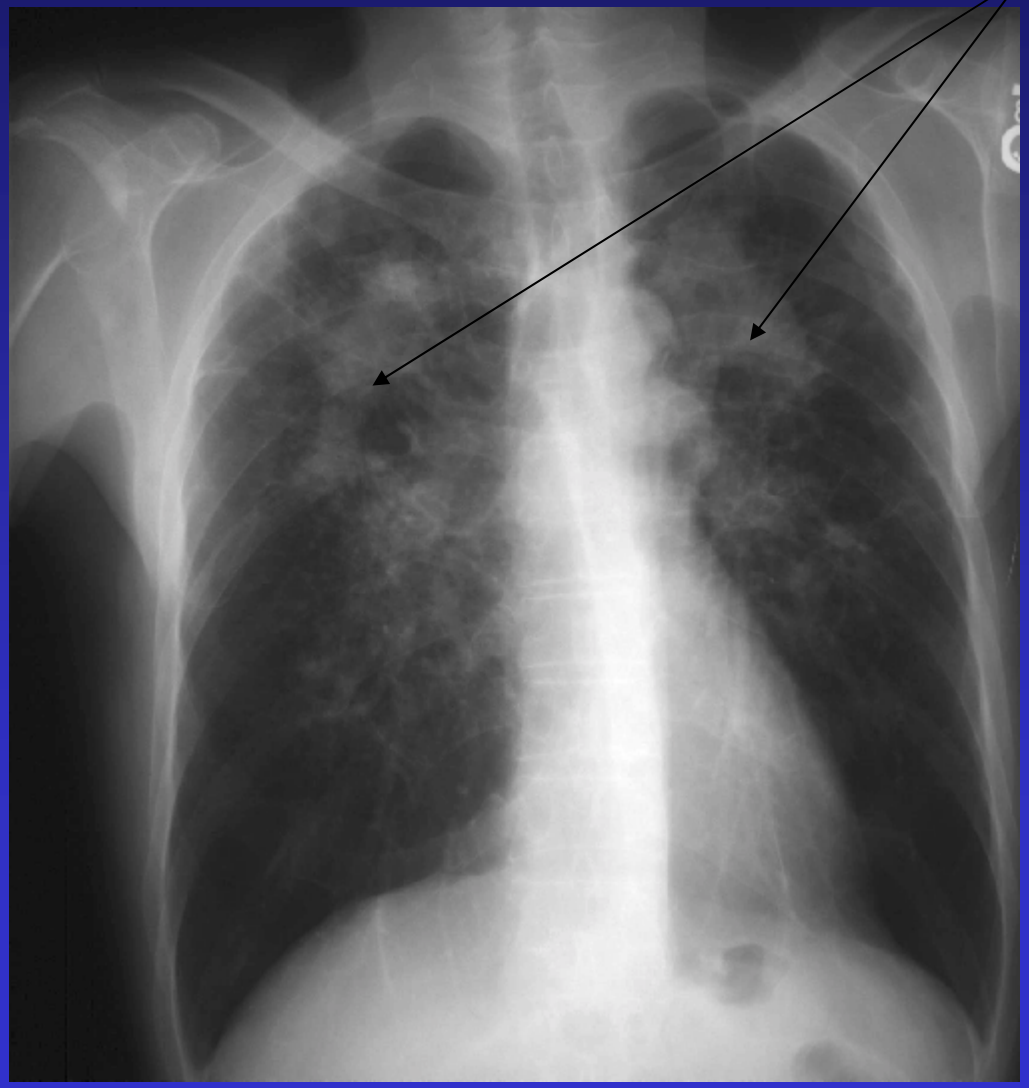


Complicated coal workers pneumoconiosis

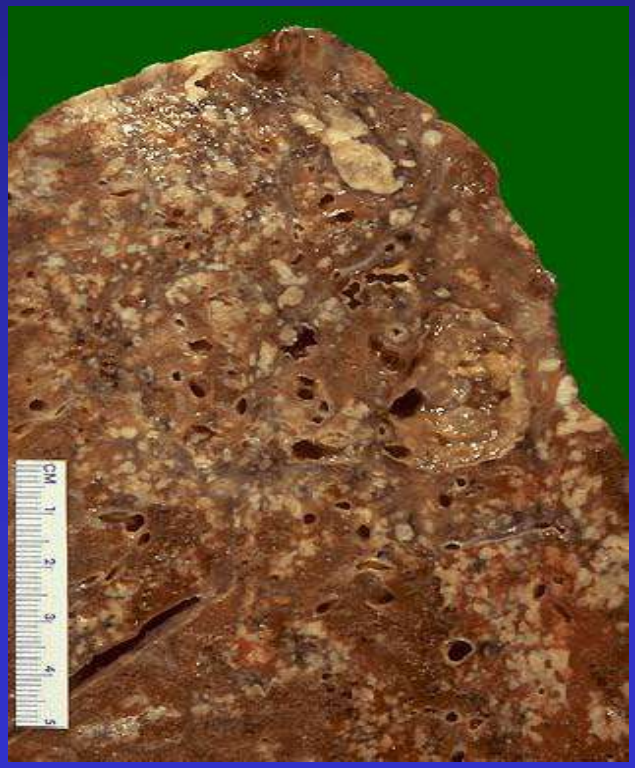


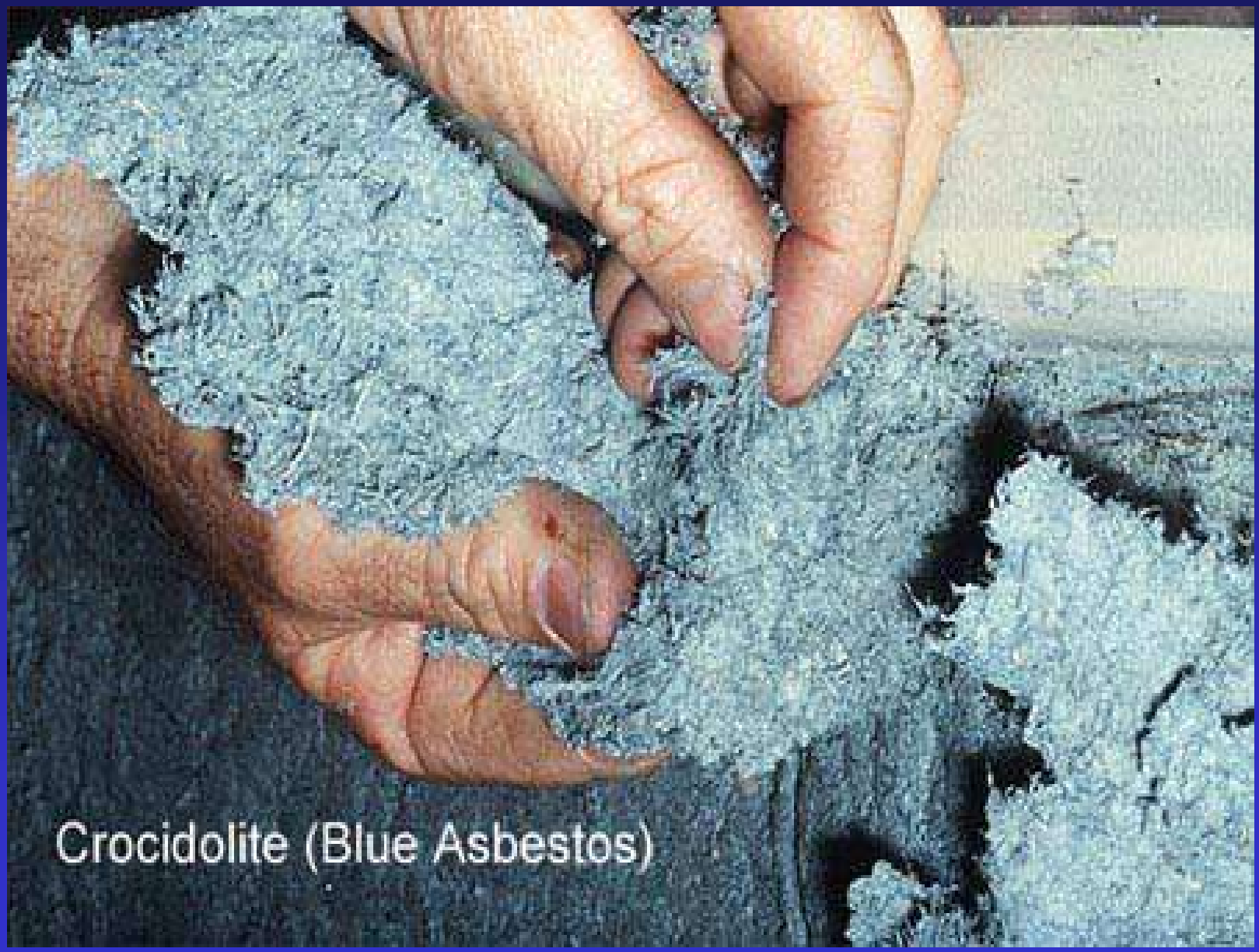
Progressive massive pulmonary fibrosis in a coal worker

Lung diseases associated with mining: the spectrum of silica-related disorders



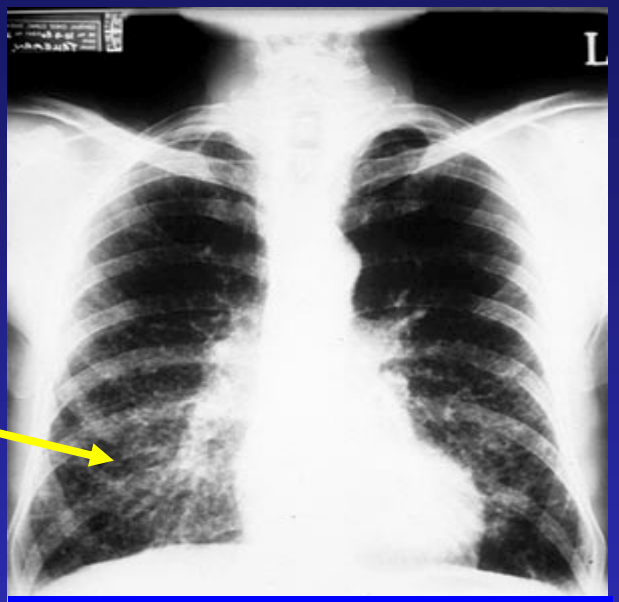
Increased risk of protracted TB



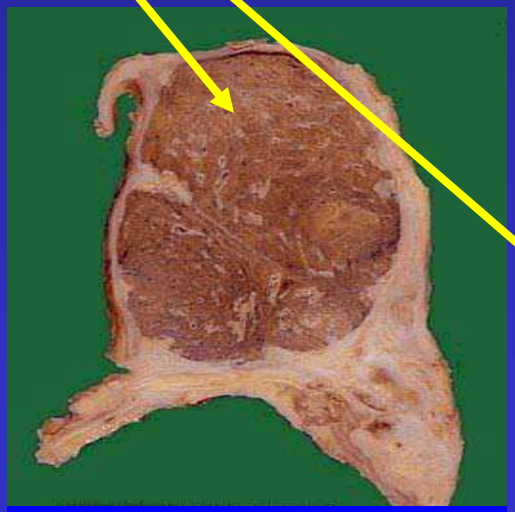

Crocidolite (Blue Asbestos)

Lung diseases associated with mining: the spectrum of asbestos-related disorders

Asbestos fibre in lung tissue



Asbestosis



Enormous mesothelioma tumour mass filling chest cavity

Lung cancer adjacent to main bronchus