Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31996

Rapid and precise triple oxygen isotope analysis of diverse Earth materials via high-temperature conversion coupled to laser spectroscopy

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Triple oxygen isotopic measurements ($\Delta'^{17}O$) of Earth materials are an emerging area of research with applications from igneous petrology to paleoclimate. Most techniques involve conversion of an oxygen-bearing material to O_2 via fluorination followed by measurement with isotope ratio mass spectrometry (IRMS). Recent studies have taken an approach to use rapid high-temperature pyrolysis techniques to measure oxygen in a variety of materials including organics, waters, silicates, phosphates, nitrates, carbonates, and sulfates by converting sample oxygen to CO with subsequent conversion to O_2, with or without a fluorination step for IRMS analysis [1,2]. Recently, laser spectroscopy has become possible for $\Delta'^{17}O$ measurements of CO_2 and H_2O, reaching similar analytical precision as IRMS. The ability to work with CO_2 simplifies some measurements, given the long history and simple techniques for its purification and analysis.

Here we present a new and automatable method for high-precision $\Delta'^{17}O$ determination that is applicable to a large range of materials via tunable infrared laser direct absorption spectroscopy (TILDAS; [3,4]). Our approach is inspired by prior measurements of organic oxygen isotopes in which oxygen is liberated as CO, then converted to CO_2 [5]. In our procedure, sample oxygen is first converted to CO at high-temperature (i.e., TC/EA). CO is then disproportionated to CO_2. Conversion is rapid and quantitative, taking less than 15 minutes. CO_2 is then transferred to an automatic gas-mixing and delivery system attached to the spectrometer, with measurements taking approximately 45 minutes. The TILDAS system is automated to allow for about 30 measurements per day. The method may be applied to any pyrolytic materials where quantitative oxygen conversion is possible. The versatility, simplicity, and high throughput of this method may make it an appealing option for laboratories interested in $\Delta'^{17}O$ measurement.

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