

ORGANIC GEOCHEMICAL INVESTIGATION OF A HIGHLY CONTAMINATED URBAN WATERWAY: THE GOWANUS CANAL, BROOKLYN, NEW YORK, USAMichael A. KRUGE¹, Kevin OLSEN¹ and Eric A. STERN²

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The Gowanus Canal is an industrial waterway constructed in the mid-19th century by widening and deepening a natural tidal channel. It is ca. 3 km in length and empties into Gowanus Bay, an arm of New York Harbor. Its banks, reinforced by bulkheads and piers, became the site of intensive industrial activity, including oil refining, coal gasification, soap making and tanning. Even though much of the industrial activity along the canal has ceased, its sediments remain highly enriched in organic and inorganic contaminants, with combined sewer outfalls continuing to transport pollutants into the canal. The canal area remains densely populated and community pressure is providing impetus for remediation and redevelopment (U.S. Army Corps of Engineers, 2004).

As part of a program of continuing sediment quality monitoring, a series of 10 grab samples were collected along the length of the canal. Standard environmental chemical analyses were performed (volatile and semi-volatile organics, PCBs, metals). Dried sediment samples were also analyzed by pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) and thermodesorption-gas chromatography/mass spectrometry (TD-GC/MS). Py-GC/MS results from two samples are presented in Figure 1. Sample 15A was collected near the mid-point of the canal and is the most highly enriched in parent PAHs, up to several hundred mg/kg. Sample 29A was collected near the head of the canal, i.e., the point farthest inland, with parent PAH concentrations of 5-70 mg/kg.

The pyrolyzates contain phenols, pyrroles, indoles and guaiacols as both terrestrial and aquatic biomass signatures, but these are overshadowed by the 3 to 5 ring PAHs, parent and methylated, for sample 15A and by sterenes and fatty acids for sample 29A (Fig. 1). For sample 15A, the phenanthrene series (up to the C₃-alkylphenanthrenes), the pyrene series (up to C₂-alkylpyrenes and isomers), and the chrysene series (including methylchrysenes and isomers) are strongly predominant, along with benzofluoranthenes and benzopyrenes. The dibenzothiophene and benzonaphthothiophene series attest to a significant organosulfur component within the mixture. The pyrolyzate of sample 29A contains the same aromatic compounds, but at much lower concentrations. Rather, there is the striking predominance of

C_{27} and C_{29} sterenes, along with C_{16} and C_{18} fatty acids. Steradienes, C_{28} sterenes, alkylnitriles and alkylamides are also detected, but at lower concentrations. The sterenes and fatty acids are minor components in sample 15A as well.

The PAH distributions are characteristic of creosote, a coal-tar derivative and by-product of coal gasification. If these had been due to petroleum or petroleum product contamination, more abundant petroleum biomarker compounds would be expected. These were detected by TD-GC/MS using selected ion monitoring, but in trace quantities only. The sterenes and fatty acids likely derive from raw and/or partially treated sewage. In spite of the recent reopening of the flushing tunnel at the head of the canal after decades of disuse, it is evident that acute sediment pollution persists in the Gowanus sediments.

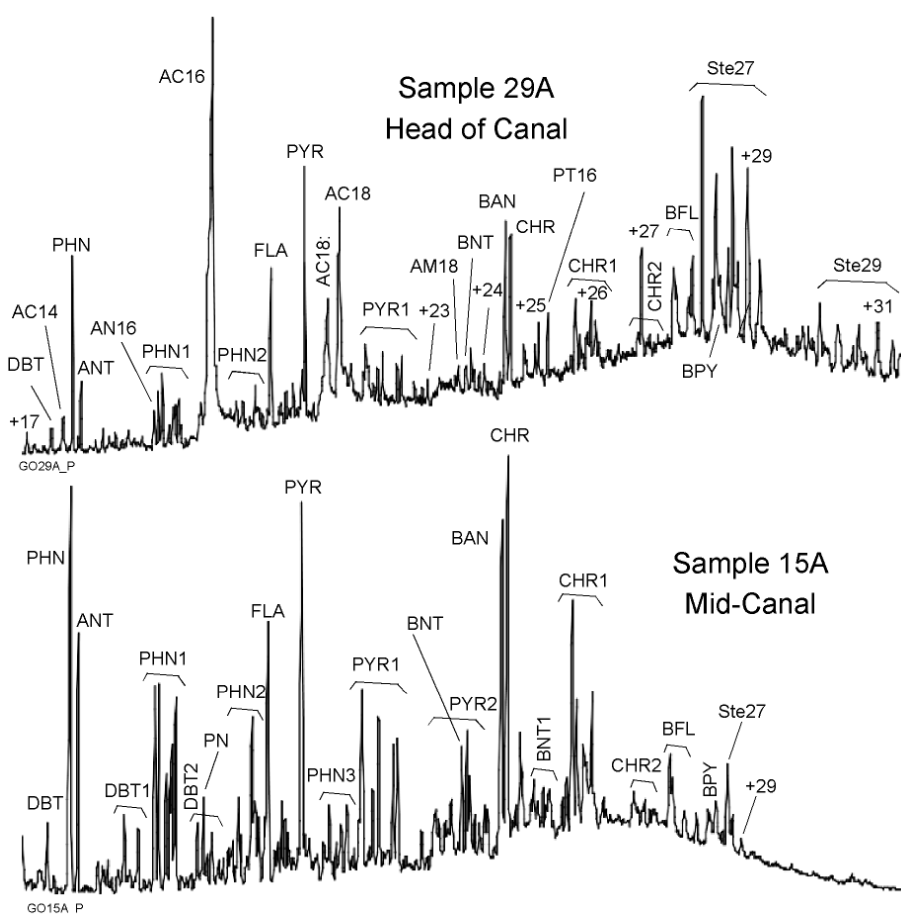


Figure 1. Partial pyrograms showing two contrasting sediment pyrolyzates.

DBT, DBT1, DBT2: dibenzothiophene series; PHN, PHN1, etc.: phenanthrene series; ANT: anthracene; FLA: fluoranthene; PYR, PYR1, PYR2: pyrenes and isomers; BNT, BNT1: benzonaphthothiophenes; BAN: benzo[*a*]anthracene; CHR, CHR1, CHR2: chrysenes and isomers; BFL: benzofluoranthenes; BPY: benzopyrenes; +17, etc.: n - C_{17} alkane, etc.; AC14, etc.: C_{14} fatty acid, etc.; AN16: C_{16} alkylnitrile; AM18: C_{18} alkylamide; PT16: bis-ethylhexylphthalate; Ste27, Ste29: C_{27} & C_{29} sterenes. (Py-GC/MS conditions: CDS 1500 pyroprobe (610 °C, 20 sec.), Thermo Finnigan Focus DSQ, 60 m J&W Scientific DB-1MS column (0.25mm i.d., film thickness 0.25 mm). GC program: 5 min at 50 °C; 5 °C/min. to 300 °C and then isothermal for 25 min. The MS was operated in full scan (50-550 Da, 1.08 scans/sec., 70eV ionization voltage.)

REFERENCE

U.S. Army Corps of Engineers (2004) Sediment Quality Evaluation Report: Gowanus Canal and Bay Ecological Restoration Project. Final Report. 37 p. plus appendices.