PALEOLIMNOLOGICAL INVESTIGATION OF THE RECLAMATION OF ARM PIT AND ASHBY LAKE

Bethany L. Kile, Shana K. Shepard, Jeffery R. Stone, & Jennifer C. Latimer
Department of Earth and Environmental Systems, Indiana State University, Terre Haute, IN
belle-kile@purdue.edu

Abstract
A short sediment core was collected from the center of both Arm Pit and Ashby lakes. The lake sediments were sampled at a 0.5-cm resolution to analyze changes in fossil diatom assemblages, major/minor element concentrations, and detailed phosphorus geochemistry. Diatoms are particularly sensitive biological indicators of acidity in aquatic systems and are commonly used to evaluate potential changes in water quality over time. A sequential extraction technique was employed to elucidate sedimentary phosphorus associations to assess how the nutrient status of the lake has changed over time. Changes in the elemental concentrations will be evaluated by hand-held XRF and ICP-OES to determine heavy metal loads resulting from past mining activities and ongoing acidic drainage. Together these geochemical proxies will be used to explore landscape/watershed/lake interactions. Combining the geochemical and fossil diatom assemblage results will allow us to reconstruct the temporal variability in biogeochemical cycling of nutrients and metals within this aquatic system.

Objectives
- To explore the potential impact of acidic drainage on this system
- To assess the effectiveness of the reclamation process on water quality over the past several decades

Site Description
Arm Pit and Ashby Lakes are located in the Sugar Ridge Fish and Wildlife Area in Winslow, Indiana. These lakes were formerly part of a region used as a coal strip mine that was donated to the Division of Fish and Wildlife in 1980. Since then, they have been reclaimed along with many other aquatic systems in the area (Sugar Ridge, 2015).

Methods
A 30-cm core was collected from Arm Pit and a 33.5-cm core was collected from Ashby Lake in the spring of 2014. Sediment from each core was extruded at half-centimeter intervals. These samples were subsampled for diatom and detailed phosphorus geochemistry (SEDEX, Table 1). After samples were dried and powdered, ~0.1 g of sediment was weighed into new 15 mL polyethylene centrifuge tubes. SEDEX uses a sequential extraction technique to evaluate different sedimentary associations of phosphorus: adsorbed or oxide-associated, mineral, and organic. The sum of step II and step III is referred to as “mineral P.” Approximately 20% of the samples were evaluated as replicate sample to evaluate analytical precision. NIST SRM1646a (estuarine sediment) was also analyzed to evaluate accuracy. All samples were analyzed using a Shimadzu UV-Visible scanning spectrophotometer at 880 nm using the molydate blue color development technique (Parsons and Strickland, 1972). The CDB reagents (step I) interfere with color development requiring an additional processing step that requires combustion and additional extraction with HCl prior to analysis.

For diatom analysis, each sample was weighed and processed in 30% hydrogen peroxide to remove organic matter. The samples were then rinsed and microspheres were added to each sample to enable the calculation of valves per gram. Slides were mounted using Naphrax. Up to 300 diatom valves (when available) were identified to genus on a transmitted light microscope.

Table 1 explains the serial extraction method used. There are four steps: each step isolates a different type of phosphorus. Step 1 must be prepared for spectrophotometric analysis differently from Steps 2, 3, and 4.

<table>
<thead>
<tr>
<th>Step</th>
<th>Reagents</th>
<th>Isolated P Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>10mL 1M MgCl2 Citrate, 0.11 M NaHCO3, 0.01 M Na2EDTA</td>
<td>Exchangeable P</td>
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<tr>
<td>Step 2</td>
<td>25mL 1M NaHCO3 and 10mL 1M MgCl2</td>
<td>Oxide/organic P</td>
</tr>
<tr>
<td>Step 3</td>
<td>10mL 1M Na2EDTA</td>
<td>Phosphate P</td>
</tr>
<tr>
<td>Step 4</td>
<td>10mL 1M HCl</td>
<td>Mineral P</td>
</tr>
</tbody>
</table>

Future Work
The Ashby Lake core needs to be counted to species. We also plan to analyze the samples using a hand-held X-ray fluorescence analyzer and inductively coupled plasma-optical emission spectrometry for major and minor elements.

Acknowledgements
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Conclusions
Organic phosphorus percentages were rather high in both lakes. Phosphorus results indicate that the lake is highly productive, evident by high relative organic phosphorus concentration and high total phosphorus burial. Preliminary diatom data shows major transitions throughout the record, potentially attributed to lake evolution. To see if these changes are related to acidity and to determine the relationship of the phosphorus record and diatom assemblage changes, diatoms will need to be counted to species.

References