Sediment Core Analysis

In [2]:
```
%matplotlib inline
import pandas as pd
import numpy as np
import matplotlib.pylab as plt
from scipy import stats
from matplotlib.backends.backend_pdf import PdfPages
from IPython.display import Image
from IPython.display import HTML
```

In most areas of the United States it is assummed that leaded gasoline was a major cause of lead pollution before it was banned in the 1970's. However New York City may be a unique case and could be different. A colleague at Lamont put out this nice article saying that incineration of municipal waste was the main cause of lead to the atmosphere in New York City and not Leaded Gasoline during the 20th century. This was based on data collected from a sediment core. Here is a link to the paper (http://pubs.acs.org/doi/abs/10.1021/es9807892) and the pdf (http://pubs.acs.org/doi/pdf/10.1021/es9807892). See the abstract below. This notebook is for information and you only need to read it. I have now also made a podcast talking to Steve about the paper. https://itunes.apple.com/us/podcast/chillrud-lead/id1418618791?i=1000416725089&mt=2 (https://itunes.apple.com/us/podcast/chillrud-lead/id1418618791?i=1000416725089&mt=2)

In [9]:
```
Image(filename='Chillrud-Abstract.png',width=300)
```

Out[9]:

Twentieth Century Atmospheric Metal Fluxes into Central Park Lake, New York City

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It is generally assumed that declining atmospheric lead concentrations in urban centers during the 1970s and 1980s were due almost entirely to the progressive introduction of unleaded gasoline. However, most environmental data are from monitoring programs that began only two to three decades ago, which limits their usefulness. Here, trace metal and radionuclide data from sediment cores in Central Park Lake provide a record of atmospheric pollutant deposition in New York City through the 20th century, which suggests that leaded gasoline combustion was not the dominant source of atmospheric lead for NYC. Lead deposition rates, normalized to known Pb-210 atmospheric influxes, were extremely high, reaching maximum values (>70 μg cm^{-2} yr^{-1}) from the late 1930s to early 1960s, decades before maximum emissions from combustion of leaded gasoline. Temporal trends of lead, zinc, and tin deposition derived from the lake sediments closely resemble the history of solid waste incineration in New York City. Furthermore, widespread use of solid waste incinerators in the United States and Europe over the last century suggests that solid waste incineration may have provided the dominant source of atmospheric lead and several other metals to many urban centers.

Here is a picture of the authors collecting the core in central park!

In [5]:
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Image(filename='central_park_core.jpg',width=600)
```

Out[5]:

We want to think about the results from Chillrud et al., and use them to develop questions and hypotheses about other sediment cores.

We collected a sediment core from a Backyard in Greenpoint Brooklyn.

Your goal is to

1. read the Chillrud paper.
2. Listen to the podcast
3. Determine their main conclusions and hypothesis.
4. Develop your own hypothesis to test on the Brooklyn Core
5. Test that hypothesis with the sediment data from the Brooklyn Core.
6. Report your findings (This is going to include multiple graphs) and writing in markdown

This is a picture of a core geting collected in a Brooklyn Back Yard

In [3]:
```
Image(filename='core-data/BrooklynCore.jpg',width=400)
```

Out[3]:

Here is what a core looks like once it is collected

In [4]:
```
Image(filename='core-data/core-cropped.jpg',width=300)
```

Out[4]:

What is the inventory?

It is the total amount of lead in your core normalized to the area and has units of g/m^2

How do I calculate?

- For each layer of the core
- You multiply the weight of the sediment by the concentration of lead. In Steve's paper they subtract a background concentration of 26 ug/g from the concentrations at first which is the same as mg/Kg as this is the natural levels in soils. This is stated in figure caption 3.
- Lead is in units of mg/Kg which is mg of lead per kg of soil
- the soil weight is in grams so you convert to kg.
- this gives you the weight of the lead in each section in units mg.
- You sum of the weights
- You convert to grams
- you divide by the cross-sectional area of the core in units of m^2
- the core radius is 1.27 cm

As math this looks like (watch the units!)

$$Inventory = \frac{1}{CoreArea} * \sum_{n=1}^{Sections} SedMass * (ConcentrationPb - 26)$$

$$CoreArea = \frac{1.27^2 * \pi}{100 * 100} = 0.000507$$

Lead

In order to understand the data you need to understand a little bit about lead isotopes. We are using total lead and lead isotopes in two ways in this study and in this paper. Lead-210 is a natural radionuclide of lead and has a half life of 22 years. Lead is deposited at basically a constant rate from the atmosphere. But once sediment is buried it can't get anymore Lead-210. So the lead-210 decays and after 22 years you will have half as much as when you started. So by measuring lead-210 you can get an idea of the time since depositions! That is how Steve has dates on the core. The lead-210 used for dating is also called Excess Lead-210. But at the same time there is total Lead in the atmosphere. This is all the stable and unstable isotopes of lead. The amount of this total lead has changed in the atmosphere over time and we are interested in its temporal patterns and its controls. So Lead-210 is helping with dating the sediment and total lead is telling us about atmospheric contamination. Also, within these cores there is deposition of Cs-137 from nuclear fallout. Also, there are other elements and metals that may have a contamination source while many elements are just natural. Can we figure out which are natural and which correlate with the different sources of contamination?

In [3]:
```
HTML('<iframe src=https://blogs.ei.columbia.edu/2017/10/09/many-backyards-in-brooklyn-neighborhood-are-contaminated-with-high-levels-of-lead/ width=700 height=800</iframe>')
```

```
C:\Users\bmaillou\AppData\Local\Continuum\anaconda3\lib\site-packages\IPython
\core\display.py:701: UserWarning: Consider using IPython.display.IFrame inst
ead
  warnings.warn("Consider using IPython.display.IFrame instead")
```

Out[3]:

State of the Planet

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HEALTH

High Levels of Lead Contaminate Many Backyards in Brooklyn Neighborhood

BY SARAH FECHT | OCTOBER 9, 2017