

# Table 1: Pb-210, Bi-210, and Po-210 activity measurements in rain, lake water, and dreissenid (Quagga) mussels collected in the Milwaukee Inner Harbor on Lake Michigan, Nov. 2018

**Website:** <https://www.bco-dmo.org/dataset/809807>

**Data Type:** Other Field Results

**Version:** 1

**Version Date:** 2020-04-22

## Project

» [The measurement and use of bismuth-210 as a tracer of particle flux in aquatic systems](#) (Bi 210 measurement)

| Contributors                     | Affiliation   | Role                   |
|----------------------------------|---|------------------------|
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## Abstract

Pb-210, Bi-210, and Po-210 activity measurements in rain, lake water, and dreissenid (Quagga) mussels collected at the School of Freshwater Sciences' slip in the Milwaukee Inner Harbor on Lake Michigan, Nov. 2018. This is table 1 in Waples (2020), *Limnol. Oceanogr. Methods*.

## Table of Contents

- [Coverage](#)
- [Dataset Description](#)
  - [Methods & Sampling](#)
  - [Data Processing Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Project Information](#)
- [Funding](#)

## Coverage

**Spatial Extent:** N:43.01784 E:-87.903 S:43.01772 W:-87.90352

**Temporal Extent:** 2018-11-04 - 2018-11-20

## Dataset Description

Pb-210, Bi-210, and Po-210 activity measurements in rain, lake water, and dreissenid (Quagga) mussels collected at the School of Freshwater Sciences' slip in the Milwaukee Inner Harbor on Lake Michigan, Nov. 2018. This is table 1 in Waples (2020), *Limnol. Oceanogr. Methods*.

## Methods & Sampling

A detailed description of the methods for determining in situ  $^{210}\text{Pb}$ ,  $^{210}\text{Bi}$ , and  $^{210}\text{Po}$  activities is given by Waples (2020).

A second manuscript describing the use of Pb-210, Bi-210, and Po-210 as particle tracers in aquatic systems is currently in review for *Limnology and Oceanography* (March/2020).

Water samples collected by submersible pump were weighed and filtered through nitrocellulose filters (0.45

um, 293 mm, Millipore) within two hours of sample collection to separate dissolved and particle-bound nuclide fractions of <sup>210</sup>Pb, <sup>210</sup>Bi, and <sup>210</sup>Po. Yield monitors of <sup>207</sup>Bi and <sup>209</sup>Po (Eckert & Ziegler Isotope Products) were then added to both fractions. No lead monitor was required. Dissolved nuclide fractions (< 0.45 um) of <sup>210</sup>Pb, <sup>210</sup>Bi, and <sup>210</sup>Po were co-precipitated onto newly formed ferric hydroxide and collected by filtration. Both particle-bound and dissolved nuclide fractions were then digested in concentrated nitric acid. Bismuth and polonium were completely separated from lead on Empore™ anion solid phase extraction (SPE) disks (3M, 47 mm, product number 2252, now manufactured by CDS Analytical). Eluate from the particle-bound fraction was re-spiked with <sup>207</sup>Bi and set aside for ~one month for the determination of particle-bound <sup>210</sup>Pb (via <sup>210</sup>Bi in secular equilibrium with its parent). Anion SPE disks were then counted- first for <sup>210</sup>Bi via b-decay on a low background gas-flow proportional detector with anticoincidence circuitry (G542 System, Gamma Products), then for <sup>207</sup>Bi via g-emission to determine yield. Polonium was then removed from the SPE disks, plated to copper, and a-counted for <sup>210</sup>Po and the yield monitor <sup>209</sup>Po. Total <sup>210</sup>Pb was determined in a separate water sample via <sup>210</sup>Bi that had grown into secular equilibrium with its parent. Activity calculations including uncertainty propagation and decay corrections are all fully described by Waples (2020).

Rainwater was collected at ground level (43.017719, -87.903000) in a large plastic barrel fitted with a funnel (0.216 m<sup>2</sup> collection area) over a 40-h period during an extended rain event beginning at 17:20 (CST) on 03 November 2018. The funnel and barrel were rinsed before and after the collection event with a total of 0.4 L of 1 M HCl.

Lake water samples (~ 50 L) for radionuclide analyses were collected from the slip (43.017835, -87.903521) with a submersible pump from a depth of 2 m on 08 November, 15 November, and 20 November 2018.

Quagga mussels (*Dreissena rostriformis bugensis*) were collected from the slip wall (43.017829, -87.904407) on 29 November 2018. Each mussel was measured for shell length and sorted into two groups of large (range: 18-22 mm; geometric mean: 19 mm; n = 10) and small (10-16 mm; geometric mean: 13 mm; n = 20) mussels. Mussel tissue was separated from the shell, pooled by group into two glass beakers, and digested in concentrated HNO<sub>3</sub>. Shell-free biomass was estimated using the allometric equation  $m = 0.0018 \times L^{3.11}$ , where m is the tissue dry weight in mg (DW mg) and L is the mussel shell length in mm (Waples et al. 2017).

#### Software used:

- Maestro software (v. 6.04 and 6.06, Advanced Measurement Technology)
- SigmaPlot (v. 11, Systat Software)
- Excel (v. 2002, Microsoft)

## Data Processing Description

### BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- re-formatted date-time from m/d/yy H:M to yyyy-mm-ddTHH:MM:SS
- added column for ISO\_DateTime\_UTC
- split standard deviations into separate columns
- added columns for calculation method which were originally indicated by italic values

[ [table of contents](#) | [back to top](#) ]

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## Data Files

| File   |
|--|
| <b>Table1.csv</b> (Comma Separated Values (.csv), 1.78 KB)<br>MD5:ebc2169b609820aa79224d204b7753e4 |
| Primary data file for dataset ID 809807  |

[ [table of contents](#) | [back to top](#) ]

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## Related Publications

Waples, J. T. (2020). Measuring bismuth-210, its parent, and daughter in aquatic systems. *Limnology and Oceanography: Methods*, 18(4), 148-162. doi:[10.1002/lom3.10352](https://doi.org/10.1002/lom3.10352)

*Results*

*Methods*

[ [table of contents](#) | [back to top](#) ]

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## Parameters

| Parameter          | Description  | Units  |
|--------------------|--|--|
| sample             | sample identifier  | unitless   |
| type               | fraction of sample: T = total; D = dissolved (< 0.45um); P = particulate                                     | unitless   |
| ISO_DateTime_Local | sample collection local date and time; ISO formatted yyyy-mm-ddTHH:MM:SS (UTC- 6 hr)                         | unitless   |
| ISO_DateTime_UTC   | sample collection date and time; ISO formatted yyyy-mm-ddTHH:MM:SSZ (converted to UTC from local: UTC- 6 hr) | unitless   |
| latitude           | latitude; north is positive  | decimal degrees                                      |
| longitude          | longitude; east is positive  | decimal degrees                                      |
| depth              | sample depth   | meters   |
| Pb_dpm             | Lead 210Pb activity in total (T); dissolved (D); or particulate (P) fraction of sample                       | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Pb_stdev           | standard deviation of 210Pb activity   | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Pb_calc_method     | c = comment that 210Pb values were calculated by difference or sum (errors propagated)                       | unitless   |
| Bi_dpm             | Bismuth 210Bi activity in total (T); dissolved (D); or particulate (P) fraction of sample                    | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Bi_stdev           | standard deviation of 210Bi activity   | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Bi_calc_method     | c = comment that 210Bi values were calculated by difference or sum (errors propagated)                       | unitless   |
| Po_dpm             | Polonium 210Po activity in total (T); dissolved (D); or particulate (P) fraction of sample                   | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Po_stdev           | standard deviation of 210Po activity   | disintegrations/minute/minute <sup>3</sup> (DPM m-3) |
| Po_calc_method     | c = comment that 210Po values were calculated by difference or sum (errors propagated)                       | unitless   |

[ [table of contents](#) | [back to top](#) ]

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## Instruments

|   |  |
|---|--|
| <b>Dataset-specific Instrument Name</b> | low background gas-flow proportional detector with anticoincidence circuitry (G542 System, Gamma Products)                 |
| <b>Generic Instrument Name</b>          | Gamma Ray Spectrometer   |
| <b>Generic Instrument Description</b>   | Instruments measuring the relative levels of electromagnetic radiation of different wavelengths in the gamma-ray waveband. |

[ [table of contents](#) | [back to top](#) ]

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## Project Information

### The measurement and use of bismuth-210 as a tracer of particle flux in aquatic systems (Bi 210 measurement)

**Coverage:** Lake Michigan 43.0 N 87.9 W

Naturally occurring radioactive nuclides provide invaluable "clocks" with which to investigate a wide range of processes in earth and environmental sciences. Nuclides with shorter half-lives are well suited to studying rapid processes, but are often present at very low concentrations and are particularly difficult to measure. The goal of this Early Concept Grant for Exploratory Research (EAGER) is to develop and demonstrate a new analytical method for measuring bismuth-210 (half life, 5 days) in lake water, seawater, and associated particles. Because bismuth tends to become associated with particles more than its parent isotope lead-210 (half life, 22 years), the bismuth-210/lead-210 daughter/parent pair can potentially be used to investigate very short time-scale processes associated with particle (sediment) formation and cycling in lakes and the coastal ocean. Knowledge about such processes is important to understanding carbon and nutrient cycling in these productive and dynamic areas.

The specific goals of this exploratory project are to 1) demonstrate an improved method for measuring the lead-210/bismuth-210/polonium-210 trio in aquatic system samples; 2) measure lead-210/bismuth-210/polonium-210 in Lake Michigan; and 3) explore the feasibility of using bismuth-210/lead-210 disequilibrium as a proxy for particle flux. The project would support an undergraduate student researcher for the summer.

[ [table of contents](#) | [back to top](#) ]

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## Funding

| Funding Source   | Award                       |
|--|-----------------------------|
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-1639865</a> |

[ [table of contents](#) | [back to top](#) ]