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In-situ Oxygen Isotope Determination of Diverse Minerals via aBridge Crossing Method Using SIMS

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Oxygen isotopes serve as vital tracers for understanding both abiotic and biotic processes. In modern geosciences, there is a growing need for the ability to obtain in-situ oxygen isotope ratios across multiple mineral phases within rock samples. However, this is often constrained by the lack of matrix-matched standards for all target minerals on the same sample mount. To address this challenge, we utilized secondary ion mass spectrometry (SIMS) to evaluate the relative instrumental mass fractionation (RIMF) between different phases across two consecutive sample mount sessions. A diverse set of oxygen isotope standards, including glass, quartz, calcite, monazite, zircon, olivine, and apatite, was employed. Our findings reveal, for the first time, that the RIMF between any two standards remains consistent within typical SIMS analytical uncertainties across consecutive mount switch sessions. Building on this result, we developed a novel "bridge crossing calibration" method. This approach employs a shared "bridge" standard present in both the sample mount and standard mount to calibrate for mount-to-mount bias. When combined with a matrix-matched standard in the standard mount, this method allows for the accurate determination of the instrumental mass fractionation (IMF) of unknown samples, even in the absence of matrix-matched standards on the sample mount. Furthermore, this method is both time- and cost-efficient, reduces the consumption of standard materials by reusing standard mounts with multiple standards, and eliminates systematic biases when analyzing different minerals across different sessions. This innovative calibration method provides a universal and robust solution for oxygen isotope analysis using SIMS, paving the way for more efficient and precise multi-phase isotopic studies in geosciences.