Boron in Soils, Fertilizers and Plants in a Pilot Garden Study

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Nitrate is a well-established contaminant to Long Island groundwaters. Previous studies have demonstrated that fertilizer (both organic and synthetic) and septic systems are two main contributors to this pollution. Nitrogen and oxygen isotopes of the nitrate itself are insufficient for identifying the source of nitrate. Many other studies have suggested that boron isotopes, which co-occur with the nitrate sources can help to establish which sources are important. To establish the use of boron isotopes as a contaminant tracer, one must first establish the isotope composition of the contaminants as well as of the uncontaminated waters. We have undertaken such a study on Long Island, with a survey of boron concentration and isotope ratios in rain and snow, local ponds, local wells, tap water, and river waters. Almost all the waters studied have very low (ppb level) concentrations of boron. These waters have a wide range of $\delta^{11}B$, with a general trend that rainwaters have elevated $\delta^{11}B$ and the lowest concentrations, and surface and groundwaters that range between rainwater values to very much lighter $\delta^{11}B$ with a range of concentrations mostly greater than rainwater. These very light $\delta^{11}B$ waters are likely reflecting the sources of contaminants. There is high variability locally and it seems that each spring and lake has its own history. This is consistent with the expectation that the contaminates come from non-point sources that could easily have a range of $\delta^{11}B$. However, not all of the boron needs to be from contaminates and to have a full picture of boron sources we need to study soils, plants and fertilizers. In this study we sampled soils and plants from a pilot garden that is using kelp grown off Long Island as a natural fertilizer. We sampled tomato and basil plants when they were first planted (before they had been fertilized by seaweed) and we sampled them a month later. We were also able to sample the tomato plant in the autumn.

Seaweed from Long Island Sound has a range of $\delta^{11}B$ of 14-19 ‰ (Wright et al., in review). The seedling basil plant had a $\delta^{11}B$ of 32 ‰, and the seedling tomato plant had a $\delta^{11}B$ of 26.6 ‰. Both the basil and tomato plant leaves showed a large change in $\delta^{11}B$ after one month of growing in the seaweed fertilized soil. Basil leaves were 16.6 ‰ and tomato leaves were 18.6 ‰. This significant change to values that overlap with values of seaweed suggests that the plants are taking in boron from the seaweed fertilizer with little or no change in isotope composition.

We also sampled the soils at the beginning of the pilot study. The original soil was 31.3 ‰, similar to the isotope composition of the seedling plants. After a month of decomposition of the seaweed into this soil, the $\delta^{11}B$ was 26.3 ‰ and after 3 months the $\delta^{11}B$ of this soil was 24.8 ‰. This suggests that with continued decomposition of seaweed, the soil boron budget becomes more like the seaweed. It is interesting that the plants show a much more dramatic change than the soils. This suggests that the plants are extracting boron from the seaweed fertilizer directly and without acquiring much, if any, from the original soil.

In future work will we compost seaweed and monitor how boron isotopes change through decomposition. We will also mimic loss of this boron to water by leaching batches of soil with different proportions of seaweed to see if the water reflects both the soils and seaweed, or just the seaweed.