

## **Removing the barriers for measuring phosphate oxygen isotope compositions of low P concentration freshwater samples**

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World food security relies on enhanced P inputs to the environment, inducing widespread P-enrichment of aquatic ecosystems in many parts of the globe and potentially leading to eutrophication. The oxygen isotope composition of dissolved inorganic phosphate ( $\delta^{18}\text{Op}$ ) offers new opportunities to understand the sources and fate of phosphorus (P) in freshwater ecosystems. By developing and testing a new technique, we enable  $^{18}\text{O}$  analyses of inorganic phosphate composition in environments of low ambient P concentration. Our approach is based on the use of a new sampling approach, the Twist Spinning Mode (TSM) protocol. The TSM allows the extraction of inorganic phosphate from large samples (>1000 L) exhibiting very low P concentrations (<0.016 mg P/L). Subsequently, a laboratory separation of the dissolved compounds allows the conversion of phosphate in the samples to silver phosphate. A novel approach using freeze-drying helps to maximise the yield and minimise contamination from silver oxide which can interfere with the silver phosphate generated for isotope ratio mass spectrometry.

We evaluated the TSM protocol using synthetic solutions and subsequently applied the protocol to samples from lakes and river water around Montreal, Canada. With this novel technique, the methodological protocol will help to extend the application of  $\delta^{18}\text{Op}$  into a much wider range of freshwater ecosystems than has previously been possible.