

元素分析 / 同位体比質量分析計 (EA/IRMS) を用いた 炭素・窒素安定同位体比の測定方法とその応用*

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Abstract

Continuous-flow (on-line) system has revolutionized the study of natural stable isotope variations in organic matter and organic compounds. In particular, carbon and nitrogen isotope analysis of bulk samples using elemental analyzer/isotope ratio mass spectrometer (EA/IRMS) has been widely used in various field of studies, which allows a simple and rapid analysis of the isotope ratios for all types of organic and a wide range of inorganic samples, with a small amount of sample materials compared to the traditional off-line Dual-Inlet method. However, stability, accuracy, and precision on the observed isotope ratios strongly reflect various factors associated with continuous-flow system, such as peak intensity (*i.e.*, sample weight), memory effect, and He dilution ratio. Unfortunately, the complete removal of such uncertainties should not be realistic, particularly in routine isotope measurements of a great number of samples. Here, we review the principles of stable isotope analysis on the traditional off-line Dual-Inlet and continuous-flow EA/IRMS methods, and also show an applicable calibration and standardization sequence. We hope that this paper is useful for routine application of EA/IRMS technique to various studies in geochemistry, ecology, biology, food science, and other area of sciences.

1. はじめに

かつて有機物の安定同位体比 (水素: D/H, 炭素: $^{13}\text{C}/^{12}\text{C}$, 窒素: $^{15}\text{N}/^{14}\text{N}$ など) 分析は, ごく一部の科学者だけが扱える特殊な技術であった。1990年代中頃までは, 試料をケルダール法・封緘燃焼法・低温精製法など, 高度な技術を要する複数の前処理を組み合わせ, CO_2 や N_2 などのガスとして精製したのち, Dual Inlet タイプの同位体比質量分析計 (IRMS) で同位体比を測定するという方法 (例えば, Wada and Hattori, 1976; DeNiro and

Epstein, 1978, 1980; Minagawa et al., 1984) が主流であり, 装置にかけるまでの前処理に多くの手間と時間を要し, 非常に取り扱いにくかった。そのため, 得られる測定結果の数も極めて少なかった (例えば, 著者らのラボでは一週間で10~20試料程度)。

しかし近年の技術発展, とくに元素分析/同位体比質量分析計 (EA/IRMS) に代表される, 前処理装置と IRMS をオンラインでつなぐ連続フロー (continuous-flow) タイプの測定機器 (例えば, Preston and Owens, 1983; Fry et al., 1992; Brenna et

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