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A unified analytical system for high-precision triple oxygen isotope measurements in inorganic minerals, aqueous fluids, and organic materials

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Accurate triple oxygen isotope measurements are becoming increasingly important for a wide range of natural and synthetic materials. Calibration of reference gas using the O_2 extracted from VSMOW and normalization with a VSMOW-SLAP scale are recommended for triple oxygen isotope measurements of unknown samples [1]. However, in many laboratories, different oxygen extraction and purification methods are used for different types of samples, and secondary standard materials are often used, which can lead to analytical bias. Here, the analytical system that can determine the highly accurate triple oxygen isotope ratios for multiple types of samples such as silicate/oxide minerals, aqueous fluids, and organic matter using the same purification system will be presented. Fluorination of carbon-containing materials forms C-F-O molecules, which fractionate oxygen isotope ratios from those of the extracted O_2. Therefore, it is necessary to separate carbon from oxygen prior to fluorination when O_2 is used as the analyte. This study investigated a methanation reaction using a platinum group element (PGE)-based catalyst in the hydrogen stream after converting the oxygen in the sample to carbon monoxide by high-temperature conversion. PGE-based catalysts are advantageous compared to Ni and Fe [2-4], which can promote the methanation process under relatively low temperatures and have a long lifetime. The establishment of this analytical system has made it possible to process silicate/oxide minerals, aqueous liquid, and organic matter using the same purification system, and made it possible to calibrate the triple oxygen isotope ratios of various types of materials using the VSMOW-SLAP scale.

[1] Pack et al. (2016) *Rapid Commun. Mass Spectrom*, 30, 1495-1504; [2] Brenninkmeijer & Röckmann (1998) *Rapid Commun. Mass Spectrom*, 12, 479-483; [3] Passey et al. (2014) Geochim. Cosmochim. Acta, 141, 1-25; [4] Ellis & Passey (2023) Chem.Geol., 635, 121616