Quantification of phosphorus release potential from various fractions via the SEDEX extraction

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Background

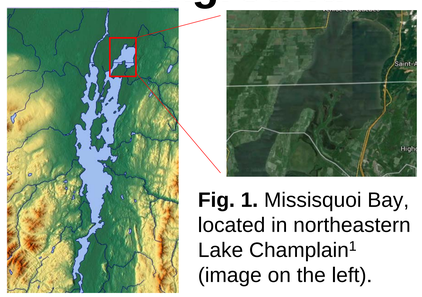
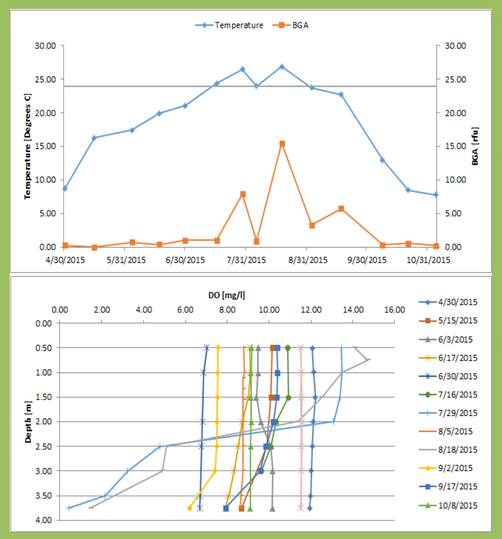


Fig. 1. Missisquoi Bay, located in northeastern Lake Champlain[1] (image on the left).

- In shallow eutrophic freshwater systems such as **Missisquoi Bay** phosphorus is a limiting nutrient tightly cycled[2] and bound to different factions within the sediment[3].
- Cyanobacteria can access the nutrients in the sediments[1], becoming the predominant phytoplankton in the bay.
- Due to recent increases in temperature and aquatic phosphorous levels from external sources, the persistence of these cyanobacterial blooms have become regular seasonal toxic blooms[1].
- **Harmful algal blooms degrade water quality**, with negative effects on recreation and consumption in freshwater systems.

Environmental Parameters



- Temperature threshold for cyanobacterial growth is **24 ºC**
- Peaks in BGA correspond to peaks in temperature and thermal stratification
- Thermal stratification occurred during periods of highest surface water temperatures

Hypothesis

The SEDEX extraction will extract more phosphorus fractions from the sediment compared to the previously implemented aqua regia digestion leading to greater understanding of the fraction which has the greatest potential for phosphorus release.

Methods

Field Work (Fig. 2)
- Sediment cores taken biweekly (4/30/2015 - 11/4/2015)
- Cores partitioned into:
  0-1cm, 1-2cm, 2-3cm, 3-4cm, 4-6cm, and 6-10cm sections → freeze dried → homogenized

Phosphorus Extraction (Fig. 3, Fig. 4)
- SEDEX (Ruttenberg 2009) method used to extract phosphorus from 5 phosphorus fractions
- Samples from top 0-1cm of sediment core
- Two replicates from each sampling date
- Reference material- domestic sludge.

Quantification of Phosphorus Concentration
- Extractants diluted 20x and analyzed with ICP-OES.
- These values were compared to aqua regia totals

Fig. 2. Sediment cores

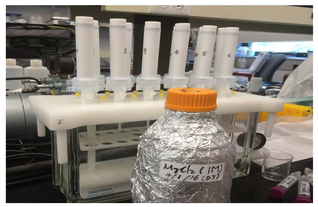


Fig 3. SEDEX extraction apparatus setup

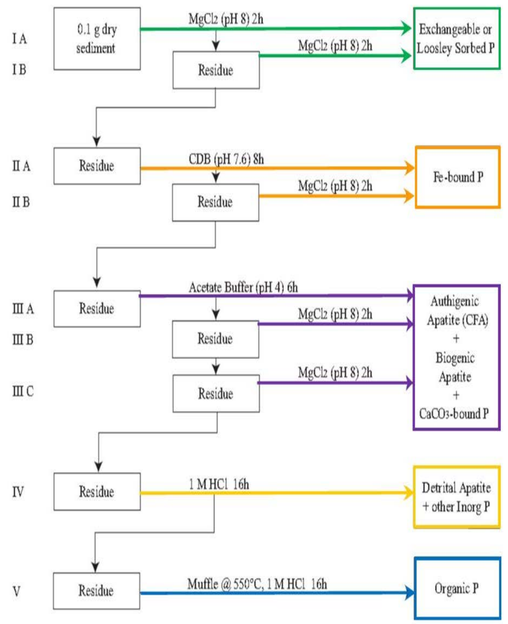


Fig 4. SEDEX method[3]

Phosphorus Pool Dynamics

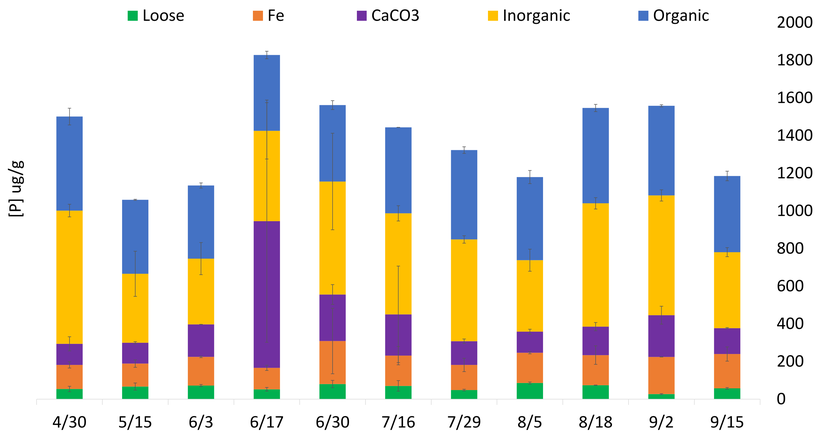


Fig 5. Phosphorus fractions of Missisquoi Bay sediment (2015). The Fe-bound and the $CaCO_3$ were the most variable fractions across time.

Accuracy & Precision

Fig 7. Total Phosphorus in both Aqua Regia (AR) and SEDEX method. ICP-OES has a detection limit around 20 ppb which may produce noise in data that has a low concentration.

Conclusions

- SEDEX provides a more holistic representation of the composition of total P released over the course of the bloom
- SEDEX produces higher values for total P compared to AR and reaches fractions unattainable by AR.
- AR extract total amounts of 'environmentally available' P, it does not extract iron bound tightly in many silicate minerals
- Analysis of fractional P release over course of the bloom will provide insight on highest contributor to bloom formation

References

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2. Giles, C.D., P.D Isles, T. Manley, Y. Xu, G. K. Druschel, & A.W. Schroth. (2016)
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