The Fate of Combustion-Derived Carbon Deposition in Urban Soil

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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

1. Number of sources (traffic density) and proximity to source (distance to the road) will predict PAH concentration in soils.

2. Future experiments: PAH concentration may also be determined by:
   a. 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.
   b. Climate/Environment: Solar irradiation, temperature, and precipitation may alter degradation, accumulation, and transportation dynamics of PAHs.
   c. 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).

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.

• 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.

Table 1. Summary of Study Locations

<table>
<thead>
<tr>
<th>Study Location</th>
<th>Σ 12 PAH concentration (µg/kg)</th>
<th>Mean max temp. (°F)</th>
<th>Annual precipitation (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangkok, Thailand²</td>
<td>250</td>
<td>32.78</td>
<td>55</td>
</tr>
<tr>
<td>Phoenix metropolitan area, AZ</td>
<td>1,155</td>
<td>30.42</td>
<td>8.4</td>
</tr>
<tr>
<td>Brisbane, Australia³</td>
<td>3,300</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Agra, India¹</td>
<td>12,900</td>
<td>31.67</td>
<td>27</td>
</tr>
<tr>
<td>Los Angeles, CA, US¹</td>
<td>58,680</td>
<td>23.89</td>
<td>15</td>
</tr>
</tbody>
</table>

• 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.)

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.

References


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