Other Medical Geology Issues

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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
- Organics - VOCs, MTBE, PAHs, Antibiotics, Pesticides
- Radionuclides - Radon, Radium, Uranium
- Microbes, Pathogens - West Nile Encephalitis, LaCrosse Encephalitis, Plague, Hantavirus, Rift Valley Fever, Lyme disease, etc.
- Global Climate Change

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Other Medical Geology Issues – Outline

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

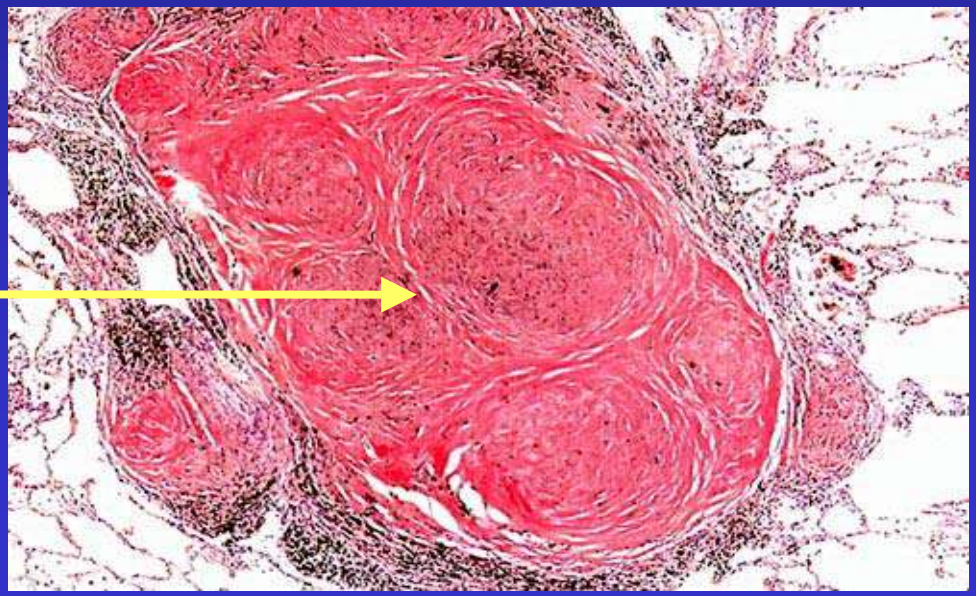
The health effects of tephra dispersal

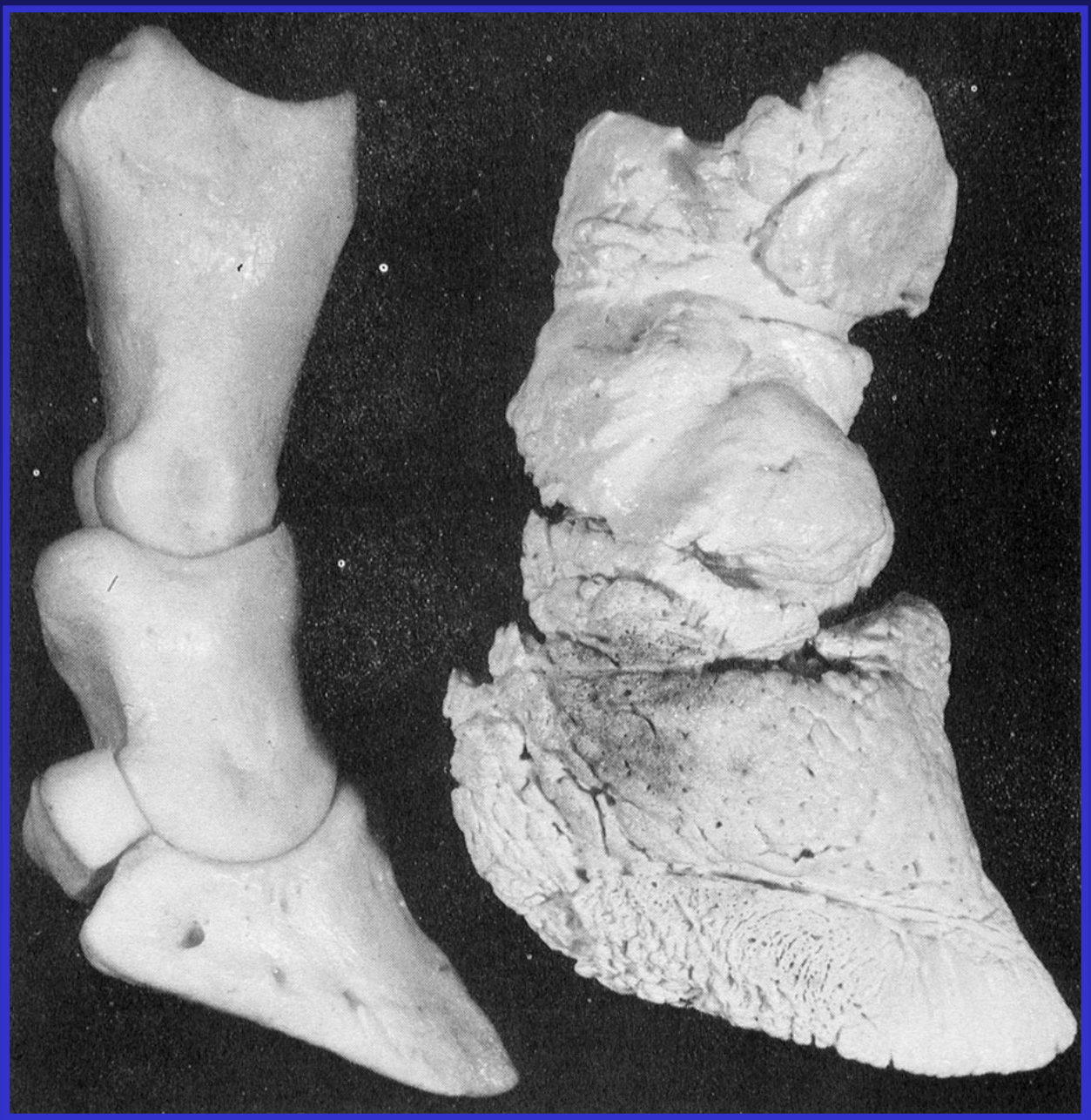
Volcanic tephra dispersal

- Mucous membrane irritation
- Silicosis
- Adsorbed toxins

- Calcium fluorosilicate ($CaSiF_6$)

Silicotic nodule in the lung tissue with disruption of surrounding alveoli





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**
  - **Acid rain**

Noxious asphyxiants

- **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

Health effects of other eruptive events

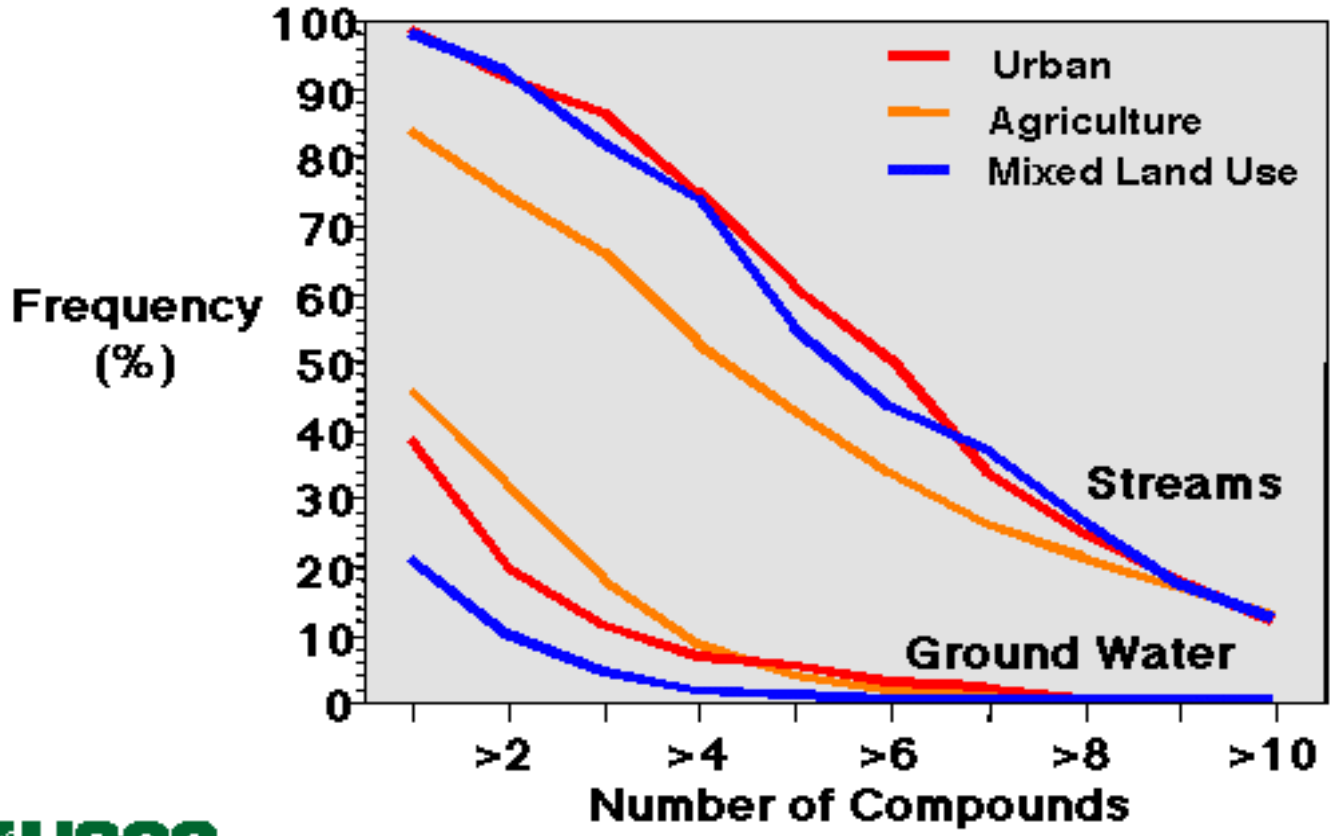
- **Lava flows**
- **Pyroclastic flows**
- **Volcanic activity and aquatic environments**

Medical – geology interface

- **A review of recent disaster responses has indicated a degree of mismatching between the acquisition of eruption data and its health-related utilisation.**

- **From a medical perspective, geologic monitoring has a pivotal - but often under-utilised – role in helping those living in the shadows of volcanoes.**

Pesticides almost always occur as mixtures



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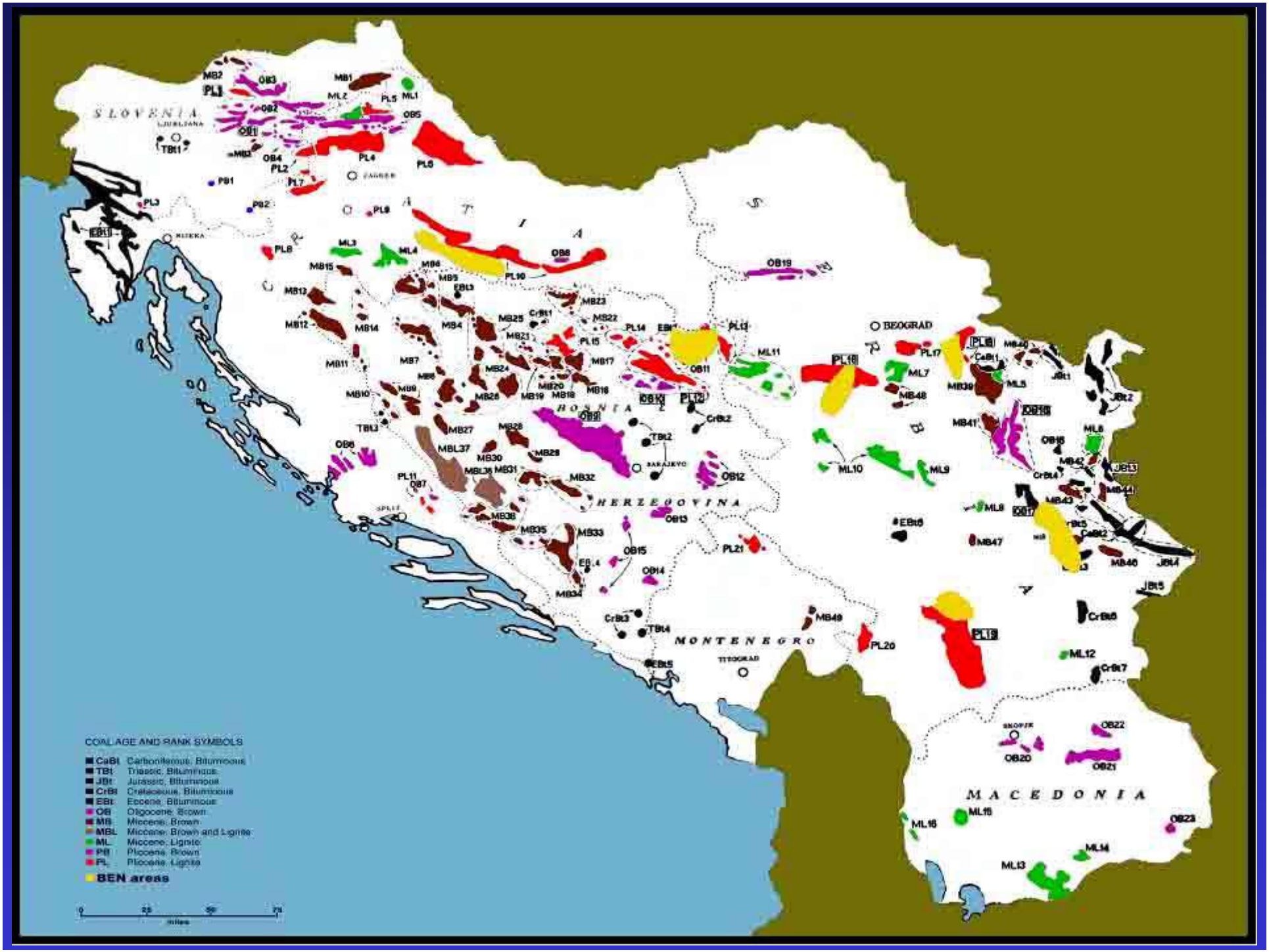
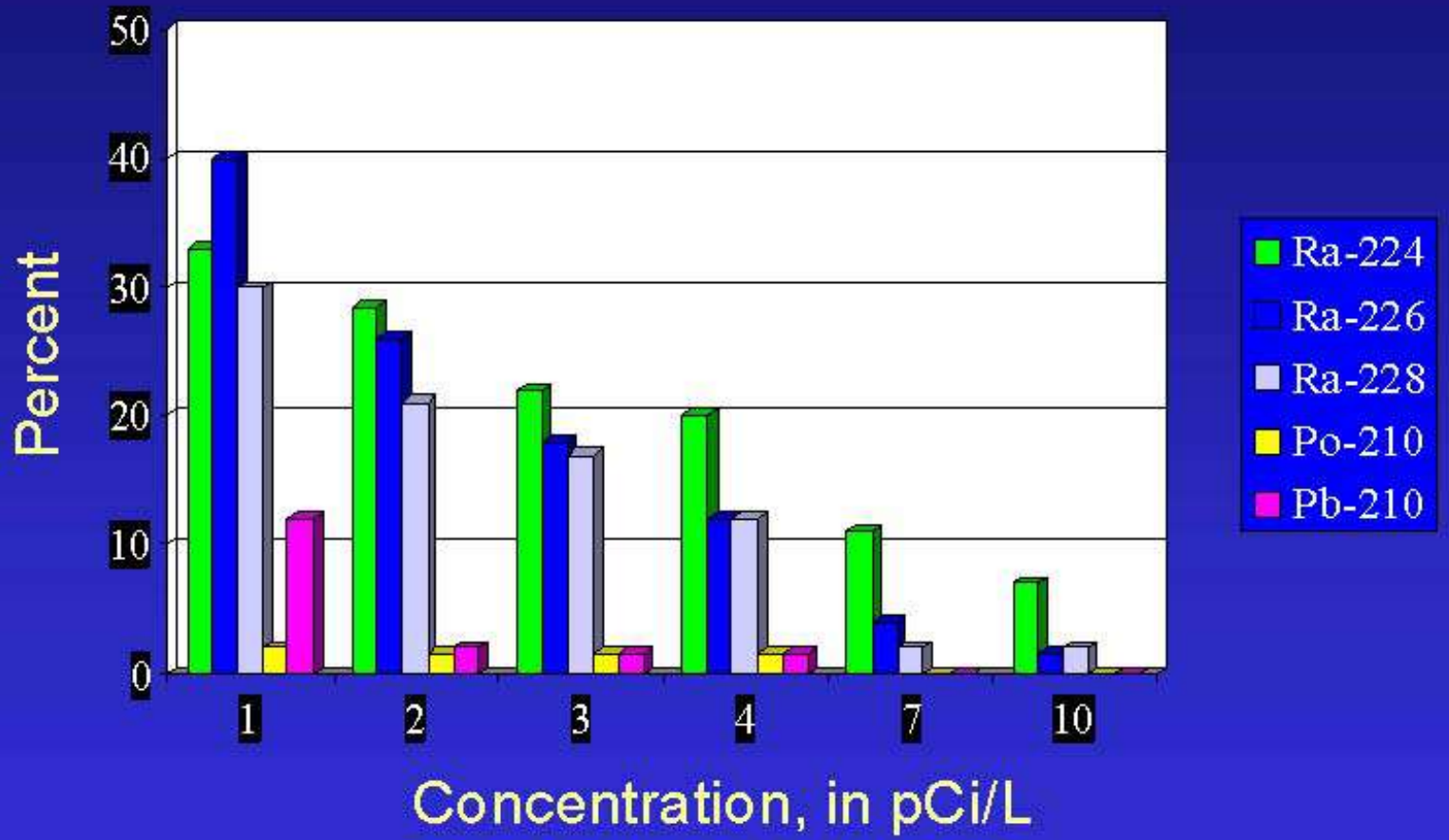
BALKAN ENDEMIC NEPHROPATHY (BEN)


SLOVENIA
LJUBLJANA
ZAGREB
RIJEKA
BEOGRAD
SARAJEVO
SPLIT
TITOGRAD
SKOPJE
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

Radionuclide Samples Collected from Public Water Supplies

Percent of samples exceeding targeted concentrations



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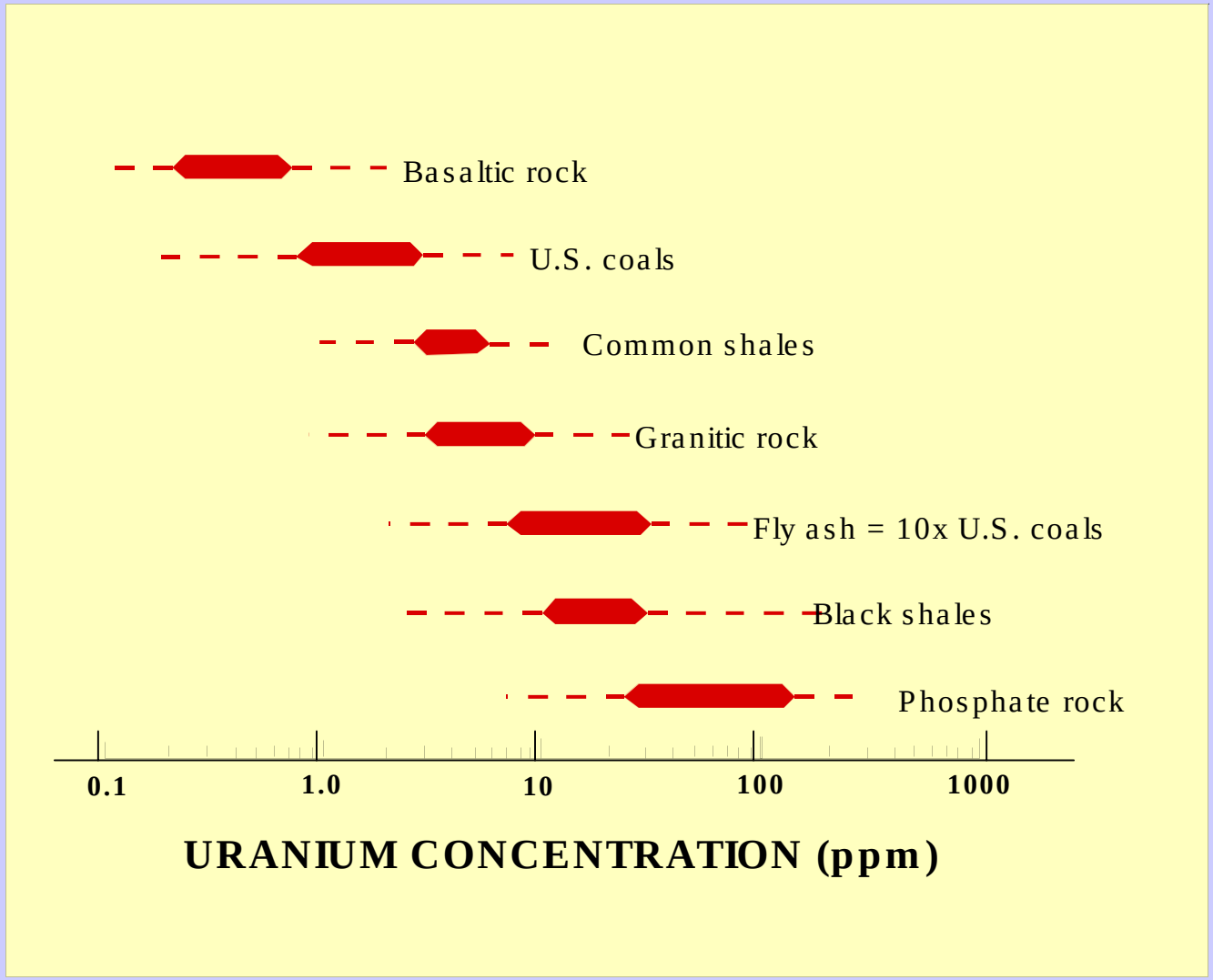
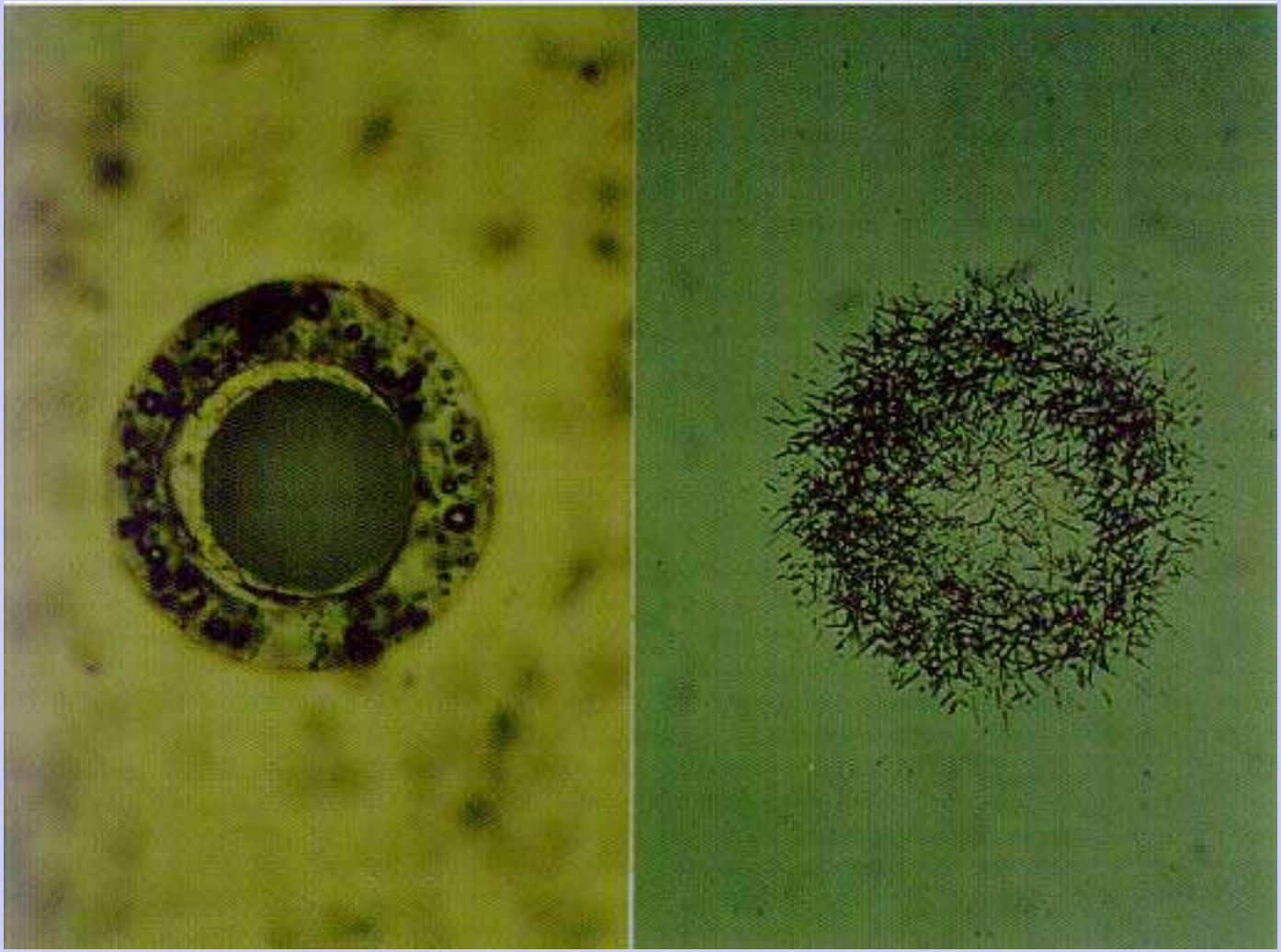
PREDICTED CANCER FATALITITES DUE
TO IONIZING RADIATION:
GENERAL POPULATION: AVERAGE DOSE

		RADIATION FATALITIES	
	mrem/yr	Total Number in U.S. per year	Per Million Persons per year
MEDICAL DIAGNOSTIC	70	3080	14
COSMIC RADIATION	35	1540	7
TERRESTRIAL (rocks and soil, etc.)	35	1540	7
POTASSIUM-40 IN FOOD	20	880	4
NUCLEAR WEAPONS FALLOUT	4.4	194	0.9
USE OF NATURAL GAS IN HOMES	2	89	0.4
BURNING OF COAL	1	44	0.2
SLEEPING WITH ANOTHER PERSON	0.1	4.4	0.02
NUCLEAR POWER	0.1	4.4	0.02
CONSUMER PRODUCTS (TV, etc.)	0.03	1.3	0.006
TOTAL	168	7377	

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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Landscape Epidemiology

By knowing the ecological conditions necessary for the maintenance of specific pathogens in nature, one can use these characteristics to identify the spatial and temporal distribution of disease risk.

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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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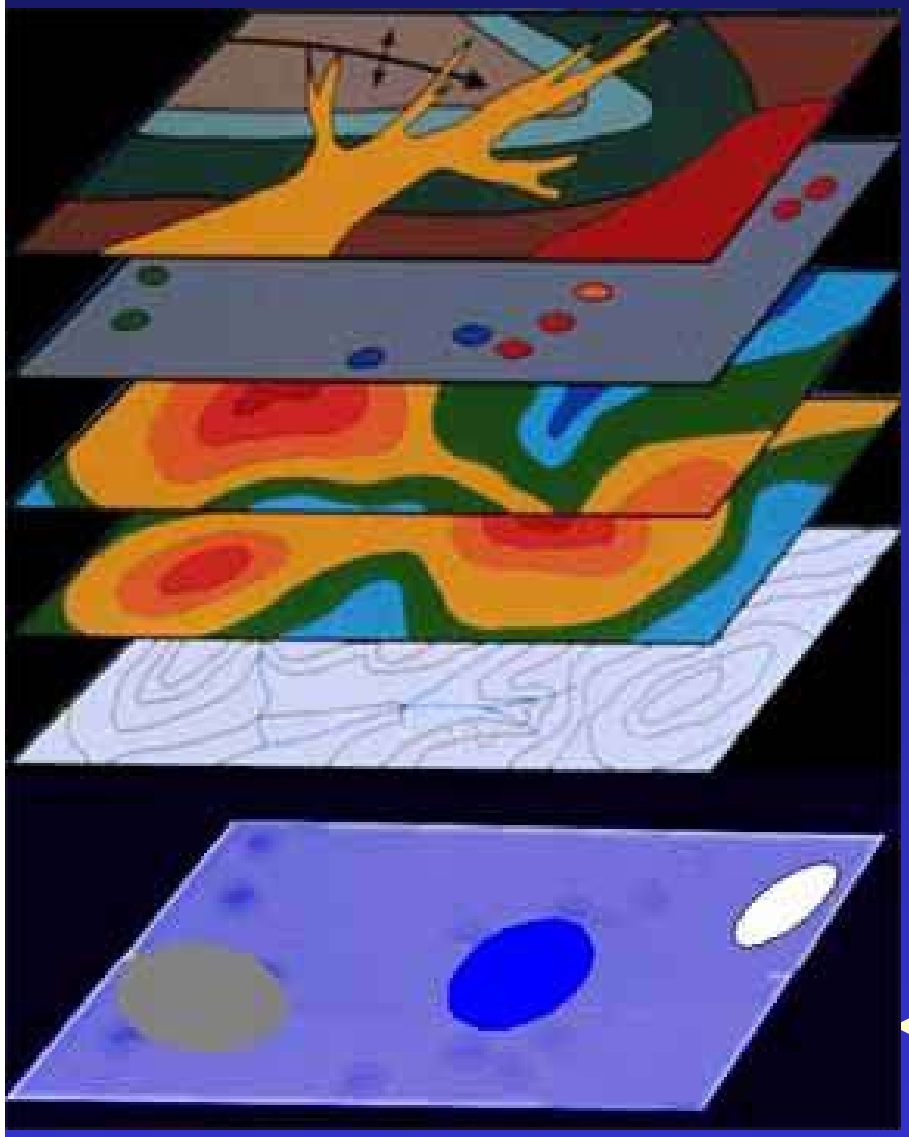
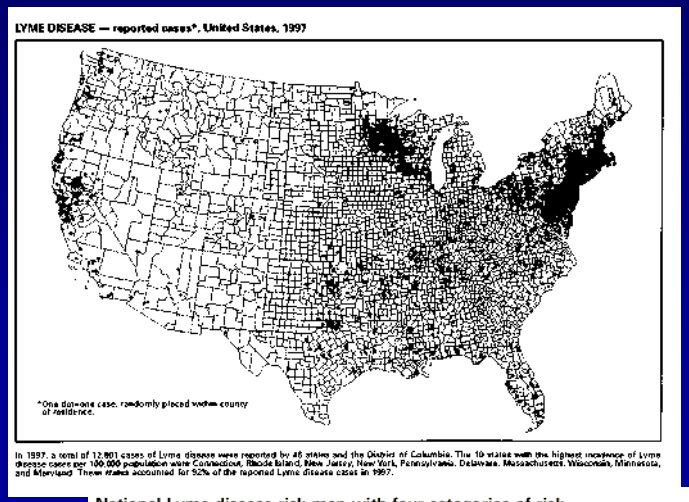
Valley Fever: Geological/Ecological occurrence modeling

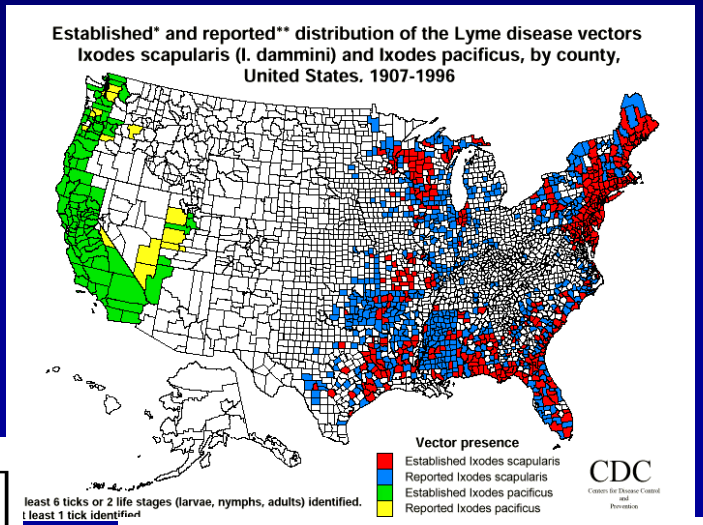


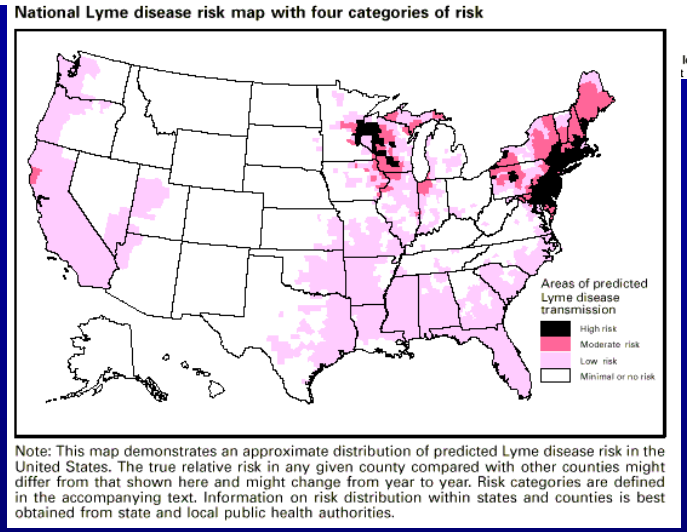
- geology
- geochemistry
- soils
- remote sensing interpretation
- elevation
- ….
- spatial data$_i$

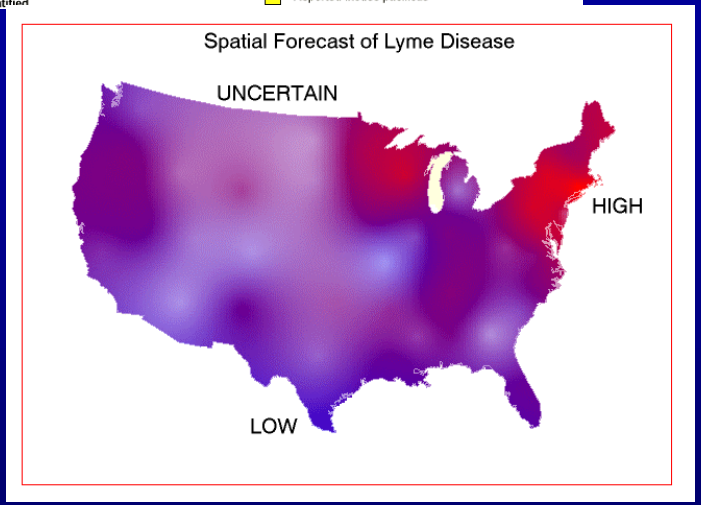
→ *Valley Fever* favorableness

Analysis of Lyme Disease









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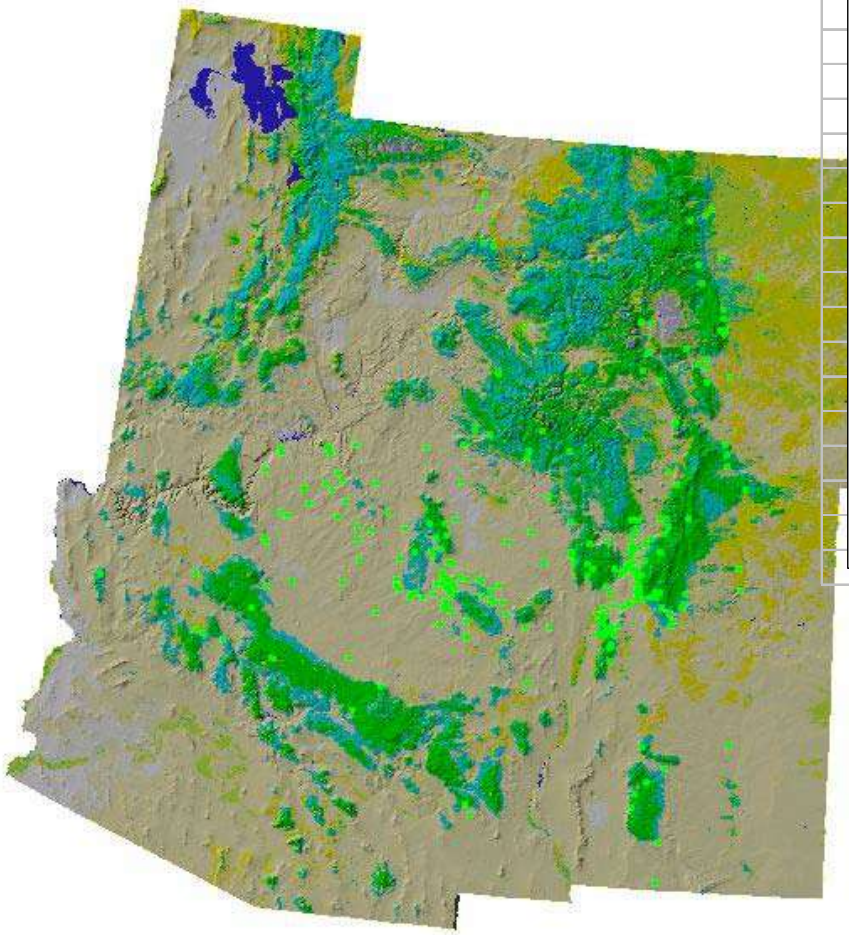
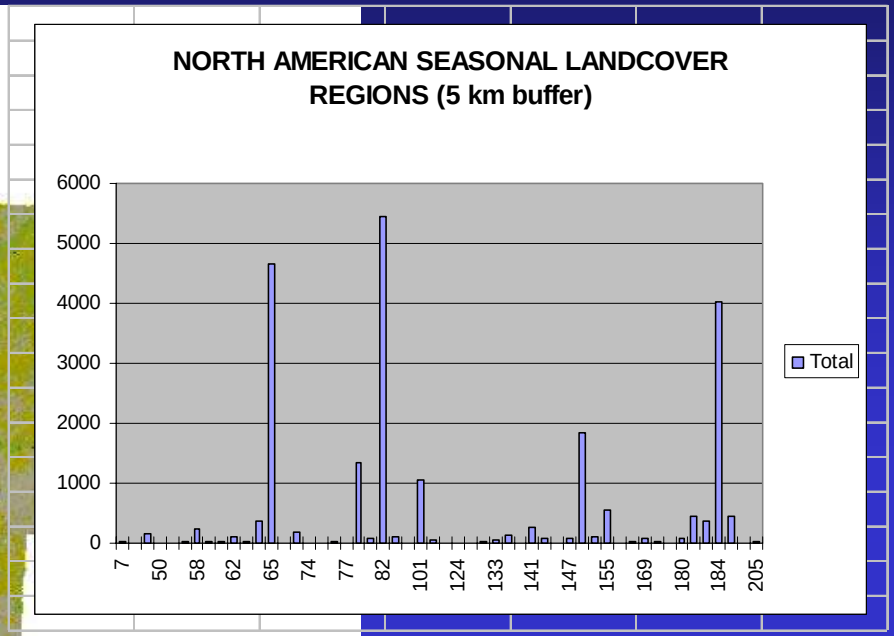
Plague Cases in the SW United States



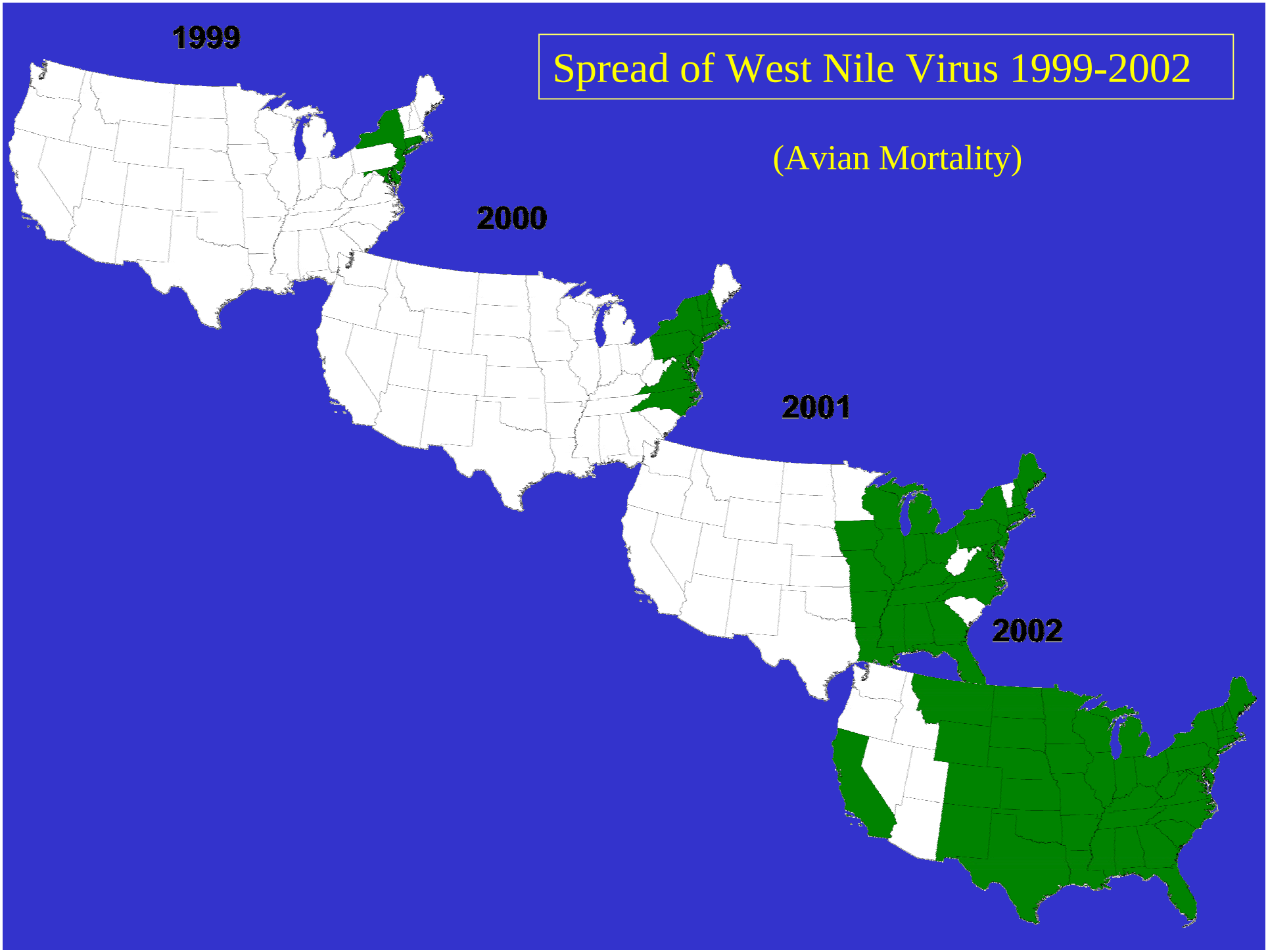


#65 - Mixed Rangeland

#82 - Desert Shrubland & Grassland

#148 -Ponderosa Pine

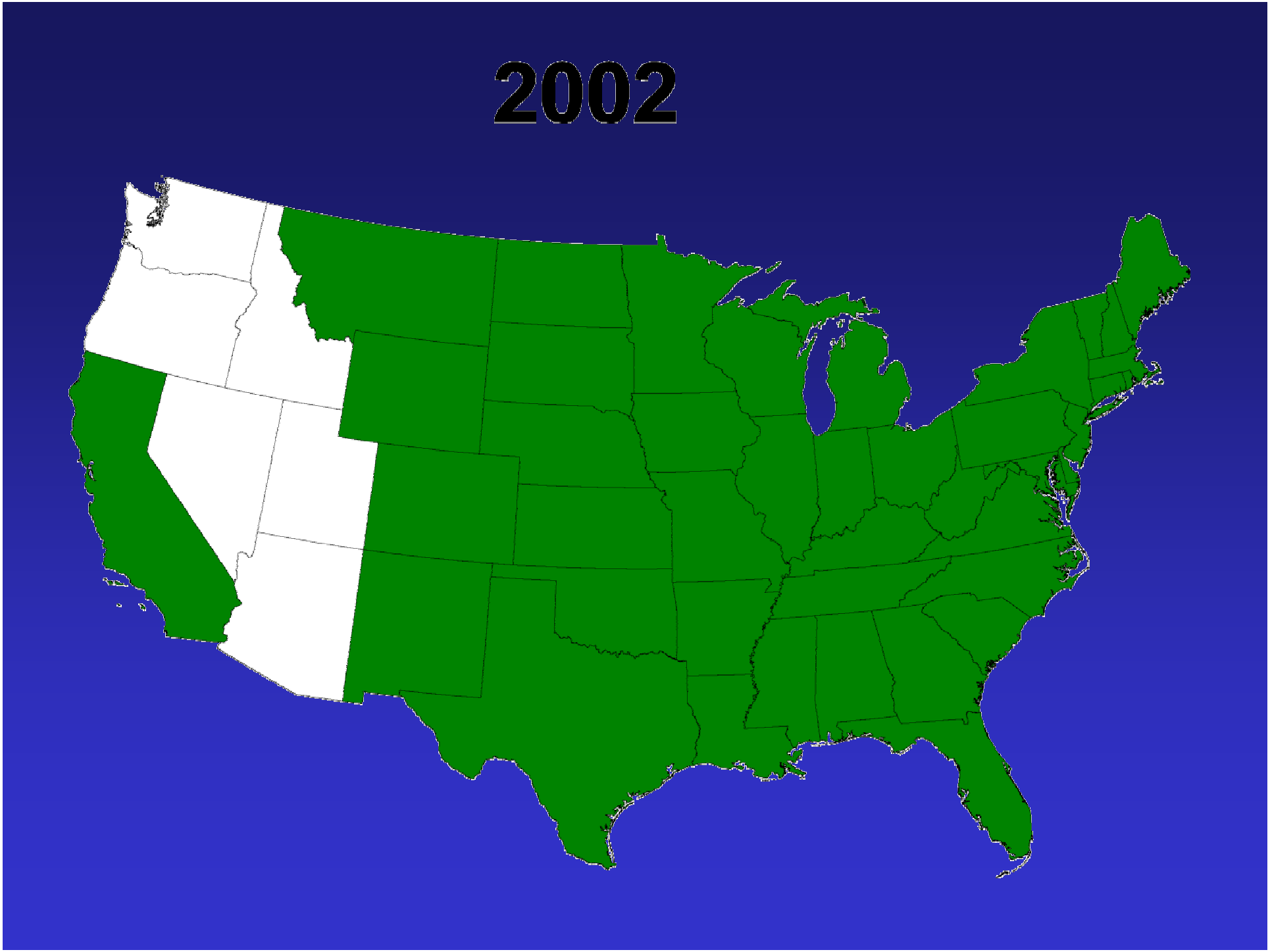
#184 -Pinyon Juniper



Spread of West Nile Virus 1999-2002

(Avian Mortality)

2002



Conclusions

- Geographic analysis tools can model the processes that affect the occurrence and spread of diseases
- Collaborating with health professionals, we can understand the linkages between environmental factors and human health and work to reduce the risk of disease.

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Medical Geology and Occupational Health

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

MINING AND OCCUPATIONAL HEALTH

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)

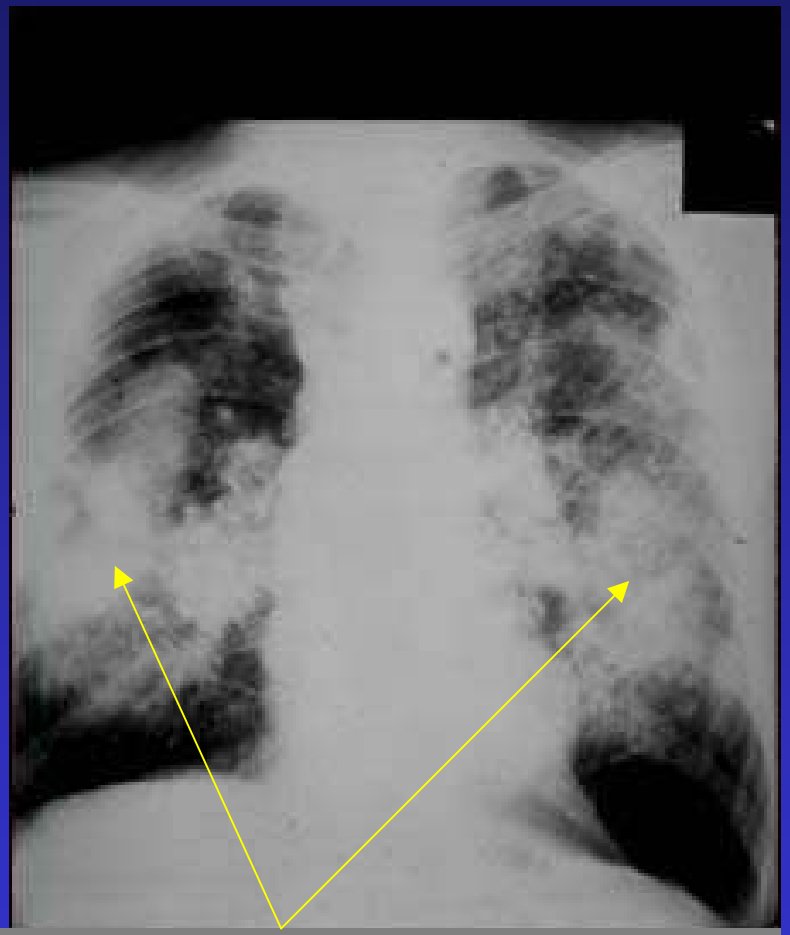
Delayed /chronic health effects

- 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

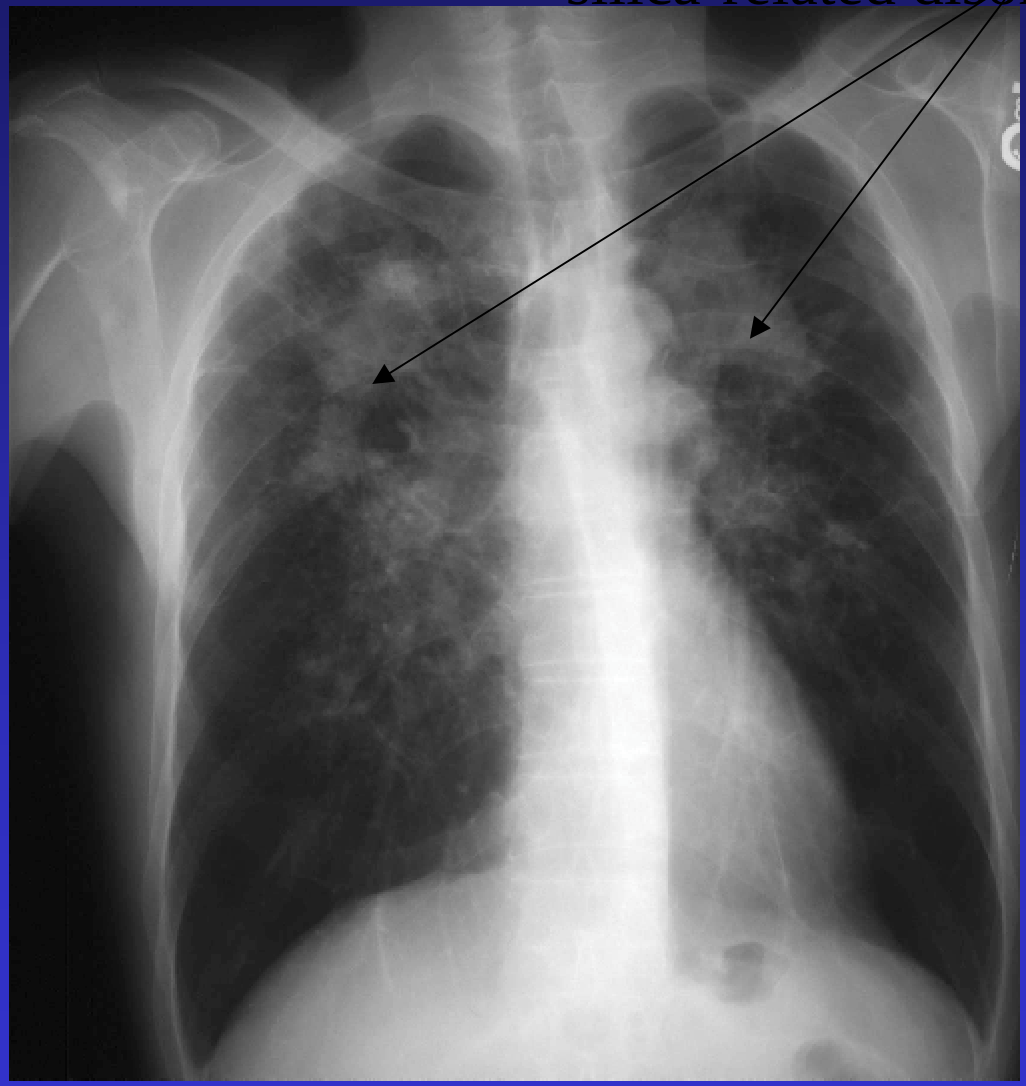
Lung diseases associated with mining 1: exposure to coal dust



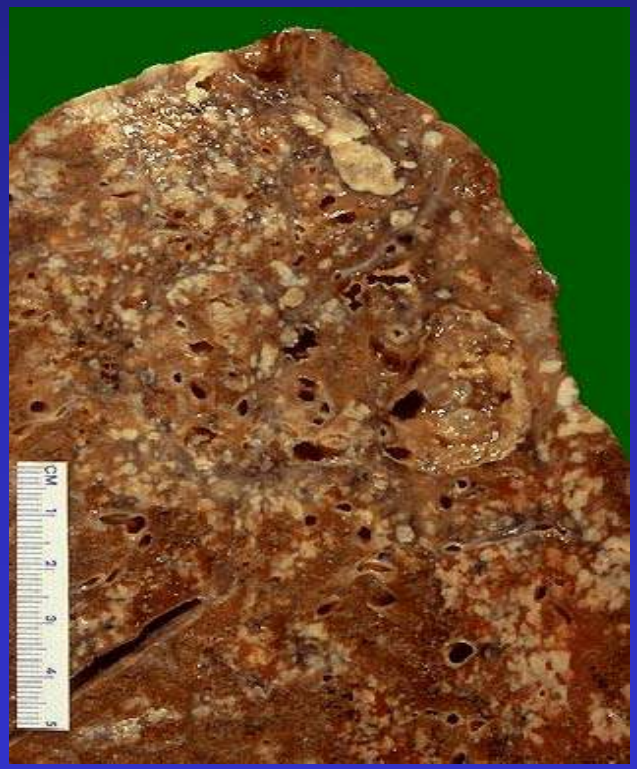
Complicated coal workers pneumoconiosis

Progressive massive pulmonary fibrosis in a coal worker

Lung diseases associated with mining 2: the spectrum of silica-related disorders



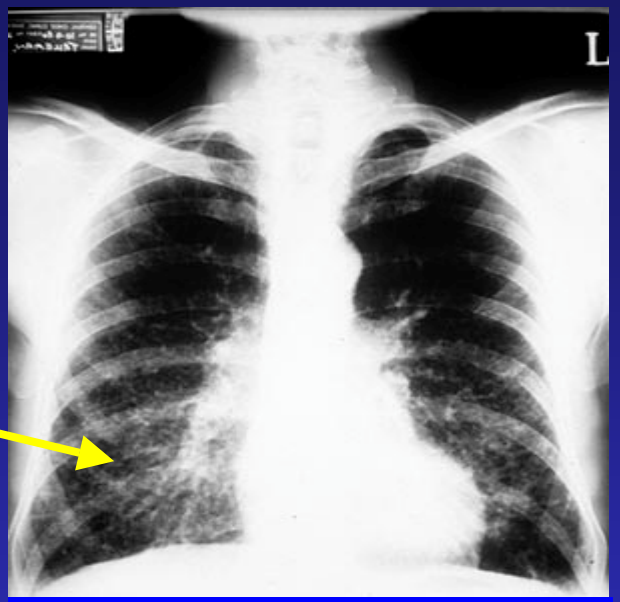
Increased risk of protracted TB



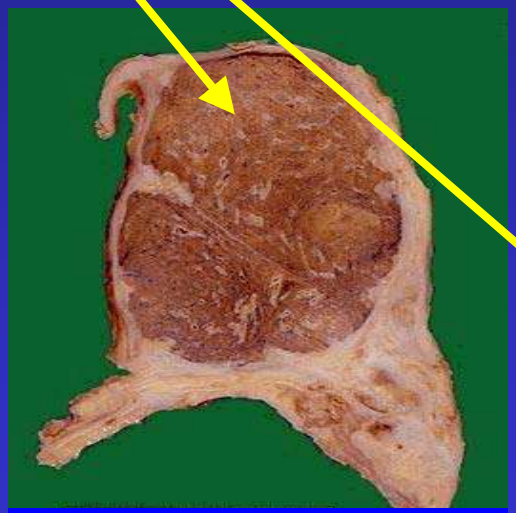
Crocidolite (Blue Asbestos)

Lung diseases associated with mining 3: the spectrum of asbestos-related disorders

Asbestos fibre in lung tissue

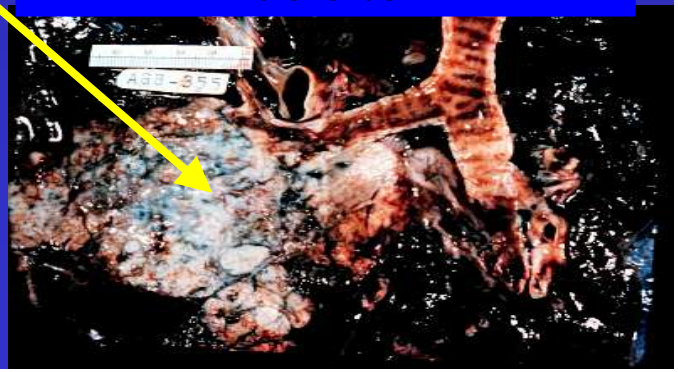


Asbestosis



Enormous mesothelioma tumour mass filling chest cavity

Lung cancer adjacent to main bronchus



Mercury in the soil and food chain

Mercury poisoning causes motor and visual impairment

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

Prior Geochemical Research

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

Grey Fernwood Sand

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