Instrumental biases for SIMS magnesium isotope analyses

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Secondary ion mass spectrometery (SIMS) is useful for ^{26}Al-^{26}Mg chronology of early solar system materials, such as CAIs and chondrules [1-3]. Multi-collection Faraday cup analyses of olivine and pyroxene phenocrysts in chondrules (typically using 12-15μm spots at 2-4 nA primary beam current) determine intercepts of isochron regression lines with precision as good as ±0.03‰ in δ^{26}Mg* (i.e., the mass-fractionation corrected ^{26}Mg/^{24}Mg ratio) [2]. The same analyses also provide stable Mg isotope fractionation (δ^{25}Mg) in chondrule olivine and pyroxene with precision better than ±0.2‰ amu^{-1} [2] if instrumental biases are properly corrected. The raw δ^{25}Mg values of terrestrial standards obtained via SIMS show strong linear correlations with olivine Fo contents (–4‰ to –0.5‰ for Fo_{100}-Fo_{60}), but show smaller variability among pyroxene (–0.3‰ to +1‰) that correlate weakly with En and Wo contents [2]. Based on olivine and pyroxene standard calibrations, instrumental biases of unknowns in chondrules are corrected as a function of their Fo, En, and Wo contents [2]; historically, this has been achieved by assuming that $\delta^{25}Mg_{DSM\text{-}3}$ values of SIMS olivine and pyroxene standards are 0‰, or the same as average terrestrial mantle derived rocks (–0.13‰ [4]).

In order to improve the accuracy of instrumental bias corrections, we obtained $\delta^{25}Mg_{DSM\text{-}3}$ values for several olivine and pyroxene standards by solution MC-ICPMS. For the 7 standards analyzed so far, the $\delta^{25}Mg_{DSM\text{-}3}$ values vary between –0.2‰ and 0‰, except for synthetic pure forsterite (–0.4‰) and diopside from Adirondack Mountains (–0.5‰) which deviate significantly from the terrestrial mantle value (–0.13‰ [4]). By using the new MC-ICPMS data of these standards, the linearity of instrumental bias calibration lines are improved for both olivine and low-Ca pyroxene against Fo and En contents, respectively. The biases of two diopside standards, which have different Al_2O_3 contents (1% and 5%, respectively) differ by 0.6‰ in δ^{25}Mg, suggesting biases are also sensitive to minor element abundances.

[1] Kita *et al.* (2012) *GCA* **86**, 37–51. [2] Ushikubo *et al.* (2013) *GCA* **109**, 280-295. [3] Tenner *et al.* (2015) *MaPS Suppl.* **50**, Abstract #5326. [4] Teng *et al.* (2010) *GCA* **74**, 4150-4166.