

The Fate of Combustion-Derived Carbon Deposition in Urban Soil

Yevgeniy Marusenko¹, Pierre Herckes² and Sharon J. Hall¹ ¹School of Life Sciences, ²Department of Chemistry and Biochemistry, Arizona State University, Tempe, Arizona

INTRODUCTION

- Polycyclic aromatic hydrocarbons (PAHs) are immunotoxic and carcinogenic compounds that are commonly 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.



QUESTION

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

HYPOTHESES

- Number of sources (traffic density) and proximity to source (distance to the road) will predict PAH concentration in soils.
- Future experiments: PAH concentration may also be determined by:
 - Microbial metabolism:** Because soil microbes use reduced carbon compounds for growth, microbes adapted to high PAH concentrations 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.
 - Anthropogenic modification of soil properties** that may affect carbon sequestration in soils, including soil moisture, pH, and road features (pavement type, age of highway, landscape slope).

References

- Masih, A. and A. Taneja (2006). *Chemosphere* (3) 65: pp. 449-456.
- Mielke, H. W. et al. (2004). *Environ. Toxicol. Pharmacol.*(3) 18: pp. 243-247.
- Rogge, W.F. et al. (1993). *Environ. Sci. Technol.* 27: pp. 1892-1904.
- Yang, S.Y.N. et al. (1991). *The Science of the Total Environ.* 102: pp. 229-240.

METHODS

- During summer 2008, 63 sites were chosen from Phoenix metropolitan area highways (Fig. 1). 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.
- Five sites were used for additional soil sampling at intervals of 0.5, 1.5, 5.0, and 15 m away from the road using perpendicular transects.



Fig. 1. Map of soil sampling locations in the Phx valley.



Fig. 2. 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 (Fig. 2). To date, 35 of 83 samples have been quantified.

RESULTS

- Concentrations of PAH compounds in the Phoenix metropolitan area are low compared to other cities worldwide (Table 1).
- Preliminary data (n = 15 of 63) show high variability and no correlation between traffic density and PAH concentration.

Study Location	Σ 12 PAH concentration (ug/kg)	Mean max temp. (F)	Annual precipitation (inches)
Bangkok, Thailand ²	250	32.78	55
Phoenix metropolitan area, AZ	1,155	30.42	8.4
Brisbane, Australia ⁴	3,300	25	45
Agra, India ¹	12,900	31.67	27
Los Angeles, CA, US ³	58,680	23.89	15

Acknowledgements

Many thanks to James Hutchings, Tejkaran Dhillon, David Huber, and Jolene Trujillo for field/lab assistance and method training. The research has been funded by the CAP LTER Summer Grad Grant and CAP LTER Summer REU.

- PAHs may preferentially deposit or otherwise remain in soils near roads, although, due to high variability of PAH compounds between sites, a larger sample size is necessary for increased statistical power. (Fig. 3.)

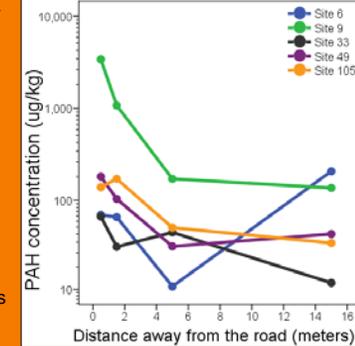


Fig. 3. Concentration of PAHs on a distance gradient at five highway sites.

DISCUSSION/CONCLUSION

- Preliminary data suggest that PAH concentrations in Phoenix soils are nearly an order of magnitude **lower** than expected based on data from other, more densely populated cities.
- High variability between preliminary samples obscures relationships between soil PAH concentrations, traffic density, and distance to roads.
- Both abiotic and biotic factors may control PAH retention in urban soils.

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: In our complete valleywide analysis, we will explore the relationship between soil PAH concentrations and social factors such as income and ethnicity.