

# Magnitude, Distribution, and Fate of Polycyclic Aromatic Hydrocarbons in Urban Highway Soils

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## INTRODUCTION

- Polycyclic aromatic hydrocarbons (PAHs) are immunotoxic and carcinogenic compounds
- PAHs are a subset of compounds produced from combustion sources (vehicle exhaust, fires, cooking).
- Urban soils are increasingly exposed to deposition of carbon-based pollution from non-point sources.
- These contaminants may be a resource for urban soil microorganisms, modifying microbial community structure and function.

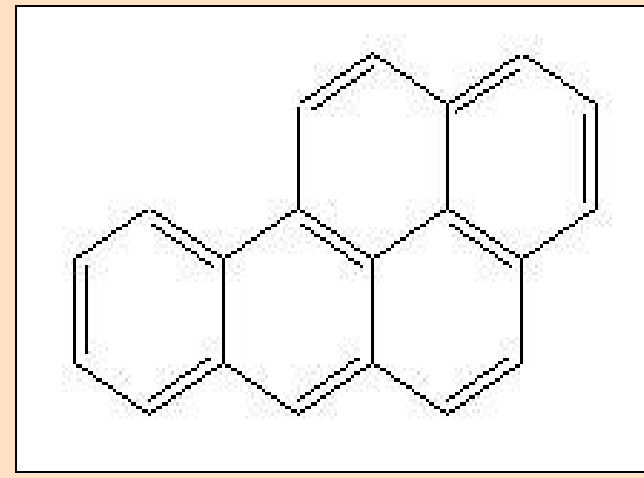


Fig.1. Benzo[a]pyrene

## QUESTION

What is the magnitude, distribution, and fate of PAHs in highway soils of a low population density, arid urban area?

## HYPOTHESES

- Number of sources (traffic volume) and length of deposition time (age of highway) will predict PAH concentration in soils.
- Carbon retention properties in soils will affect PAHs; i.e. soil organic matter, which can be anthropogenically modified.
- Ongoing experiments: PAH concentrations may also be determined by:

**Microbial metabolism:** Because soil microbes use reduced carbon compounds for growth, microbes adapted to PAH pollution may be able to metabolize these complex carbon compounds.

**Climate/Environment:** Solar irradiation, temperature, and precipitation may alter degradation, accumulation, and transportation dynamics of PAHs.

## METHODS

- During summer 2008, 60 sites were chosen from Phoenix metropolitan area highways (Fig. 2). One sample from each site consisted of three homogenized soil cores, collected from the top 2 cm of soil, taken 0.5 meters away from the side of the road.



Fig. 2. Map of soil sampling locations in the Phoenix valley, including PAH concentrations.



Fig. 3. Samples after ultrasonic solvent extraction.

- Soil samples were analyzed for soil properties and PAH concentrations. After sample preparation and cleanup methods, PAH compounds were identified and quantified with a GC-MS.

## RESULTS

- Phoenix data shows high variability and a weak significant correlation between traffic load and PAH concentrations across all sites ( $r^2 = 0.13$ ,  $p = 0.003$ ).
- Weak significant correlation between age of highway and PAH concentrations ( $r^2 = 0.1$ ;  $p = 0.007$ ).
- Concentrations of PAH compounds in the Phoenix metropolitan area are low compared to other cities worldwide (Table 1).

Study Location	Concentration of PAHs ( $\Sigma 16$ compounds $\mu\text{g}/\text{kg}$ )	Mean annual temp. (C)	Annual precipitation (mm)
Bangkok, Thailand <sup>2</sup>	107	28.00	1320
Phoenix, AZ, US	1,174	23.00	193
Brisbane, Australia <sup>4</sup>	3,346	20.00	1090
Agra, India <sup>1</sup>	12,980	25.00	660
Ji'nan, China <sup>3</sup>	14,230	14.20	675

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## More results...

- Soil organic matter predicts PAHs ( $r^2 = 0.43$ ;  $p < 0.001$ ) (Fig. 4).
- 87% of sites dominated by vehicles, 93% by pyrogenic sources (Fig. 5).

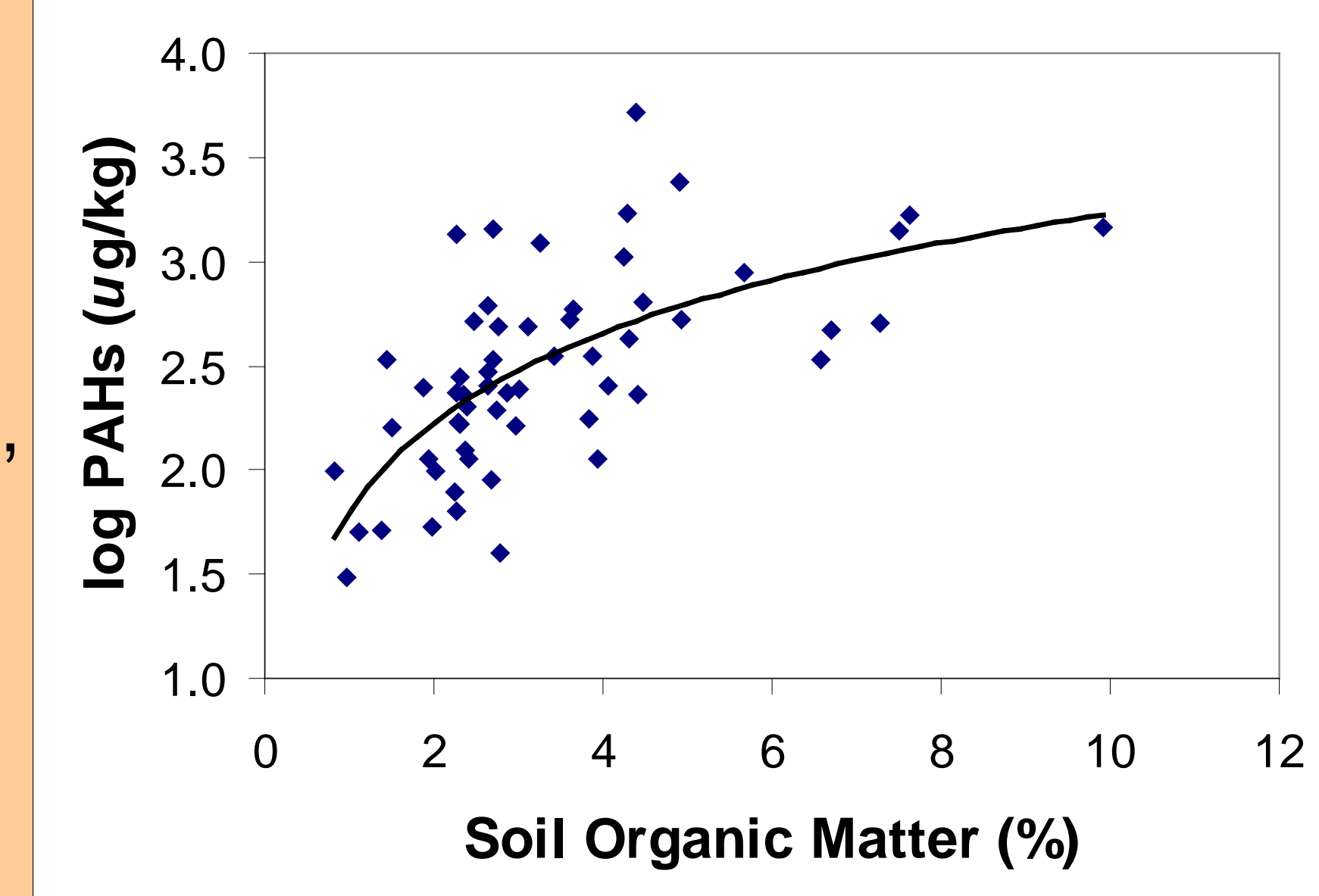
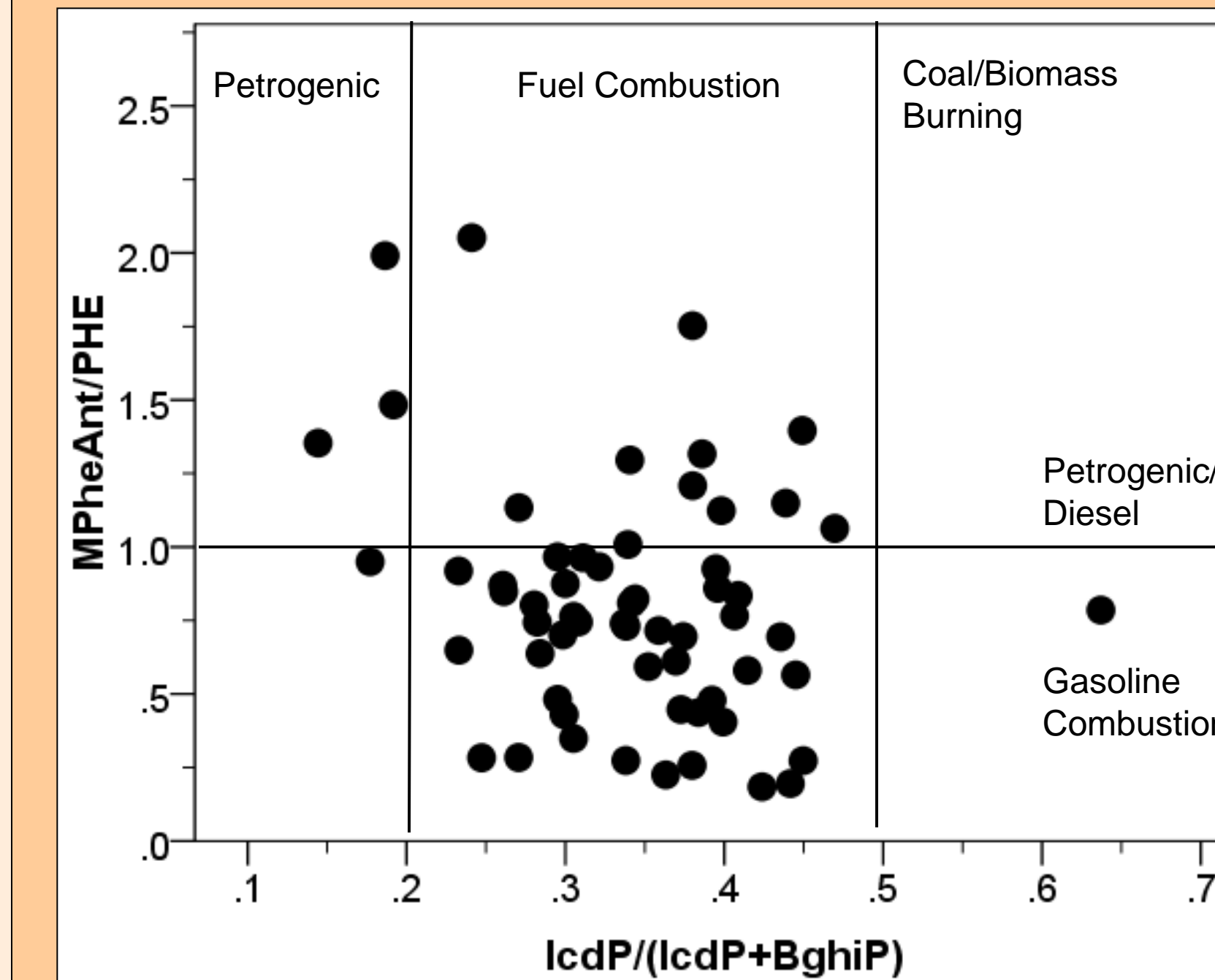


Fig. 4. Scatterplot showing positive correlation between PAH concentrations and SOM.

Fig. 5. Source apportionment using diagnostic ratio analyses.

## DISCUSSION/CONCLUSION

- Diagnostic ratios based on PAH partitioning reveal a dominance of motor vehicle emission sources and an environmental influence.
- Data suggest that PAH concentrations in Phoenix soils are **lower** than expected based on data from other, more densely populated cities.
- High variability** between samples obscures some relationships between PAH concentrations and other factors (e.g. traffic, other soil properties).
- Both abiotic and biotic factors may control **PAH retention** in urban soils, especially soil organic matter.

## FUTURE WORK

- We plan to use molecular fingerprinting techniques to explore the effects of urban deposition on microbial community structure and function of specialized degrader microorganisms in urban soils.
- We will also test other factors controlling PAH concentrations, such as effects of photodegradation (UV radiation) on PAH breakdown.
- Application to socio-ecological issues and environmental justice: We will explore the relationship between soil PAH concentrations and social factors such as income and ethnicity at a city scale.

## References

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