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A new proxy for tracking residual phosphorus sources in the environment

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Jessica M. Anton, first author of the study, collecting sediment for isotope analyses. Photo courtesy of Deb Jaisi, University of Delaware.

Phosphorus (P) pollution continues to pose a significant threat to our nation's water quality. While point sources of P have largely been eliminated, a persistent challenge remains with non-point (diffuse) sources such as agricultural lands. And due to the ubiquity of P in the environment, identifying the sources of "legacy" P in soil and sediment requires new methods.

Researchers from the University of Delaware aimed to identify legacy P sources that are present in residual P pools in a mini-watershed in Eastern Shore, MD, using isotopes—alternative versions of elements that have the same number of protons, but a different number of neutrons, resulting in different atomic masses. Through the integration of phosphate oxygen ($\delta^{18}\text{O}_\text{P}$), nitrogen ($\delta^{15}\text{N}$), and carbon ($\delta^{13}\text{C}$) isotopes along with advanced Bayesian modeling, the team developed a reliable tool for P source discrimination. The harsher reagents necessary to extract residual P were tested and found not to alter the isotope compositions, enabling researchers to identify distinct elemental fingerprints.

The unique ranges of phosphate oxygen isotopes among different residual P pools, combined with carbon and nitrogen isotopes, provided the advantage of a multi-isotope tool for understanding the sources and transport of residual P pools in the watershed. These methods could be implemented to address problematic sources of pollution and restore water quality in watersheds with excess nutrients.

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Anton, J., Jiang, Z., Ishida, T., & Jaisi, D. P. (2025). Identification of phosphorus sources using oxygen isotope signatures of the recalcitrant and residual

phosphorus pools in soils and sediments. *Soil Science Society of America Journal*, 89, e70127. <https://doi.org/10.1002/saj2.70127>

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