Analysis of the Contribution of Agricultural Use on Organic Carbon

SURG | Natural Sciences and Engineering (NSE) | *Tags: Lab-based*

This cover page is meant to focus your reading of the sample proposal, summarizing important aspects of proposal writing that the author did well or could have improved. ***Review the following sections before reading the sample****. The proposal is also annotated throughout to highlight key elements of the proposal's structure and content.*

Proposal Strengths	Areas for Improvement
The proposal has a clear flow from the introduction into the background, and the background into the methods. The proposal moves from a broader topic to more specific issues to the precise aims of the research project.	The proposal utilizes passive language in some parts. Generally, stick to active phrasing such as "I will" "I aim to" "I plan to" to make your role in the project clear. Also, though your work may happen collaboratively, we recommend using "I" language rather than "we".
Most jargon is well defined in simple terms.	
The methods section includes how the results of intermediate steps will be interpreted, and it includes a specific description, justification, and interpretation of the way the results will be analyzed.	We encourage you to include specific course numbers when talking about your coursework while you are demonstrating your relevant skills in the preparation section.
A timeline is used, which gives the methods structure and makes it clear this project is feasible within 8 weeks.	

Other Key Features to Take Note Of
While the scope of the 2 page proposal should focus on the project that will be conducted during the funding period, if your project is a part of a larger project (either a lab's project or something you have continued over different funding periods), it is good to situate the proposed project in terms of the broader work.
If you have won previous awards (especially from our office) you should mention them specifically.
If you include figures in your appendix, you should write your own figure descriptions so that unnecessary detail, which may confuse a reader, is not included.

SURG Application (Summer 2017): Earth & Planetary Sciences; Chemistry

Intro moves from broad topic to specific issue

Globally, an estimated 16.7 million reservoirs (from dammed rivers) make up 305,000 km^2 of the world's surface area (Lehner et al 2011). These reservoirs have been accumulating organic carbon (OC) at a rate of 150-300 Tg C/yr, comparable to that in oceans at ~300 Tg C/yr (Vorosmarty et al 2003). Part of the accumulating OC originates from eutrophication, an excess of nutrients supported by agricultural nutrient run-off that results in rapid growth of algae and death of animals from lack of oxygen (Downing et al 2008). In addition, recent research has linked reservoirs to the emission of the greenhouse gas, methane, which is produced by the anaerobic decay of buried OC (Deemer et al 2016). Despite the potential importance to the global C-cycle and climate, little research has been done on the nature of the OC in reservoir sediments. My project will study the composition of Lake Decatur sedimentary organic matter with the objective of understanding the sources of OC to the lake.

Clear research/project statement occurs in 1st paragraph

Background goes beyond summarizing relevant literature. It sets up a justification for the specific research aims

Lake Decatur in Illinois was created when the Sangamon River was dammed in 1922 (Keefer 2010). The Sangamon watershed is part of the NSF-sponsored Intensively Managed Landscape Ð Critical Zone Observatory (IML-CZO, http://criticalzone.org), an outdoor laboratory created to study how agricultural practices influence landscapes, including how the erosion and transport of soils and their associated carbon occur. Lake Decatur provides a unique opportunity to study the nature of the OC that has been lost from an agricultural system because the reservoir serves as a sediment trap (Fitzpatrick et al 1987). By studying the import of OC to Lake Decatur, it will be possible to better understand how much carbon is being lost due to farming, and how it may contribute to methane production that affects climate change.

Identifies gap in knowledge and justifies why gap should be filled

The Lake Decatur sedimentary OC is expected to be a mixture from multiple sources. These include vascular plant inputs from land (including crops), and algal inputs supported by agricultural nutrients delivered to the lake. In addition, some of the OC likely consists of old soil carbon delivered by erosion. Any mixture can be further modified by microbes that selectively oxidize organic carbon fractions in a process called diagenesis (Meyers and Ishiwatari 1993).

One important parameter that can be used to identify OC components in mixtures is the $^{13}C/^{12}C$ stable isotopic ratio, which is reported as the $\delta^{13}C$ value (Libes 1992). The stable isotope composition can be applied to a variety of materials including sediment and plant materials and has been used to trace ecological change (Werner et al 2012). C_3 and C_4 vascular plants have acutely different isotope ratios due to their photosynthetic mechanisms, which provides a means to distinguish between the two types of plants (O'Leary 1988). Most plants use the C_3 pathway. Corn is the common C_4 plant in agricultural settings. As Lake Decatur is an agriculturally rich location, the C-isotope ratios of sedimentary OC in Lake Decatur should provide an indication of corn cultivation in the Sangamon watershed over time.

Isotopic measurements of Lake Decatur bulk sediment do reveal compositions between C_3 and C_4 values (Fig. 2). However, temporal trends in $\delta^{13}C$ values from lake cores do not parallel those expected from a model based on known changes in corn cultivation (Fig. 1, 2). One explanation is that other sources of OC, such as algae, are partially masking the crop signal. Diagenesis may also have altered the original mixtures.

Passive language makes it hard to know what role the student played in these actions

To isolate the signals that the different organic sources might have, an academic year URG project for the spring quarter was proposed and funded to separate and study low density plant fragments in Lake Decatur sediments. This will be done on an archived core from Lake Decatur. It was hypothesized that the plant debris isotope ratios will correlate with known changes in corn acreage. For the summer project, we will continue analyzing and studying the low density plant fragment; along with that, we seek to study the high-density, lithogenic fraction of the sediment.

Situates project within previous work

For the summer project, we will continue analyzing and studying the low density plant fragment; along with that, we seek to study the high-density, lithogenic fraction of the sediment. The lithogenic fraction presents greater complexity given its composition of microbial products, algae material, historical soil carbon, and decomposed plant fragments (Meyers and Ishiwatari 1993). C-isotope ratios

Background leads to specific goals of 8 week project

will be measured for the lithogenic portion in order to study its relationship to the bulk sediment isotope value. The goal of this summer is to study the different fractions in order to achieve an isotope mass balance between the various samples ($\delta^{13}C$ (bulk) = $f_1\delta_1 + f_2\delta_2$, where f is the fraction of component 1 and 2). A predicted bulk isotope value from the high density and low density isotope fractions will be compared to the measured bulk isotope value.

Methods are defined and justified.

In addition to the isotope measurements, I also propose to study the high-density lithogenic fraction using Fourier transform infrared spectroscopy (FTIR) analysis. FTIR analysis provides information about compound functional groups (Li et al., 2013). In this case because the sediments are largely inorganic minerals (97-99% by wt), I expect the FTIR spectra to be dominated by those materials. I will specifically look for qualitative and/or semi-quantitative (peak area ratios) changes downcore that might signal changes in source. If none are seen, this simplifies the interpretation of the OC signatures. If variability in the mineral phase is evident, corresponding changes in the C-isotopes will be sought.

Good description of how intermediate results will be interpreted

Tube cores collected from Lake Decatur were previously sectioned every 5 cm and froze. Radionuclide analyses (^{210}Pb, ^{137}Cs) have produced age models (depth vs time) of the cores (Blair et al., in prep). Plant material has a density at ~<1.60 g/cm^3 whereas aluminosilicates (the bulk of the sediment and the fraction where the bulk of OC resides) have a density of 2.5 g/cm^3 (Wakeham et al 2015). Sediments will be placed in a solution of sodium polytungstate adjusted to a density of ~2.0 (Leithold et al 2005). The heavier minerals will sink to the bottom upon centrifugation, while the lighter plant debris will float and be collected via filtration. The presence of the plant material will be confirmed using a microscope. The plant debris will be analyzed using a Costech Elemental Analyzer (EA) coupled to a Thermo Delta V Isotope Ratio Mass Spectrometer (EA-IRMS) in Northwestern's Stable Isotope Laboratory, providing data on isotope values. Similarly, the high density (lithogenic) fraction will be analyzed isotopically. Over the course of the eight-week summer, six weeks are being used to prepare the samples for elemental analysis and analyze the data. In addition, I also plan to perform transflectance FTIR analyses on the lithogenic fraction and compare the results to known mineral spectra (Hanifi et al. 2013). FTIR analysis will take an estimated two weeks to run on samples and analyze.

The isotope data will be used for the mass balance calculation. Additionally, a simple regression model using the least squares method will be used to compare measured isotopic compositions to predictions from the 'corn' model in order to ascertain if one fraction or the other provides a better record of corn cultivation. A poor correlation would indicate that other sources of OC overprint the corn signal.

I joined the Blair lab in Winter 2015 and have worked there ever since. Last summer, I prepared samples for the EA-IRMS and the FTIR analysis. Coupled with my coursework, I am capable and proficient of accomplishing the tasks in order to reach the overall goal of this summer project. I have recently received an academic year URG that will give me ample time to understand the techniques behind the separation process in order to go further in depth with my isotope and FTIR analysis. This research will prepare me for further exploration into scientific reasoning and enrich my skills in scientific inquiry as I consider graduate or medical school.

Should mention specific course numbers

Good to mention past awards

Appendix:

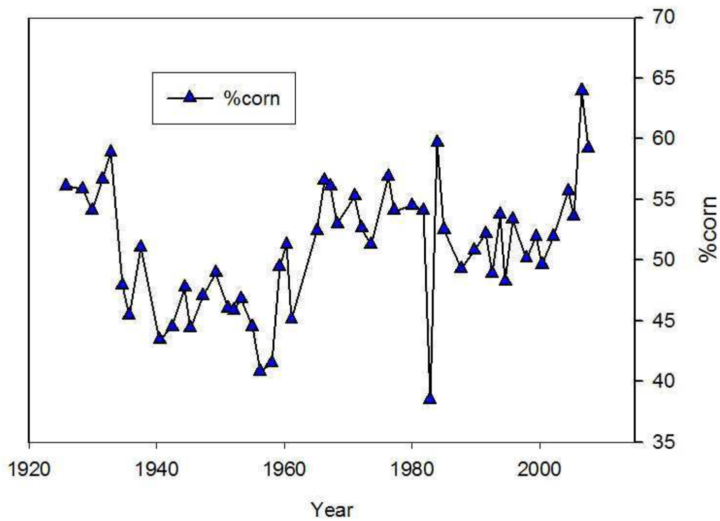

Figure 1: The % corn cultivated in the Sangamon watershed relative to other crops (principally soybean). (Keefer 2010).

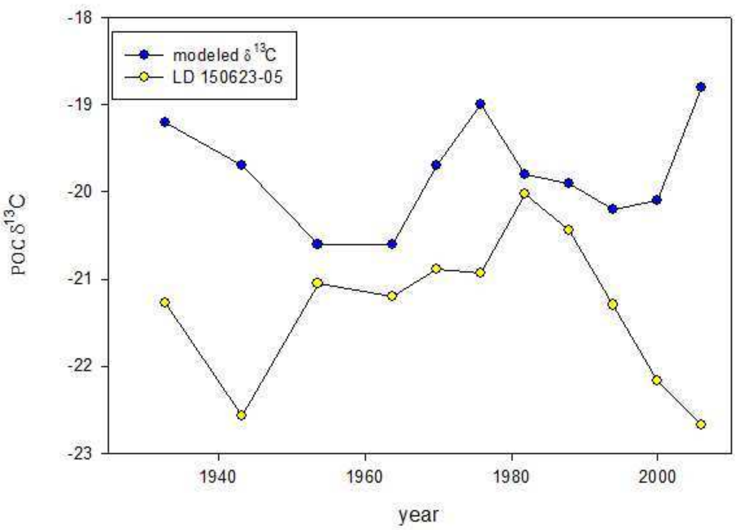

Figure 2: The data from the percentage of corn provided in Fig 1 allowed us to make a prediction of the plant $\delta^{13}C$ value exported from agricultural land. The predicted corn $\delta^{13}C$ was calculated using the equation $\delta^{13}C = (\%corn/100)*-13 + (1-\%corn/100)*-27$ where -13 is the value of the corn $\delta^{13}C$ and -27 is the isotope ratio of C_3 plants. The predicted values (blue) are shown relative to actual measured isotope ratios of the bulk Lake Decatur organic sediment from a core (yellow). Depth in the core was translated to approximate time using radionuclides.

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