Tarballs on Texas Beaches following the Texas City “Y” Oil Spill in 2014: Chemical, Microbiological, and Modeling Studies

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Texas City “Y” Spill

- March 22, 2014 in Galveston Bay
- collision of cargo ship *MV Summer Wind* with the oil tank-barge *Kirby* near Texas City
- 168,000 gallons of marine residual oil (RMG 380) released
What is in crude oil?
What is in crude oil?

Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs)

TOXIC
The Marine Bacterium Alcanivorax feeds on oil

Sea Water

Alcanivorax secretes natural emulsifiers which help to break up oil droplets

Oil Droplet

Biofilm of Alcanivorax at oil water interface

1000 nanometres (1/1000 of a millimetre)
Tarball Location
Tarballs collected from Galveston (14) and Mustang Islands (30).

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Date of sampling</th>
<th>Time after spill</th>
<th>No. of samples</th>
<th>Sample label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galveston Island</td>
<td>3/28/2014</td>
<td>6 d</td>
<td>8</td>
<td>Gv1-Gv8</td>
</tr>
<tr>
<td>Mustang Island</td>
<td>4/02/2014</td>
<td>11 d</td>
<td>8</td>
<td>Mt1-Mt8</td>
</tr>
<tr>
<td>Mustang Island</td>
<td>6/20/2014</td>
<td>3 mo</td>
<td>6</td>
<td>Mt9-Mt14</td>
</tr>
<tr>
<td>Galveston Island</td>
<td>2/20/2015</td>
<td>11 mo</td>
<td>6</td>
<td>Gv9-Gv14</td>
</tr>
<tr>
<td>Mustang Island</td>
<td>4/19/2015</td>
<td>13 mo</td>
<td>16</td>
<td>Mt15-Mt30</td>
</tr>
</tbody>
</table>
Tarballs collected
Research Questions?

• Were the tarballs collected from Galveston Is. and Mustang Is. sourced from the Texas City “Y” Spill?

• How did the hydrocarbon composition change from Galveston to Mustang Island?

• What are the bacteria associated with these tarballs?

• Will numerical modeling accurately predict the transport of oil?
METHOD: Hydrocarbon analysis

Silica gel fractionation

Gas Chromatography—Mass Spectrometry (GC/MS)

Freeze-drying at -70°C

Aliphatics

Aromatics
All data is normalized to Hopane (17α(H)-21β(H)-hopane)

- Resistant to degradation by bacteria
- Resistant to photooxidation
- Biomarker for oil fingerprinting

\[
\text{Hopane ratio} = \frac{\text{Concentration of } X}{\text{Concentration of Hopane}}
\]
Bacterial community analysis

Tarball
Peripheral sand

DNA Extraction

Next-generation sequencing (Illumina)
Source-fingerprinting of tarballs based on biomarkers (hopanones and steranes)

Only the 8 tarballs from Galveston Is. collected 6 d after the spill, and 8 tarballs from Mustang Is. 11 d after the spill were from TCY
Chromatograms showing depletion of alkanes

Source Oil

Galveston

Mustang
Depletion of alkanes in 3 tarballs from Galveston and 3 tarballs from Mustang Island
Depletion of PAHs in 3 tarballs from Galveston and 3 tarballs from Mustang Island

79% 82%
Bacterial communities in tarballs and peripheral sand

**Alcanivorax/Psychrobacter** - degrade alkanes

**Pseudoalteromonas** - degrades PAHs
Bacterial communities in tarballs are similar and clustered differently from that of peripheral sands.
Simulation of oil transport from the entrance of Galveston Bay to Mustang Island
Conclusions I

• Oil-fingerprinting confirmed that only the tarballs collected 6 d and 11 d after the TCY Spill from Galveston and Mustang Island, respectively were sourced from TCY.

• Galveston tarballs were depleted of 58% of alkanes and 79% of PAHs, mainly of low to mid-molecular weight compounds.

• Tarballs from Mustang Is. were just slightly more depleted in alkanes (60%) and PAHs (82%).
Conclusions II

• Tarballs harbor unique microbial communities potentially degrading certain hydrocarbon compounds.

• The physical model confirmed the transport of oil from the spill site to Mustang Island at or prior to the time of sample collection, which was 11 d after the TCY Spill.

• This study provided an integrated view of oil transport and evolution from Galveston to Mustang Island following the TCY Spill in 2014.