Precise and accurate analysis of stable Sr isotope ratios by DS-TIMS and its application to paleoenvironmental studies

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Recent studies of the "non-traditional" stable Sr isotope ratios revealed that significant Sr isotope fractionation occurs in diverse geochemical processes such as carbonate precipitation, silicate weathering, magmatic mineral crystallization and dietary uptake (e.g. Fietzke and Eisenhauer, 2006; Charlier et al., 2012; Stevenson et al., 2016; Lewis et al., 2017). When combined with the "traditional" $^{87}Sr/^{86}Sr$ ratios, stable and radiogenic Sr isotope systematics is able to evaluate both source and process and will be a powerful tool to investigate global scale cycling of Sr in earth surface environments.

We developed a method for stable and radiogenic Sr isotope analysis using DS-TIMS with a long-term external reproducibility of ± 0.02 ‰ for $\delta^{88}Sr$. NIST SRM987 was repeatedly analyzed during an analytical session and $\delta^{88}Sr$ values are calculated using the measured values on session-by-session basis. This is effective to reduce the systematic bias among analytical sessions, which resulted from faraday cup aging effect.

Eleven seawater samples including four deep seawater samples taken below the CCD in the North Pacific Ocean were analyzed for $\delta^{88}Sr$ to evaluate the homogeneity of $\delta^{88}Sr$ in the modern ocean. Isotopically light calcium carbonates formed in shallow ocean may sink down and re-dissolved at depth below CCD, transporting isotopically light Sr into deep sea. Our analysis of the deep seawater samples, however, show indistinguishable $\delta^{88}Sr$ values with the surface waters, indicating that the light Sr transportation rate was not sufficiently large to change the deep water $\delta^{88}Sr$ in the North Pacific (Wakaki et al., 2017).

We will also present our resent application of the high precision stable Sr isotope analysis to reconstruct the oceanic $\delta^{88}Sr$ values during Quaternary using planktonic foraminifera separated from a sediment core sample (Yoshimura et al., *in prep*) and to paleodietary studies using archeological human remains.

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