Organic Aerosols:
Combustion Source Emissions & Air Pollution

A Search for Causative Agents & Comparative Risks

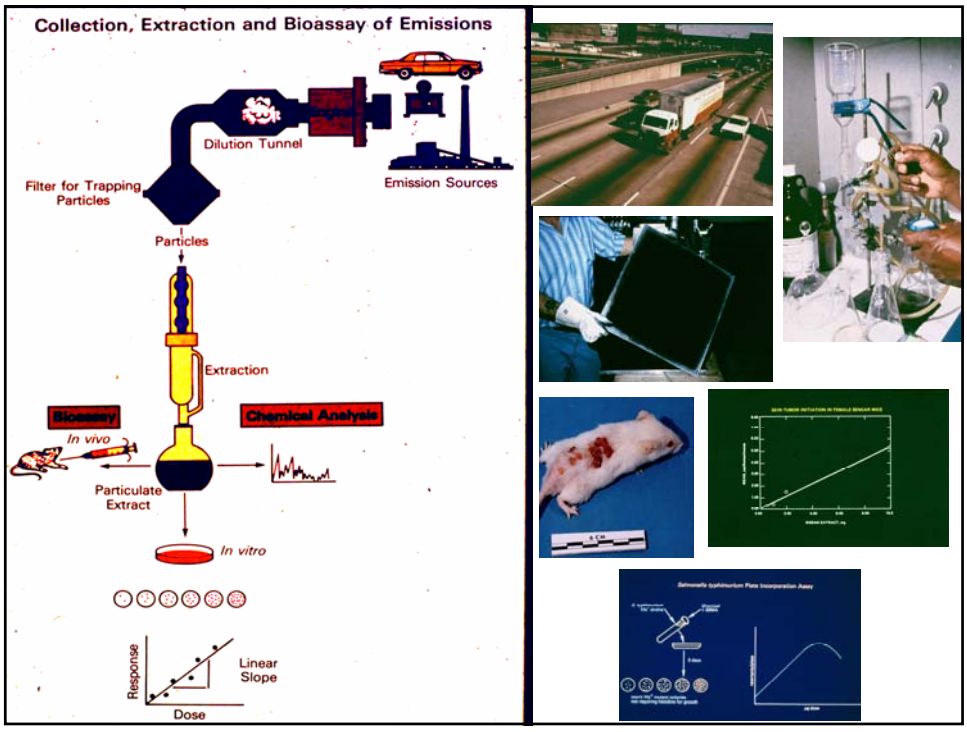
Joellen Lewtas, PhD, Professor
Dept. Environmental Health
University of Washington, Seattle
jlewtas@u.washington.edu

Substantial Evidence:
Organic Component of the Aerosol Contributes to the Adverse Effects of Combustion Emissions

- Genotoxicity
- Cancer

Air Pollution Sources & Samples:

- Vehicle Exhaust & Traffic
- Coal Combustion (Power Generation)
- Vegetative & Biomass Burning
- Cooking (residential & commercial)
- Industrial Sources
  (coke ovens, aluminum smelters, asphalt, roofing tar, incinerators, etc.)
- Home Heating
- Cooking Emissions
- Off-Road Machinery & Shipping
- Atmospheric Transformation Reactions
- Air Particles & Semi-Volatile Organics



Human Carcinogenic Mixtures

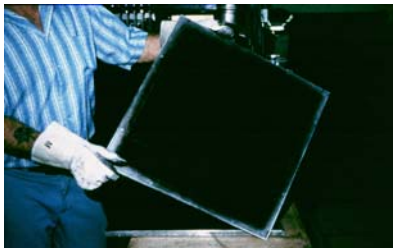
Cigarettes

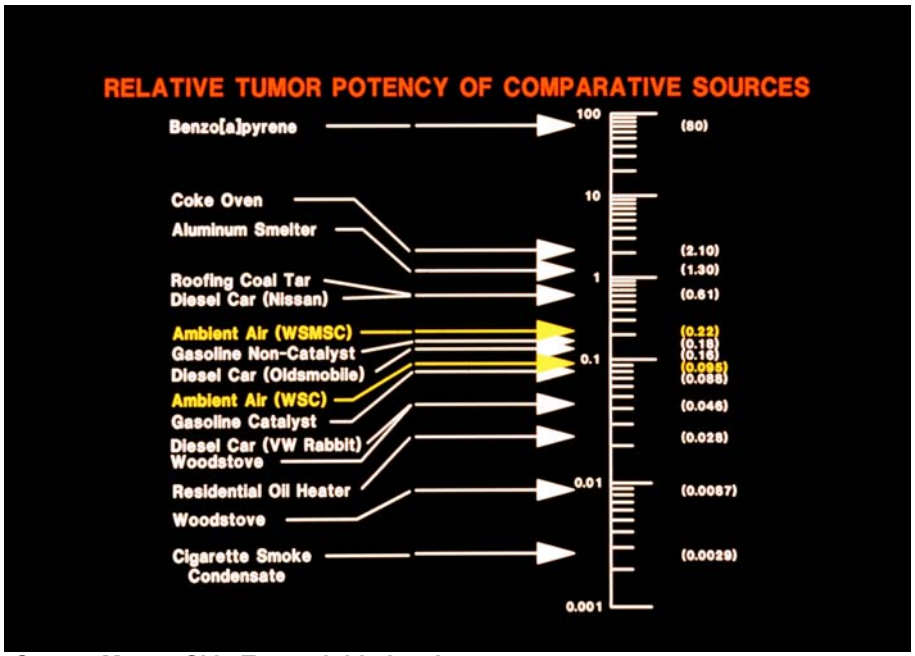
Coke Oven Emissions

Smoky Coal
China

Ostrava, CZ

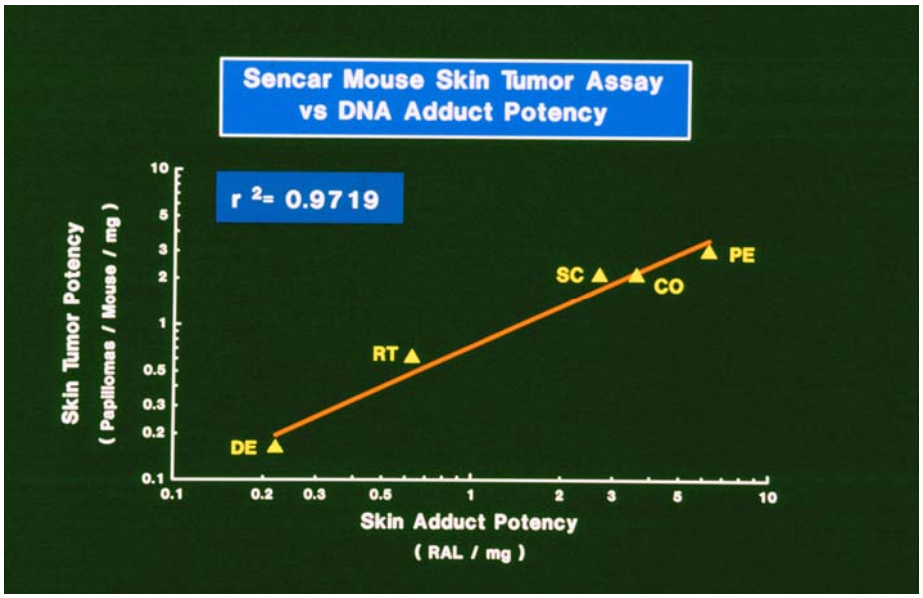
Combustion Source Samples





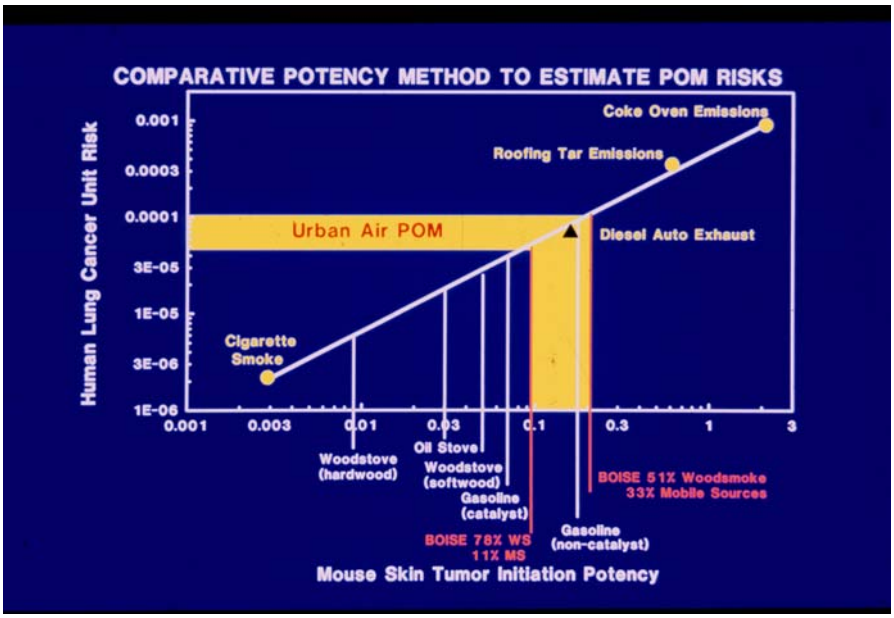
Sencar Mouse Skin Tumor Initiation Assay

Lewtas, J. (1993) Env.Health Persp., 100:211-218.



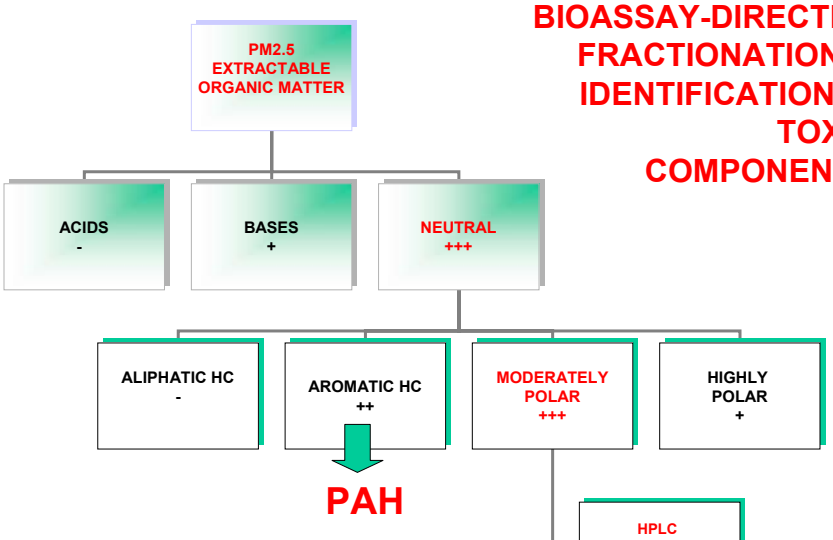
DE = Mercedes Diesel, RT = Roofing Tar, SC = Smoky Coal, CO= Coke Oven,

PE = Polyethylene Incineration



L Cupitt, W Glen, J. Lewtas. **Environ Health Perspect,** 1994,102:75-84.
R Albert, J Lewtas, S Nesnow, T Thorsland, E Anderson ***Risk Analysis*** 1983, 3:101-117

BIOASSAY-DIRECTED FRACTIONATION & IDENTIFICATION of TOXIC COMPONENTS



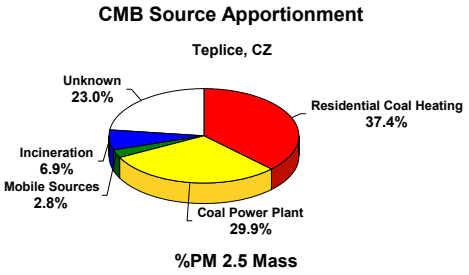
Example from Diesel Particle Bioassay-Directed Characterization Studies

Mutagenic Nitro-PAH Discovered

US EPA/Czech Acad. of Sciences: Impact of Air Pollution on Human Health

Czech Republic:

- Sources
  - Coal Combustion Dominant
- Exposure Studies
- Biomarker Studies
  - Exposure & Dose
  - Genetic Biomarkers
- Health Studies
  - Respiratory
  - Reproductive
  - Cancer
  - Mortality

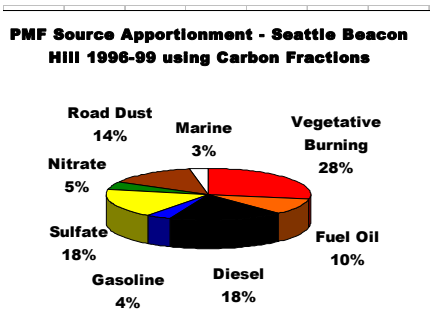


R. Sram, et al. and J. Lewtas (1996) EHP 104: 669-714.

UW/EPA NW Research Center for Particulate Air Pollution & Health

Seattle, WA:

- Sources
  - Vegetative Burning
  - Motor Vehicles
- Exposure Studies
- Biomarkers
- Health Studies
  - Mortality
  - Cardiovascular
  - Pulmonary
- Populations
  - Senior Adults
  - Asthmatic Children



N. Maykut, J. Lewtas, E. Kim, T. Larson(2003) ES&T 37:5135-42.

Important Issue

- **Substantial Evidence that organic ambient aerosols are an important health issue**
- **More research funds are needed for research in this area**

What types of studies have indicated that organic aerosol presents a health concern?

- **Studies on cancer, reproductive outcomes, cardiovascular disease, pulmonary effects, and mechanistic studies**

What are the health outcomes that have been linked to organic compounds in PM?

- **Respiratory effects, allergic reactions**
- **Cardiovascular disease**
- **Cancer and genetic effects**
- **Reproductive Effects**
- **Immunological Effects**

Which organic classes/compounds in the ambient aerosol do we need to examine because we suspect they present health concerns?

- **Polycyclic aromatic compounds (e.g. PAH)**
- **Nitro-aromatic compounds (nitro-PAH) and nitrogen heterocyclics**
- **MeIQx (amino-dimethylimidazo-quinoxalin)**
- **Dienaldehydes (e.g., *trans-trans*-2,4-decadienal or tt-DDE) and related compounds from high temperature cooking oil fumes**

What is the relative health importance of organic vs. non-organic PM components?

- Organic compounds may be more likely to be carcinogens, mutagens, and cause adverse reproductive outcomes

How could organic classes/compounds be "lumped" for hazard or risk assessment?

- By class and mode of action
  - Screening or Hazard ID
- Quantitative Risk Assessment not applicable for "lumped compounds" unless there is scientific evidence to support it

How much is known about exposure scenarios and exposure-dose-response relationships?

- **A great deal about classes of compounds studied for a long time such as PAH**
- **Much less about recently identified compounds and sources**
  - **(e.g., mutagens and carcinogens formed in cooking over or in high temperature oils (e.g., wok cooking, deep frying)**

To what extent are organic aerosol measurements the limiting factor to progress in health studies, and what specific needs are not being met?

- **More routine and well validated methods are needed for adding organic measurements to human epidemiological studies**
- **Availability of reference materials and internal standards are critical**