The Deposition and Fates of Inhaled Transport Related Particulate Material

by

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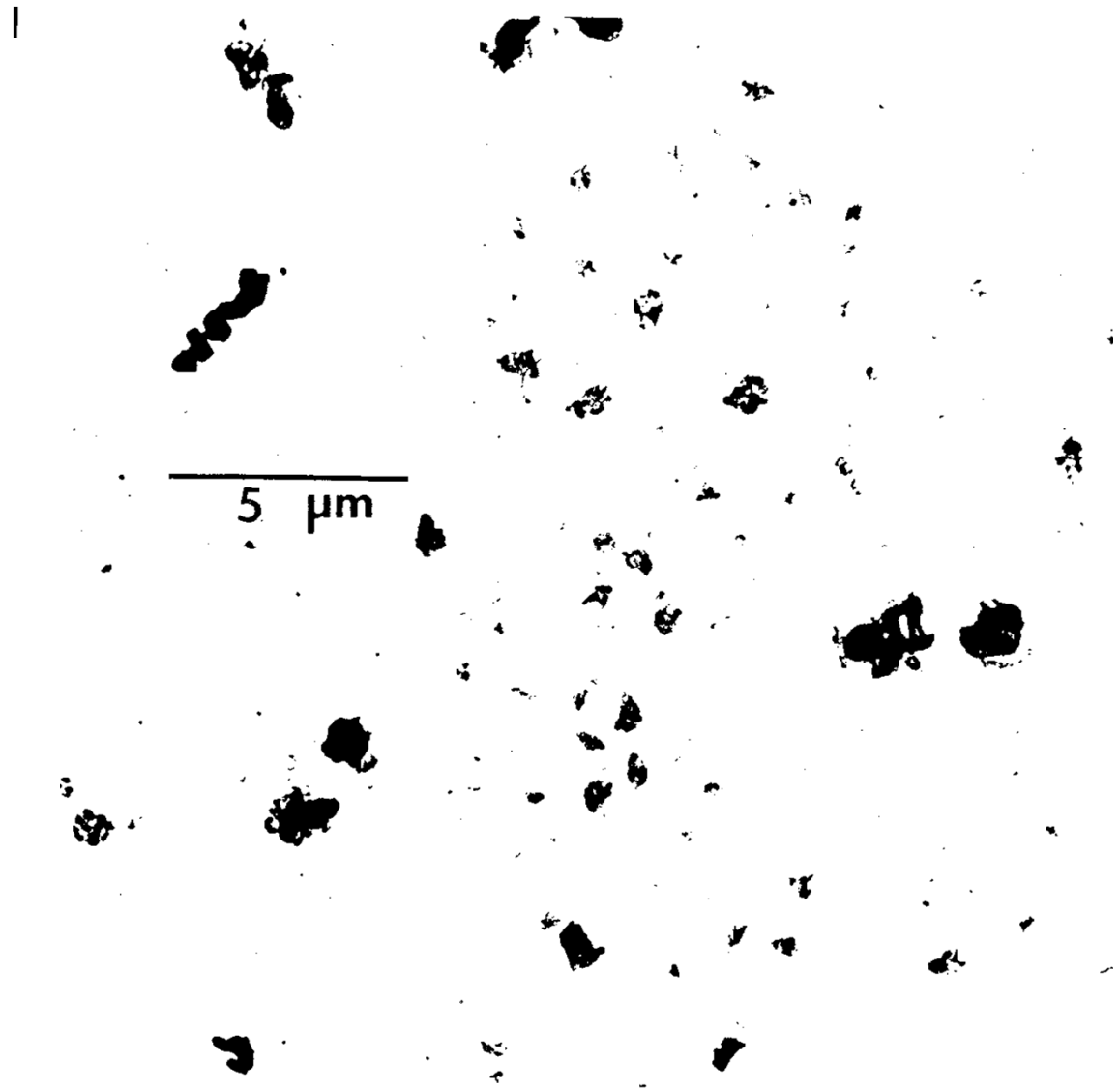
"All substances are poisons; There is none which is not a poison.
The right dose differentiates a poison from a remedy."

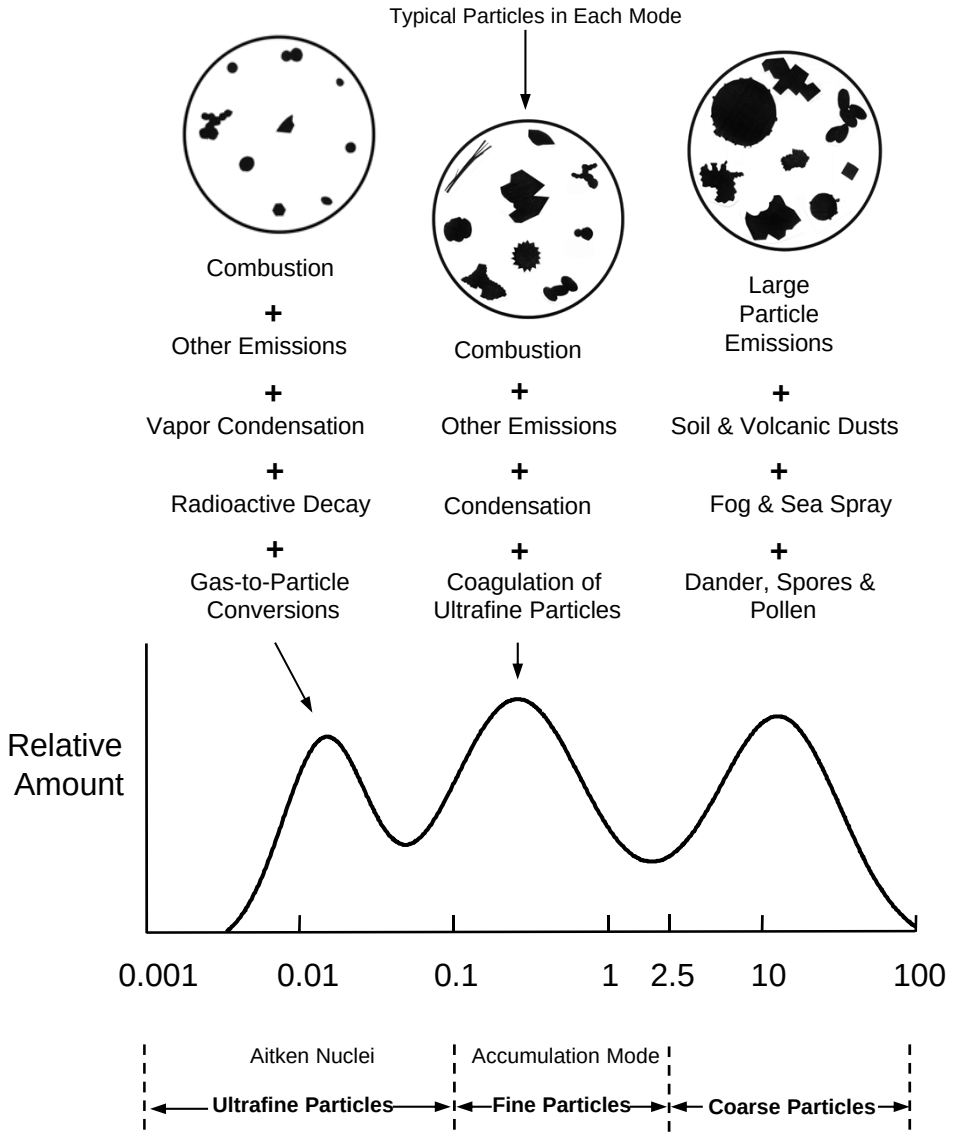
OUTLINE

* **ENVIRONMENTAL PARTICLES**
* **THE HUMAN RESPIRATORY TRACT**
* **DEPOSITION OF INHALED PARTICLES**
* **U.S. EPA CRITERIA AIR POLLUTANTS**
* **CALIFORNIA DIESEL EXHAUST DOSES**
* **CALIFORNIA PM ISSUES**
* **CONCLUDING REMARKS**
* **REFERENCES**

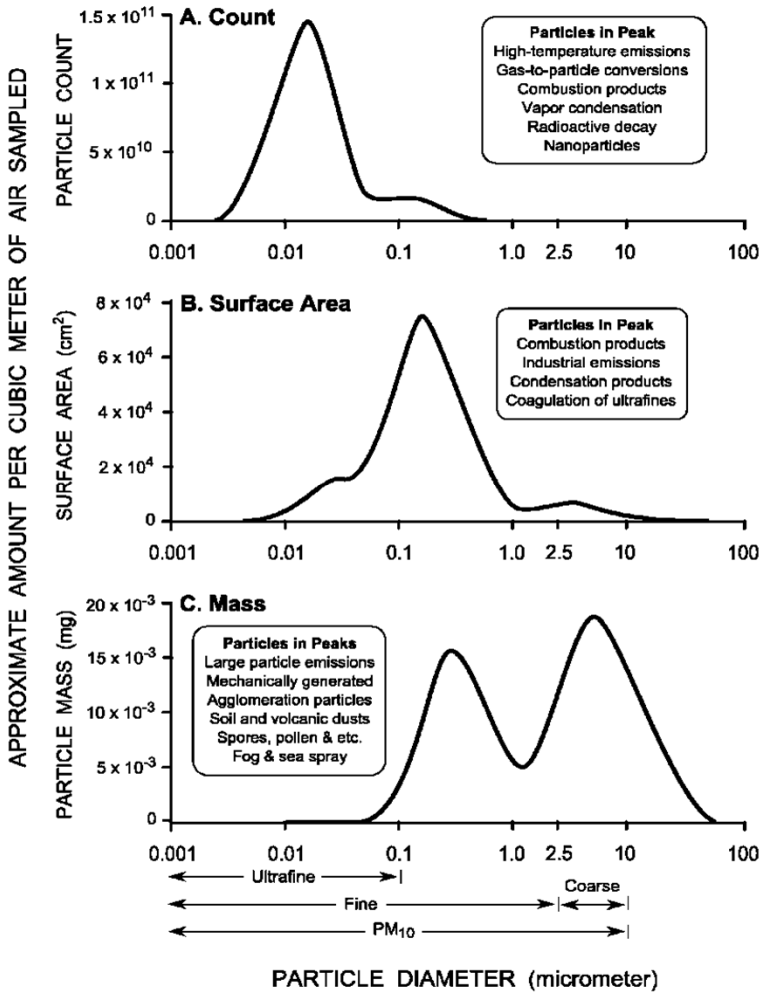
EM PHOTO OF PARTICLES IN IRVINE AIR



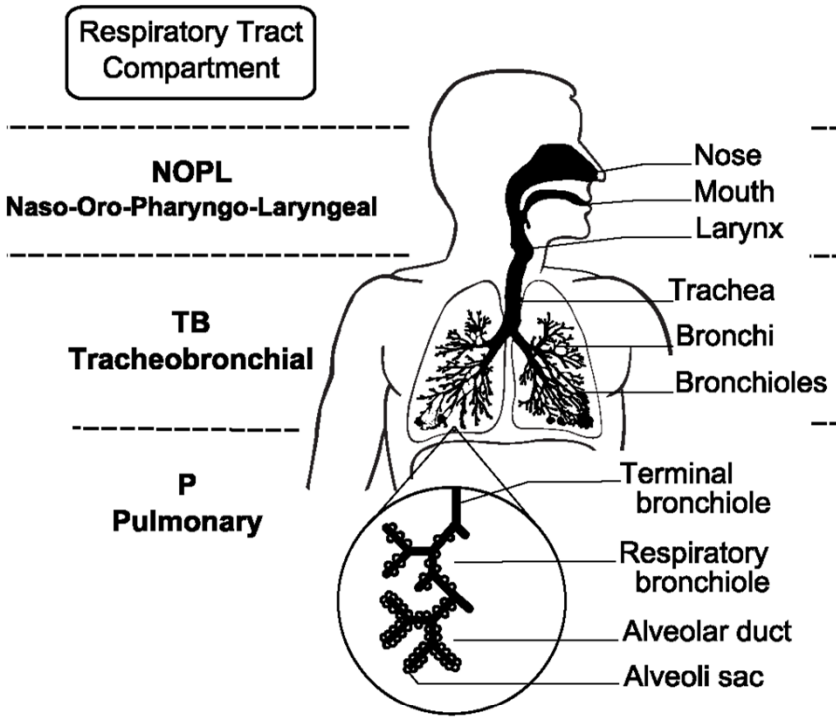
TROPOSPHERIC PARTICLES - SIMPLIFIED



TROPOSPHERIC AEROSOL USING THREE METRICS

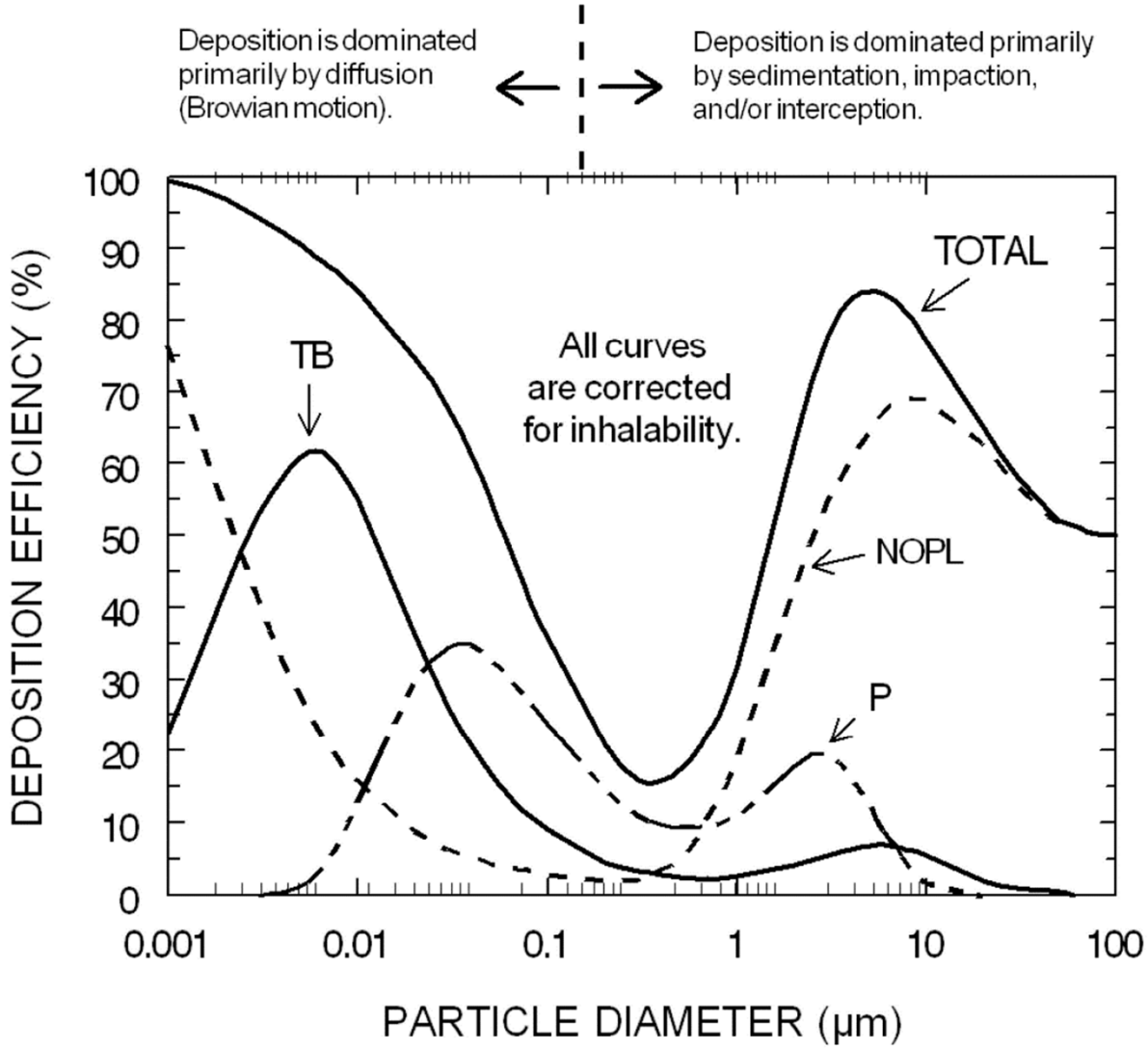


THE RESPIRATORY TRACT



Respiratory Tract Compartment	Deposition Mechanisms	Potential Pathology	Clearance Mechanisms
NOPL **Naso-Oro-Pharyngo-Laryngeal**	- impaction - diffusion - interception - electrostatic	- inflamation - infection - ulceration - cancer	- mucociliary - olfactory nerve - sneezing - blowing
TB **Tracheobronchial**	- impaction - sedimentation - diffusion - interception	- inflamation - bronchospasm - infection - obstruction - cancer	- mucociliary - coughing - transepithelial (through/between cells)
P **Pulmonary**	- sedimetation - diffusion - interception	- inflamation - infection - edema - emphysema - fibrosis - cancer	- solubilization - phagocytosis - interstitial uptake

INHALED PARTICLE DEPOSITION.



NAAQS – NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Type*	Standard	Averaging Time
Sulfur Dioxide	Primary	0.075 ppm	1 h
	Secondary	0.5 ppm	3 h
Nitrogen Dioxide	Primary	0.053 ppm	Annual
	Primary	0.1 ppm	1 h
Ozone	Primary	0.075 ppm	8 h
Carbon Monoxide	Primary	9 ppm	8 h
	Primary	35 ppm	1 h
Lead	Primary	0.15 μg/m^3	3 mo (rolling avg).
PM_{10}	Primary	150 μg/m^3	24 h
$PM_{2.5}$	Primary	35 μg/m^3	24 h
	Primary	15 μg/m^3	annual

* Primary standards are intended to protect public health, and Secondary standards are set to protect public welfare (e.g. impacts on vegetation, crops, man-made materials, ecosystems, visibility, climate, etc). When the Secondary standard is the same as the Primary standard the Secondary standard is not listed. Source: http://epa.gov/air/criteria. html, (accessed 11/15/2013).

PM 2.5 DOSE CALCULATIONS - 1

* Assume 24 hours of breathing at a low exertion level for 70 years at maximum EPA NAAQS (15μg/m^3)
* Estimate total inhaled dose to the Pulmonary Airways.
* Total 70 year outdoor 24 hour/day dose = 1.8 grams
* Total 70 year indoor & outdoor dose = 0.65 grams

PM 2.5 DOSE CALCULATIONS - 2

* Total 70 year diesel dose in CA = 0.026 grams
* Smoking 1 cigarette dose = 0.04 grams
* CA diesel dose in 70 years = 0.65 cigarettes; i.e., 0.01 cigarettes/year.
* The TWA for soot is 3 mg/m^3 giving 0.026 grams in 2 days.
* No non-infection related substance could be toxic at the average level of diesel PM exposure in CA.
* The single lethal dose of strychnine sulfate = 0.14 grams

CALIFORNIA PM ISSUES - 1

* U.S. EPA sets National Ambient Air Quality Standards (NAAQS).
* CA has a dry climate, so soil dust PM 2.5 is about 1.7 to 3.5 $\mu g/m^3$.
* PM is the only regulated air pollutant without chemical specification; mass is regulated.
* PM 2.5 is mass (natural & anthropogenic) in particles under 2.5 μm diameter.
* In CA total PM 2.5 is about 10 $\mu g/m^3$ of air. Diesel combustion contributes about 0.4 to 0.6 $\mu g/m^3$ (Mahmud, et al., 2012)
* Epidemiology studies of PM 2.5 in CA are largely negative, as opposed to some Eastern U.S. cities.

CALIFORNIA PM ISSUES - 2

* Further restrictions on diesels could have only negligible impacts on PM 2.5 in CA.

* CA has serious economic problems, which also have adverse health impacts.

* Any risk assessment should be done on the risks of a decision (e.g., regulation), not a chemical (or substance).

* CA should consider seeking a waiver to exempt the state from PM 2.5 NAAQS.

CONCLUSIONS

* PM 2.5 in CA air is quite low.
* Diesel exhaust is a small portion of PM 2.5 in CA.
* Doses from inhaled diesel exhaust particles in CA are very small.
* PM 2.5 in CA is less toxic than that in some Eastern U.S. cities.
* Is it logical for CA to impose additional restrictions on diesel exhaust?

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