Electronic Supplementary Information (ESI): Derivation of equations used in the text.

Definition of variables

I^m = Measured intensity *I* at mass *m* (in atomic mass units, amu)

I^m_{El} = Contributing intensity *I* of element or element species (*El*) to the total intensity measured at mass *m*

α = Exponential factor

$\left(\frac{^{m1}El}{^{m2}El}\right)_{Const}$ = Constant isotope ratio of isotope *m1* and isotope *m2* of element *El*[$]

$m(^{m1}El)$ = Accurate atomic mass of isotope *m1* of Element *El*[$]

R^8 = $^{18}O/^{16}O$

Throughout the text the exponential law (see, for example, Hart and Zindler [2] or Wombacher and Rehkämper [3]) is assumed to correct for instrumentally induced isotope fractionation.

Equation (1)

$$\left(\frac{^{136}Ce}{^{142}Ce}\right)=\frac{I^{136}-I^{136}_{Ba}}{I^{142}-I^{142}_{Nd}} \qquad (1a)$$

$$\left(\frac{^{136}Ba}{^{137}Ba}\right)_{Const}=\frac{I^{136}_{Ba}}{I^{137}}\times\left(\frac{m(^{136}Ba)}{m(^{137}Ba)}\right)^{\alpha}$$

$$I^{136}_{Ba}=I^{137}\times\left(\frac{^{136}Ba}{^{137}Ba}\right)_{Const}\times\left(\frac{m(^{136}Ba)}{m(^{137}Ba)}\right)^{-\alpha} \qquad (1b)$$

$$\left(\frac{^{142}Nd}{^{144}Nd}\right)_{Const}=\frac{I^{142}_{Nd}}{I^{144}}\times\left(\frac{m(^{142}Nd)}{m(^{144}Nd)}\right)^{\alpha}$$

[$] Taken from Rosman and Taylor [1] if not defined otherwise in the text.

$$I_{Nd}^{142} = I^{144} \times \left(\frac{^{142}Nd}{^{144}Nd}\right)_{Const} \times \left(\frac{m(^{142}Nd)}{m(^{144}Nd)}\right)^{-\alpha} \qquad (1c)$$

Insert (1b) and (1c) into (1a) to obtain equation (1) given in text.

Equations (4) and (5)

$$I_{^{142}Ce^{16}O}^{158} = I^{158} - I_{^{140}Ce^{18}O}^{158} \qquad (4a)$$

$$I_{^{140}Ce^{18}O}^{158} = I^{156} \times R^{8} \qquad (4b)$$

$$\left(\frac{^{140}Ce}{^{136}Ce}\right)_{Const} = \frac{I^{156}}{I^{152}} \times \left(\frac{m(^{140}Ce^{16}O)}{m(^{136}Ce^{16}O)}\right)^{\alpha}$$

$$I^{156} = I^{152} \times \left(\frac{^{140}Ce}{^{136}Ce}\right)_{Const} \times \left(\frac{m(^{140}Ce^{16}O)}{m(^{136}Ce^{16}O)}\right)^{-\alpha} \qquad (4c)$$

$$R^{8} = \left(\frac{^{142}Ce^{18}O}{^{136}Ce^{16}O}\right)_{Const} \times \left(\frac{^{136}Ce}{^{142}Ce}\right)_{Const} = \frac{\frac{I^{160}}{I^{152}} \times \left(\frac{^{136}Ce}{^{142}Ce}\right)_{Const}}{\left(\frac{m(^{142}Ce^{18}O)}{m(^{136}Ce^{16}O)}\right)^{-\alpha}} \qquad (5)$$

Inserting equations (4c) and (5) in (4b) yields

$$I_{^{140}Ce^{18}O}^{158} = I^{160} \times \frac{\left(\frac{^{140}Ce}{^{142}Ce}\right)_{Const}}{\left(\frac{m(^{140}Ce^{16}O)}{m(^{142}Ce^{18}O)}\right)^{\alpha}} \qquad (4d)$$

Inserting equation (4d) into (4a) yields equation (4) in the text.

References

1. K. J. R. Rosman and P. D. P. Taylor, *Pure and Applied Chemistry*, 1998, **70**, 217-236.
2. S. R. Hart and A. Zindler, *International Journal of Mass Spectrometry and Ion Processes*, 1989, **89**, 287-301.
3. F. Wombacher and M. Rehkämper, *Journal of Analytical Atomic Spectrometry*, 2003, **18**, 1371-1375.