What’s in the Water?  
The History and Future of Barton Springs

Dr. Barbara Mahler  
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The history and future of Barton Springs

Dr. Barbara Mahler
Karst and Karst Aquifers

- Karst is a distinctive type of landscape that is formed from the dissolution of soluble rocks, including limestone and dolomite.
- Karst is characterized by sinkholes and caves and underground drainage systems.
- Karst aquifers, that is, aquifers in karst regions, are capable of supplying large quantities of water.
- Karst landscapes are often very scenic areas.
Karst aquifers are different from other aquifers (such as sandstone) in that:

- Water doesn’t flow similarly in all parts of the aquifer (Inhomogeneous)
- Water flows preferentially in one direction rather than another (Anisotropic)

Sandstone aquifer

Water velocities are a few inches per day

Karst aquifer

Water velocities can be miles per day
Karst aquifers are very productive ...
... but very vulnerable to contamination

Flow through solution “pipes”

Thin soils

Direct recharge features
Urbanization: How has Austin grown since 1839

Original Proposal for Capital City, 1839
We live here because of karst ...
Contributing Zone, Recharge Zone, and Artesian Zone
Old Mill Spring
What can we measure in the water?

- “Physical” parameters
- Major ions (calcium, sodium, etc.)
- Nutrients
- Contaminants in water
  - Pesticides, VOCs, pharmaceuticals, waste-water indicators
- Contaminants on sediment
  - Metals, PAHs, organochlorine compounds
Physical parameters can be measured continuously

- Discharge (flow rate)
- Temperature
- Conductivity
- Turbidity
- pH
- Dissolved oxygen

Baseflow: physical parameters change slowly as the aquifer drains
… but when it rains, things happen!

- Velocity/Springflow changes reflect aquifer and local conditions
- Conductivity reflects rainfall infiltrating
- Turbidity corresponds to turbid creek recharge
Springflow and surface-water flow are closely connected

Flow in Barton Creek vs Turbidity in Barton Springs, June 2004

- Flow rate
  Barton Creek @ Hwy 360
- Turbidity
  Barton Springs
Major Ions: the natural chemical signature of the water

• Cations
  - Ca, Mg, Sr, Na

• Anions
  - HCO$_3$, SO$_4$, Cl

• Help us differentiate between different sources of water feeding the springs
Nutrients: The Right Balance Needed

- Nitrogen, phosphorous necessary for plant growth
- Additional sources: fertilizer, wastewater, animal wastes
- Too much causes eutrophication

<table>
<thead>
<tr>
<th>Site</th>
<th>NO$_2$ + NO$_3$ Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Barton</td>
<td>3.0</td>
</tr>
<tr>
<td>Upper Barton</td>
<td>2.5</td>
</tr>
<tr>
<td>Eliza</td>
<td>2.0</td>
</tr>
<tr>
<td>Old Mill</td>
<td>1.5</td>
</tr>
</tbody>
</table>

NO$_2$ + NO$_3$ August and September 2003
- “New” (post-DDT) pesticides are very soluble
- Detected in 99% of surface water and 49% of ground water sampled by the USGS
- Very low detection limit
- Toxic by design

### Dissolved Contaminants: Pesticides

#### Atrazine, August and September 2003

<table>
<thead>
<tr>
<th>site visit</th>
<th>Upper Barton</th>
<th>Main Barton</th>
<th>Eliza</th>
<th>Old Mill</th>
</tr>
</thead>
<tbody>
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<td>0.01</td>
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<td>0.01</td>
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<tr>
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<td>4</td>
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<tr>
<td>5</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
</tbody>
</table>
After rain, pesticide concentrations increase

Occurrence of Atrazine in response to May 1, 2000 rain even

- Williamson Creek
- Barton Creek above Barton Springs
- Main Springs
- Eliza Springs

Time after rainfall (hours)
Dissolved contaminants: Volatile organic compounds (VOCs)

- Gasoline compounds
  - BTEX
  - MTBE (oxygenate)

- Cleaning solvents (degreasers)
  - Industrial processes
  - Dry cleaners
  - Floor cleaners
Dissolved contaminants: “Emerging contaminants”

- Pharmaceuticals
  - Excreted into waste water
  - Antibiotics, hormones, analgesics

- Other waste-water indicators
  - Flame retardants, surfactants, fragrances

- Planned for future sampling
What's in the sediment?

Toxic chemicals taint Barton waters

TOXIC WATERS
AN AUSTIN TREASURE AT RISK

City closes Barton pool

Decades-old fuel waste cited as possible source

POOL, OTHER CITY CREEKS MAY POSE HEALTH RISK
Suspended-sediment sampling

- Metals
  - Zinc, lead, mercury
- Organochlorine compounds
  - PCBs, DDT, chlordane
- PAHs
- Compare between urban creeks and spring sediment
Comparing metals in springs and creeks

- Some metals (As, Ni, Cr, Cd) have higher concentrations in the springs.
- High concentrations in creeks are associated with the natural geochemistry of aquifer sediment.
Comparing metals in springs and creeks

- Two metals (Pb, Zn) have higher concentrations in the creeks
- High concentrations of Pb and Zn in creeks are associated with urbanization
DDE and PAH in spring and creek sediments

- Either not detected or very low in springs
- PAHs are higher than sediment quality guidelines in urban stream suspended sediments
Polycyclic Aromatic Hydrocarbons (PAH) in the urban environment

- Formed from 2 to 6 fused benzene rings
- Largest group of suspected carcinogens
- Formed by combustion of organic matter
So where are all those PAHs coming from?
## What’s in them?  
**Coal-tar emulsion vs. asphalt-emulsion**

<table>
<thead>
<tr>
<th>Coal tar</th>
<th>Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final product of destructive distillation of coal to produce coke and (or) gas</td>
<td>Derived from refining of crude petroleum</td>
</tr>
<tr>
<td>Contains 50% or more PAHs by weight</td>
<td>Contains PAHs at concentrations orders of magnitude less than coal tar</td>
</tr>
<tr>
<td>Known carcinogen &amp; classified as a hazardous waste</td>
<td></td>
</tr>
</tbody>
</table>

### Coal-tar based sealants
- Typically 20-35% coal tar
- Thought to be more widely used in the east

### Asphalt-based sealants
- Typically 28-45% asphalt resin
- Thought to be more widely used in the west
Sealant Product Analysis

(Data from City of Austin)

20% (Total PAH = \( \Sigma 16 \) parents)

Asphalt-Based Sealant Products

Coal Tar Sealant Products
• 13 parkings lots were washed off
• Runoff filtered in the laboratory
  – Stainless-steel filter holder
  – 0.45 μm Teflon filter
• Particles massaged from filter and analyzed
Particles washed off sealed parking lots are highly contaminated with PAH.
Dr. Barbara Mahler is a Research Hydrologist with the Water Resources Division of the U.S. Geological Survey. Dr. Mahler's research focus is on karst hydrogeology and sediment-associated contaminant transport. Over the past five years, she has co-authored 11 articles in peer-reviewed publications, co-authored 11 technical reports, and presented research results at numerous national and international meetings. Dr. Mahler received her Ph.D. from the University of Texas at Austin; she was a NSF-NATO International Postdoctoral Fellow, spending one year in Montpellier, France, investigating bacterial transport in karst.