Boron Isotope Analysis of Long Island Precipitation

Deanna Downs, Brooke Peritore, Kathleen Wooton, Carrie Wright and Troy Rasbury
Department of Geosciences and FIRST, Stony Brook University

Long Island obtains all its drinking water from local aquifers and maintaining low contamination levels is critical for the large population. Long Island groundwater is recharged primarily by precipitation (Franke & Cohen, 1972). As this precipitation infiltrates into the soils it picks up nitrates and other contaminants from fertilized lawns, and agriculture as well as from septic systems as it makes it was to the water table. This recharging water may also pick up boron as a co-contaminant (Widory et al., 2005). This study examines the boron isotope compositions and concentrations of snow and rainwater samples collected on Long Island over a period of 20 months. Analyzing precipitation will provide a baseline for boron in groundwater recharge. This is important because to use boron as a tracer of pollution on Long Island we must first establish the fresh endmember variability.

Water samples were collected in clean bowls during the time of the precipitation then transferred to pre-cleaned 125mL bottles. A small aliquot of each sample was analyzed for boron concentrations. Based on the concentrations, various volumes of water were put through boron resin to extract enough boron for isotope analyses. Due to low boron concentration of some samples two different methods were used in preforming column chromatography. For samples with boron concentrations of 1.5ppb or greater method 1 was used following the methods discussed in Hemming and Hanson, 1994. For samples with boron concentrations less than 1.5ppb, 50ml of sample was added to 50ml vials, then pH-adjusted to a pH of 9. Subsequently, 20µl of Amberlite boron specific resin were added to 50ml vials then set on a shaker table for 24 hours. After 24 hours, the samples were centrifuged in order to collect the resin. The top 40ml were carefully poured off and the remaining 10ml was pipetted into the columns with the resin. Once all the resin was in the columns, the columns were washed with pH adjusted deionized water, then eluted with 2% nitric acid (Hemming & Hanson, 1994). To monitor recovery seawater was run with each round of unknown samples. Both approaches yielded the boron isotope value of seawater (39.61‰).

Rainwater samples were collected periodically (not all precipitation events were sampled) from June 2019 to February 2021. The measurable concentration of boron in these samples range from 1.2ppb to 13.0ppb. There was one sample, December 4, 2020, that has a boron concentration below detection (<1ppb). The isotope composition ($\delta^{11}B$) of the samples ranges from 4.7 to 34.0‰.

Table 1: Rain samples

Date	Wind Direction	Avg. Temp (°F)	B (ppb)	$\delta^{11}B$
Jun. 11, 2019	W/Mixed	69.53	13.0	12.75
Sept. 6, 2019	NE	62.21	7.2	15.56
Oct. 27, 2019	SE	60.1	6.0	33.43
Nov. 12, 2019*	NW	41.03	8.6	21.26
Oct. 29, 2020	E/NE	50.67	4.4	31.50
Oct. 30, 2020	N/NE	41.87	4.2	34.00
Nov. 1, 2020	S	49.15	4.5	4.70
Nov. 23, 2020+	SW	53.64	4.5	26.50
Dec. 4, 2020	W/SW	48.08	too low	to measure
Dec. 14, 2020	N	37.65	1.6	13.90
Jan. 1, 2021	E/NE	35.97	1.2	27.60
Jan. 16, 2021	N/Mixed	43.79	4.6	30.80
Jan. 26, 2021*	E/NE	33.21	4.9	25.30
Feb. 16, 2021	S/Mixed	43.36	4.7	12.3

*Rain/Sleet
+Thunderstorm

Snow samples were collected across the winter of 2020-2021. The measurable boron concentration of these samples ranges from 1.2ppb to 1.4ppb. There was one sample, February 7, 2021, that has a boron concentration too low to measure. The range of boron concentrations is mostly smaller than that of the rainwater samples. The isotope composition ($\delta^{11}B$) of the samples however overlaps with rain samples with a range from 10.4‰ to 30.4 ‰.

Table 2: Snow samples

Date	Wind Direction	Avg. Temp (°F)	B (ppb)	$\delta^{11}B$
Dec. 16, 2020	NE	29.29	1.3	21.8
Dec. 20, 2020	CALM/N	33.66	1.4	10.4
Feb. 1, 2021	NE	31	1.2	27
Feb. 1, 2021	NE	32	1.1	19
Feb. 2, 2021	N	33.38	1.3	30.4
Feb. 7, 2021	N/NE	31.53	too low	to measure
Feb. 11, 2021	N/NE	27.12	1.2	25.1

Snow samples have the lowest boron concentrations that we measured, but three rain samples have low concentrations as well. The isotope compositions of these lowest concentration samples are almost as great as the range of the entire dataset with a range of 30.4 to 10.4‰. Of the higher concentration samples, the one rain collected from a storm that came from the south (Nov. 1, 2020) gave the lowest $\delta^{11}B$ measured (4.7‰). These values overlap with the range of $\delta^{11}B$ we have measured from ponds across Long Island, but the concentrations are mostly much lower. The collection durations for the rains were different depending on time of the day and how hard the rains were. The collections are also from different points during the rain. We expect that the first precipitation might be more concentrated than the last part of the rain. In the future we will collect a series of water samples through a storm to test for differences.

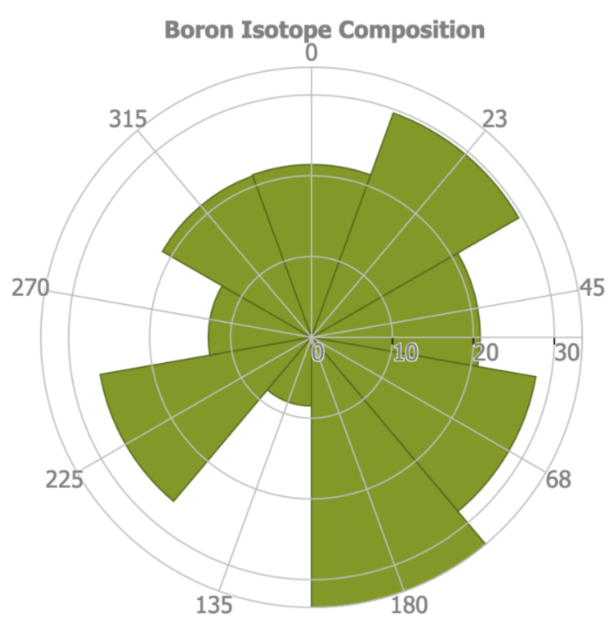

Figure 1: Rose diagram with the storm directions and the length of the petal is the $\delta^{11}B$ of the sampled waters. This shows that there is great variability in the $\delta^{11}B$ of precipitation events on Long Island and that there is not a strong correlation with the direction that the storm comes from. However, there does appear to be a tendency for storms coming from the continental interior (north and west) to have lower $\delta^{11}B$ than those from the NE and SE.

References

Franke, O. L., & Cohen, P. (1972). *Regional rates of ground-water movement on Long Island, New York*. US Government Printing Office.

Hemming, N. G., & Hanson, G. N. (1994). A procedure for the isotopic analysis of boron by negative thermal ionization mass spectrometry. *Chemical geology*, *114*(1-2), 147-156.

Widory, D., Petelet-Giraud, E., Négrel, P., & Ladouche, B. (2005). Tracking the sources of nitrate in groundwater using coupled nitrogen and boron isotopes: a synthesis. *Environmental Science & Technology*, *39*(2), 539-548.