Methane Generation in Lake Decatur, IL, a Midwestern U.S. Impoundment

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Artificial impoundments of rivers, and especially those in agriculture settings, are thought to be significant sources of methane to the atmosphere. In this study, we investigate factors influencing methanogensis in the impounded portion of the Upper Sagamon River basin, a site in the NSF-sponsored Intensively Managed Landscape Critical Zone Observatory (IML-CZO). Analyses of sedimentary pore water indicates extensive methane production throughout the lower reach of the Lake Decatur reservoir. Substantial spatial heterogeneity in methane concentrations exists and the cause is a focus of our studies. Dissolved inorganic carbon (DIC) $\delta^{13}C$ values correlate well with methane concentrations and thus we hypothesize that the DIC isotopic compositions may serve as a proxy for integrated methanogenic rates. The relationship between methane concentration and DIC $\delta^{13}C$ ($\delta^{13}C$ becomes more positive with increasing methane concentration) is the result of an isotopic mass balance constraint where the ^{13}C-depleted material flows to methane and the residual ^{13}C-enriched carbon resides in the co-produced DIC as a consequence of methanogenic isotope effects.

The extreme ^{13}C-depletion of the methane (~ -90 to -70 per mil) and the parallel relationship between the methane and DIC $\delta^{13}C$ downcore profiles (~ -10 to +7 per mil) are consistent with CO_2-reduction being the dominant methanogenic pathway. This is counter to what is typically assumed for freshwater systems.

The burial flux of particulate organic C (POC) is hypothesized to be a major control on methane production. The highest rates of methanogenesis were observed near the mouth of a rapid infilling arm of the lake, thus providing support for the hypothesis.