# Precise determination of Sr stable isotopes using MC-ICPMS

JUAN XU, XIAOLEI XIE, SHOUYE YANG

State Key Liboratory of Marine Geology, Tongji University, Shanghai 200092, China
juanxu@tongji.edu.cn

A protocol for highly accurate and precise determination of Sr stable isotope ratio, $\delta^{88/86}Sr$, by MC-ICPMS (Neptune Plus) is presented in this study. An improved Zr doping method coupled with standard-sample bracketing method was applied to online mass bias drift correction during Sr isotopes measurement using the exponential law (Equation 1).

$$^{88/86}Sr_{corr}=^{88/86}Sr_{measure} \cdot (Mass^{88}Sr/Mass^{86}Sr)^{\beta} \quad (1)$$

where $^{88/86}Sr_{corr}$ is the corrected isotopic ratio, $^{88/86}Sr_{measure}$ is the measured isotopic ratio, $Mass^{88}Sr$ ($Mass^{86}Sr$) is the isotope mass and $\beta$ is the fractionation factor determined from Zr, which is assumed to show an identical mass bias to that of Sr. During a daily analytical run the mass bias drift typically resulted in the raw $^{88}Sr/^{86}Sr$ ratio increasing with time, almost identical to the trend for raw $^{92}Zr/^{90}Zr$ ratio. The $^{92}Zr/^{90}Zr$ ratio thus allows a reliable mass bias drift correction of Sr ratios, leading to stable corrected NBS987 $^{88}Sr/^{86}Sr$ ratios and repeatable sample $^{88}Sr/^{86}Sr$ ratios through time. Compared to the standard-sample bracketing method, using the Zr-corrected ratios achieved an improvement of the uncertainty by a factor of ~2.

The reduplicate analyses for BCR-2 and BHVO-2 yield $\delta^{88/86}Sr=0.24\pm0.02‰$ ($2\sigma$, n=16), $\delta^{88/86}Sr=0.25\pm0.03‰$ ($2\sigma$, n=15), respectively, which agree well with the published values (Chao et al., 2015; Moynier et al., 2010). A seawater standard with published Sr isotope ratios (Andrews and Jacobson, 2017; Halicz et al., 2008), IAPSO, yielded $\delta^{88/86}Sr=0.38\pm0.02‰$ ($2\sigma$, n=20). An additional in-house mono-elemental Sr reference sample, which was not chemically treated, was adopted to check the potential isotopic bias induced by chemical procedure. And it yielded a comparable uncertainty of $\pm0.02‰$ ($2\sigma$, n=20), indicating the robust of the presented method for the tolerance of matrix effects. Overall, the best reproducibility was obtained using Zr doping approach, which results in the precise measurements of $\delta^{88Sr/86}Sr$ in silicate rocks and seawater.

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