What's in the air? Using passive sampling to study fracking

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Introduction

Fracking is increasing rapidly in the United States

- Potential impacts on environmental and human health
- Affects large area of the U.S. (Figure 1)
- Studies suggest exposure to fracking-related volatile organic compounds are associated with health risks[2,3]
- Polycyclic aromatic hydrocarbons (PAHs) may be of concern[4-6]
- Only one study measures ambient PAHs in relation to fracking[7]

Passive air sampling is well suited to measure PAHs in air near fracking activity

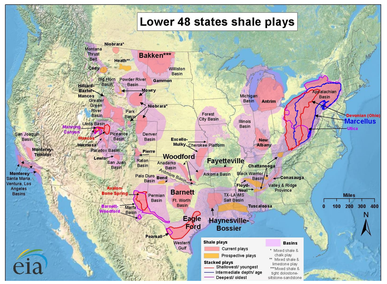


Figure 1: Map of natural gas reserves in the United States[1].

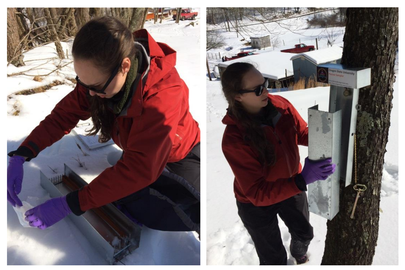
Hypothesis

PAH levels increase as distance to an active fracking well decreases

Methods

- Recruited volunteer landowners in rural Ohio
- Deployed low density polyethylene (LDPE) passive air samplers
  - 23 properties, for 3 weeks
  - Trained landowners mailed to lab at OSU
- Cleaned LDPE with isopropanol, extracted with hexane
- Analyzed for 62 PAHs using GC-MS/MS
- Calculated air concentrations using performance reference compound data[8]

Air sampling cage with a producing fracking well pad in the background.



C.E. Donald puts passive samplers in air sampling cage (left) and puts cage on tree (right).

Data Analysis

- Grouped samples based on distance to closest active fracking well (Figure 2)
  - "Active fracking well" = drilling, drilled, or producing
  - Two sample t-tests performed on pairwise combinations of distance groups, $\alpha = 0.05$
    - Asterisks indicate significant differences
    - Error bars represent one standard deviation

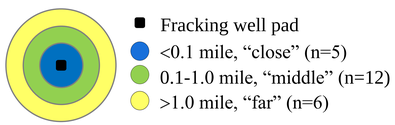
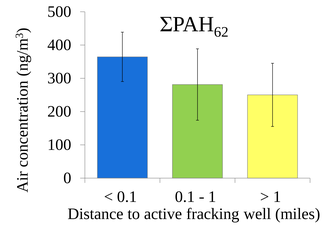
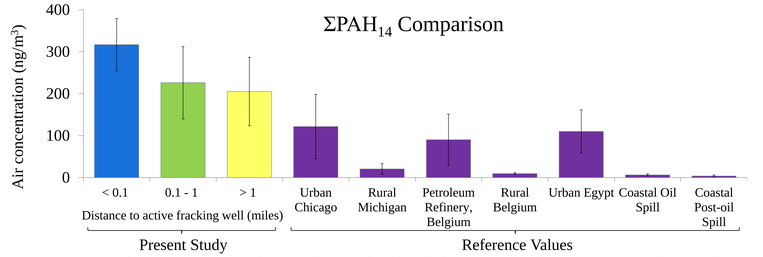


Figure 2: Visual explanation of three distance groups used in data analysis.

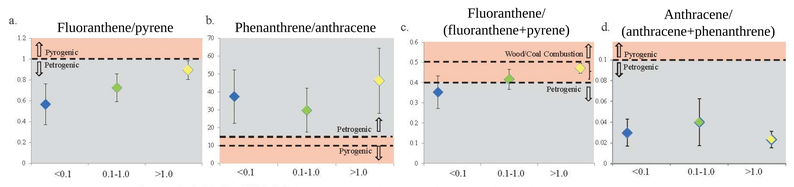
Results



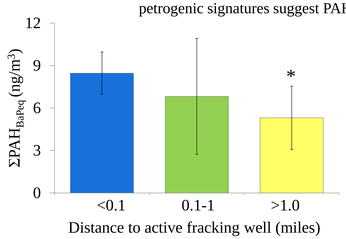
Average sum of 62 PAH concentrations. PAHs show a decreasing trend as distance to the closest active fracking well increases.



Average sum of 14 PAHs, compared to previous studies[9-12]. All data are vapor phase PAHs. PAHs closest to fracking activity are roughly an order of magnitude higher than in rural reference locations.



PAH sourcing ratios. Petrogenic mixtures are enriched in the more thermodynamically stable isomers, pyrene and phenanthrene. The predominant petrogenic signatures suggest PAH mixtures are predominantly influenced by direct releases of PAHs from the earth, not combustion.



Average carcinogenic potency of PAHs. Benzo[a]pyrene equivalent concentrations (BaP_{eq}), derived using the EPA's Relative Potency Factors.[13] Potency decreases significantly when samplers are farthest from fracking activity.

Excess Lifetime Cancer Risk Estimates

3 Exposure Scenarios[14]

Residential maximum	Residential minimum	Outdoor worker
262/million in close group	11/million in close group	54/million in close group
176/million in far group	7/million in far group	36/million in far group

Implications

- Sourcing ratios suggest PAHs near fracking wells are influenced by direct releases from the earth
  Elevated PAH levels may be related to fracking activity
- All excess lifetime cancer risk estimates are >1/million, U.S. EPA's conservative level of concern
  PAH levels are relevant to human health

A well is fracked in rural Ohio.

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