V35A-05 - High-precision triple oxygen isotope analysis of diverse materials using high temperature conversion–methanation–fluorination isotope ratio mass spectrometry

Wednesday, 14 December 2022

16:25 - 16:35

McCormick Place - S103ab (South, Level 1)

Abstract

In recent years, the triple oxygen isotope system has become an established part of the geochemist's toolbox, with demand growing significantly for high-precision measurements of all three oxygen isotopes in a variety of materials. While the field is rapidly expanding, it is limited by the scope of materials that can be analyzed with high precision (ca. 10 ppm or less for the $\Delta'^{17}O$ parameter, where $\Delta'^{17}O = \delta'^{17}O - 0.528 \times \delta'^{18}O$). Here we present a novel analytical method that allows for quantitative conversion of sample oxygen to molecular oxygen suitable for mass spectrometry in a wide range of materials, including, but not limited to, organics, phosphates, sulfates, carbonates, nitrates, and waters.

The method comprises three steps for complete conversion of sample oxygen. Sample oxygen is first converted to carbon monoxide using a high temperature (1450 °C) glassy carbon reactor (e.g., TC/EA). Hypothetically, any pyrolytic material that can be quantitatively converted to CO during this step is a viable candidate for the method. In the second step, the resultant CO is converted to water via methanation at 560 °C in the presence of an iron catalyst in a ~1 bar hydrogen environment. The water is then fluorinated using cobalt(III) fluoride at 360 °C to produce molecular oxygen. The product O_2 is then analyzed via dual inlet isotope ratio mass spectrometry, and $\Delta'^{17}O$ precisions approaching 5 per meg (ppm) have been achieved for all materials mentioned above. This high temperature conversion-methanation-fluorination (HTC-M-F) method has resulted in the first high-precision $\Delta'^{17}O$ measurements of organic molecules (to our knowledge), and up to a factor of four improvement in analytical precision for phosphates and sulfates. We will present data from a range of natural and synthetic isotope reference materials and geological samples to demonstrate the versatility of the method.

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What kind of mass spectrometer instrument and what kind of detectors (Faraday cup, electron multiplier, etc) are you using for your measurements ?

By Stephan Richter at 4:17 AM, Thursday, December 8, 2022 (EST)

Thank you for your question, Stephan. Our mass spectrometer is a magnetic sector type instrument with EI ionization and Faraday cup detectors.

By Nicholas Ellis at 11:37 AM, Thursday, December 8, 2022 (EST)

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