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Development of a UV-Catalyzed Method for Phosphite Oxygen Isotope Analysis

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Reduced-phosphorus (P) oxyanions, such as phosphite (PO_3 with P^{3+}) rather than phosphate (PO_4 with P^{5+}), are believed to have played a significant role in prebiotic chemistry and served as key nutrients on early Earth before the onset of oxygenation. The stable oxygen isotope ratio ($^{18}O/^{16}O$, $\delta^{18}O$) of phosphate has been widely used as a geochemical tool, serving as a paleo-thermometer, biomarker, and tracer for P-related (bio)geochemical processes. While methods for extracting, purifying, and analyzing the oxygen isotopes of phosphate have been well established across various sample types, no reliable or efficient techniques currently exist for the purification and isotopic analysis of phosphite. In this study, we present novel approaches for determining the oxygen isotopic composition of phosphite through ultraviolet (UV)-catalyzed oxidation.

To investigate the oxidation process of aqueous phosphite under UV exposure, we conducted experiments using ^{18}O-labeled phosphite and water in the presence of air. Our objectives were to determine (i) the sources of oxygen involved in phosphite oxidation to phosphate and (ii) the extent of oxygen isotope fractionation during oxygen incorporation into the resulting phosphate. By analyzing the $\delta^{18}O$ values of both the resulting phosphate and water after UV-driven oxidation, we can infer the $\delta^{18}O$ values of phosphite, utilizing the fractionation mechanisms established in this study.