Effect of fractionation rate on high-precision multidynamic TIMS Sr isotope analysis and the ^{84}Sr abundance of the Earth

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The multidynamic acquisition mode in TIMS isotopic analysis can effectively minimize the bias in isotopic ratios due to Faraday cup deterioration [1, 2]. However, a potential problem of this mode is that the normalising and normalised ratios are not measured simultaneously. If the fractionation is fast, this can lead to a bias in the fractionation-corrected isotopic ratios, as demonstrated in the recent studies on high-precision multidynamic Nd isotope analysis [2, 3].

Here we show that this effect can be pronounced in the high-precision TIMS analysis of ^{84}Sr. We measured ^{84}Sr/^{86}Sr ratios of the standard SRM987 and a series of terrestrial samples (BCR-2, BHVO-2, BIR-1, and seawater) using a 3-line multidynamic method with the center cup sequencially collecting masses 85, 86, and 87. The μ^{84}Sr values (defined as $10^4[(^{84}Sr/^{86}Sr_{sample})/(^{84}Sr/^{86}Sr_{SRM987}) - 1]$) of the terrestrial samples are positively correlated with fractionation rates, consistent with the expectation from our cup configuration (measuring ^{84}Sr/^{86}Sr prior to ^{88}Sr/^{86}Sr). After correcting the fractionation drifting between magnetic settings using a linear interpolation method, this correlation is eliminated, and a better measurement precision is achieved.

The drift-corrected multidynamic measurements yield a weighted average μ^{84}Sr of –31 ± 8 ppm (2 S.E., N = 33) for the terrestrial samples, which is in good agreement with our static measurement results (–31 ± 7 ppm) and those reported by [4-7]. The uncorrected multidynamic measurents yield a less negative μ^{84}Sr value (–17 ± 9 ppm), similar to the results of [7-10]. We suggest that the higher fractionation rates of terrestrial samples relative to SRM987 may have biased the multidynamic μ^{84}Sr in some of the previous reports, and that the Earth has a ^{84}Sr deficit of ~30 ppm relative to SRM987.

[1] Thirlwall (1991) *CG*, **94**, 85-104. [2] Garçon *et al.* (2018) *CG*, **476**, 493-514. [3] Roth *et al.* (2014) *CG*, **386**, 238-248. [4] Moynier *et al.* (2012) *ApJ*, **758**, 45. [5] Paton *et al.* (2013) *ApJL*, **763**, L40. [6] Yokoyama *et al.* (2015) *EPSL*, **416**, 46-55. [7] Fukai & Yokoyama (2019) *ApJ*, **879**, 79. [8] Hans *et al.* (2013) *EPSL*, **374**, 204-214. [9] Yobregat *et al.* (2017) *JAAS*, **32**, 1388-1399. [10] Henshall *et al.* (2018) *CG*, **482**, 113-120.