Supplementary information to

# Characterisation of gas cell reactions for 70+ elements using $N_2O$ for ICP tandem mass spectrometry measurements

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Table S1: Composition of multi-element standards used for evaluation of on-mass and mass-shift determinations. Measured analytes in each standard are highlighted in bold. Elements measured as single element standard solutions are given in italics.

| Standard | Matrix | Analytes |
|---|---|---|
| ICP multi-element standard solution VI | *w* = 2% $HNO_3$ | Li, **Be**, **B**, Na, Mg, Al, K, Ca, V, **Cr**, Mn, Fe, Co, Ni, Cu, Zn, Ga, **As**, Se, Rb, Sr, Mo, Ag, Cd, Ba, **Pb**, **Bi**, U. |
| AHF-CAL-7 | *w* = 2% $HNO_3$ | **Y**, **La**, **Ce**, **Pr**, **Nd**, **Sm**, **Eu**, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, **Th**, **U**. |
| Precious Metals | *w* = 2% $HNO_3$ | **Ru**, **Rh**, **Pd**, **Ir**, **Pt**, **Au**. |
| In-house A | *w* = 2% $HNO_3$ | **Sc**, **Ti**, **Ge**, **Re**, **W**. |
| In-house B | *w* = 2% $HNO_3$ | **Nb**, **Sn**, **Sb**, **Ta**. |
| In-house C | *w* = 2% $HNO_3$ | **Al**, **Ca**, **V**, **Ni**, **Cu**, **Se**, **Cd**, **Ba**. |
| In-house D | *w* = 2% $HNO_3$ | **Mg**, **Mn**, **Fe**, **Zn**, **Sr**, **Mo**, **Te**. |
| In-house E | *w* = 2% $HNO_3$ | **Gd**, **Tb**, **Dy**, **Ho**, **Er**, **Tm**. |
| In-house F | *w* = 2% $HNO_3$ | **Yb**, **Lu**. |
| In-house G | *w* = 2% $HNO_3$ | **Li**, **K**, **Ga**, **Ag**, **Cs**, **Tl**. |
| In-house H | *w* = 2% $HNO_3$ | **Na**, **Rb**. |
| In-house I | *w* = 2% $HNO_3$ | **S**, **P**, **Zr**. |
| In-house J | *w* = 2% HCl | **Hf**, **Os**, **Hg**. |
| In-house K | *w* = 1% TMAH | **Cl**, **Br**, **I**. |
| In-house L | *w* = 2% $HNO_3$ | **Co**, **In** |
| *Single Element* | *w = 2% $HNO_3$* | ***Si*** |

Table S1b: Composition of multi-element standards used for evaluation of on-mass removal of doubly-charged and oxide-based interferences. Analytes measured in each standard are highlighted in bold. Elements measured as single element standard solutions are given in italics.

| Standard | Matrix | Analytes |
|---|---|---|
| AHF-CAL-7 | *w* = 2% $HNO_3$ | Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, **Th**, **U**. |
| In-house G | *w* = 2% $HNO_3$ | **Li**, **K**, **Ga**, **Ag**, **Cs**, **Tl**. |
| In-house K | *w* = 1% TMAH | **Cl**, **Br**, **I**. |
| In-house L | *w* = 2% $HNO_3$ | **Co**, **In** |
| In-house M | *w* = 2% $HNO_3$ | **Y**, **La**, **Pr**, **Tb**, **Ho**, **Tm** |
| In-house N | *w* = 2% $HNO_3$ | **Ca**, **V**, **Sb**, **Sm**, **Lu**, **Pb** |
| In-house O | *w* = 2% $HNO_3$ | **Sc**, **Nb**, **Ce**, **Eu**, **Yb**, **Ta** |
| In-house P | *w* = 2% $HNO_3$ | **Na**, **Cu**, **Rb**, **Sn**, **Nd**, **Bi** |
| In-house Q | *w* = 2% $HNO_3$ | **Fe**, **Rh**, **Te**, **Er**, **Au** |
| In-house R | *w* = 2% $HNO_3$ | **Mg**, **Mn**, **Ba**, **Dy**, **Pt** |
| In-house S | *w* = 2% $HNO_3$ | **Ti**, **Sr**, **Cd**, **Gd**, **Re** |
| In-house T | *w* = 2% $HNO_3$ | **Cr**, **Ni**, **Zr** |
| In-house U | *w* = 2% $HNO_3$ | **Zn**, **Mo** |
| *Single Element* | *w = 2% $HNO_3$* | ***Be, B, Al, Si, P, S, Ge, As, Se*** |
| *Single Element* | *w = 2% HCl* | ***Ru, Pd, Hf, W, Os, Ir, Hg*** |

Table S2: Maximum obtained formation of selected product ions for 73 analytes using $N_2O$ reaction gas. Flow rates of $N_2O$ provided are at the optimum formation using a Perkin Elmer NexION 5000.

| Element | Isotope | $MN^+$ (+14 amu) | | $MO^+$ (+16 amu) | | $MNO^+$ (+30 amu) | | $MO_2^+$ (+32 amu) | | $MN_2O^+$ (+44 amu) | | $MNO_2^+$ (+46 amu) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Li | 7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Be | 9 | 0.03 | 0.1 | 5.5 | 0.1 | 0.02 | 0.1 | 7.8 | 0.3 | 0.07 | 0.2 | <0.01 | - |
| B | 11 | <0.01 | - | 0.98 | 0.1 | <0.01 | - | 0.14 | 0.1 | 0.01 | 0.1 | <0.01 | - |
| Na | 23 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Mg | 24 | <0.01 | - | 13 | 0.5 | <0.01 | - | <0.01 | - | 0.06 | 0.5 | <0.01 | - |
| Al | 27 | <0.01 | - | 1.5 | 0.1 | <0.01 | - | 0.48 | 0.2 | 0.06 | 0.6 | <0.01 | - |
| Si | 29 | 0.47 | 0.1 | 29 | 0.2 | 0.20 | 0.3 | 11 | 0.3 | 0.05 | 0.3 | <0.01 | - |
| P | 31 | 5.2 | 0.1 | 28 | 0.4 | 0.09 | 0.4 | 0.01 | 0.2 | <0.01 | - | <0.01 | - |
| S | 34 | 12 | 0.5 | 11 | 0.4 | 0.02 | 0.5 | 5.9 | 0.7 | <0.01 | - | <0.01 | - |
| Cl | 35 | 0.06 | 0.1 | 0.69 | 0.2 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| K | 39 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ca | 44 | <0.01 | - | 51 | 0.4 | 0.09 | 0.4 | 0.02 | 0.6 | <0.01 | - | <0.01 | - |
| Sc | 45 | 0.57 | 0.3 | 67 | 0.4 | 0.10 | 0.3 | 0.28 | 0.5 | <0.01 | - | <0.01 | - |
| Ti | 47 | 2.6 | 0.4 | 37 | 0.3 | 0.07 | 0.3 | 29 | 0.6 | <0.01 | - | <0.01 | - |
| V | 51 | 0.52 | 0.5 | 25 | 0.4 | 0.12 | 0.3 | 17 | 0.5 | <0.01 | - | <0.01 | - |
| Cr | 52 | 0.09 | 0.4 | 1.9 | 0.4 | <0.01 | - | 0.82 | 0.5 | 0.06 | 0.5 | <0.01 | - |
| Mn | 55 | <0.01 | - | 6.6 | 0.4 | <0.01 | - | <0.01 | - | 0.02 | 1.8 | <0.01 | - |
| Fe | 57 | 0.02 | 0.4 | 42 | 0.7 | <0.01 | - | 0.09 | 0.4 | <0.01 | - | <0.01 | - |
| Co | 59 | 0.01 | 0.4 | 9.4 | 0.5 | 0.02 | 0.4 | <0.01 | - | 0.09 | 0.3 | <0.01 | - |
| Ni | 60 | <0.01 | - | 3.4 | 0.4 | <0.01 | - | <0.01 | - | 0.20 | 0.4 | <0.01 | - |
| Cu | 63 | <0.01 | - | 0.15 | 0.2 | <0.01 | - | <0.01 | - | 0.89 | 0.5 | <0.01 | - |
| Zn | 66 | <0.01 | - | 1.6 | 0.4 | <0.01 | - | <0.01 | - | 0.07 | 1.8 | <0.01 | - |
| Ga | 69 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ge | 74 | 0.08 | 0.5 | 68 | 0.4 | 0.02 | 0.4 | 0.03 | 0.5 | <0.01 | - | <0.01 | - |
| As | 75 | 0.39 | 0.1 | 37 | 0.4 | <0.01 | - | 0.08 | 0.5 | 0.03 | 0.5 | <0.01 | - |
| Se | 82 | 3.0 | 0.6 | 11 | 1.3 | <0.01 | - | 0.18 | 0.7 | <0.01 | - | <0.01 | - |
| Br | 81 | 0.24 | 0.4 | 57 | 0.5 | <0.01 | - | <0.01 | - | 0.07 | 0.5 | <0.01 | - |
| Rb | 85 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sr | 88 | <0.01 | - | 56 | 0.5 | 0.12 | 0.5 | <0.01 | - | <0.01 | - | <0.01 | - |
| Y | 89 | 1.7 | 0.4 | 54 | 0.4 | 0.04 | 0.2 | 0.39 | 0.5 | <0.01 | - | <0.01 | - |
| Zr | 90 | 16 | 0.4 | 20 | 0.1 | 0.47 | 0.3 | 43 | 0.5 | <0.01 | - | 0.03 | 0.6 |
| Nb | 93 | 8.1 | 0.2 | 16 | 0.1 | 12 | 0.5 | 38 | 0.5 | <0.01 | - | <0.01 | - |
| Mo | 98 | 1.8 | 0.5 | 3.4 | 0.1 | 0.47 | 0.5 | 1.3 | 0.3 | 0.07 | 1.7 | <0.01 | - |
| Ru | 101 | 0.47 | 0.7 | 1.7 | 0.2 | 0.10 | 0.7 | 0.56 | 0.3 | 0.09 | 1.3 | <0.01 | - |
| Rh | 103 | 0.08 | 0.6 | 0.67 | 0.6 | 0.03 | 0.7 | <0.01 | - | 0.11 | 1.6 | <0.01 | - |
| Pd | 105 | <0.01 | - | 0.13 | 0.6 | <0.01 | - | <0.01 | - | 0.09 | 1.0 | <0.01 | - |
| Ag | 107 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | 0.11 | 1.7 | <0.01 | - |

*(Table S2 continued)*

| Element | Isotope | $MO_3^+$ (+48 amu) | | $MN_2O_2^+$ (+60 amu) | | $MO_4^+$ (+64 amu) | | $MN_2O.O_2$ (+76 amu) | | $MNO.O_4$ (+94 amu) | | $M(N_2O)_2.O_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Li | 7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Be | 9 | 0.10 | 0.3 | 2.7 | 0.4 | <0.01 | - | 1.8 | 0.6 | 0.04 | 1.2 | 0.12 | 0.9 |
| B | 11 | <0.01 | - | 0.05 | 0.4 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Na | 23 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Mg | 24 | <0.01 | - | 0.26 | 1.2 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Al | 27 | 0.69 | 0.4 | 0.04 | 0.3 | 0.06 | 0.6 | 0.07 | 0.4 | <0.01 | - | <0.01 | - |
| Si | 29 | 2.8 | 0.4 | 0.62 | 0.4 | 0.03 | 0.4 | 0.28 | 0.6 | 0.08 | 1.2 | 0.05 | 1.0 |
| P | 31 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| S | 34 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Cl | 35 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| K | 39 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ca | 44 | <0.01 | - | 0.16 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sc | 45 | <0.01 | - | 0.32 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ti | 47 | <0.01 | - | 0.02 | 0.3 | <0.01 | - | 1.8 | 0.8 | 1.4 | 1.3 | 2.1 | 1.1 |
| V | 51 | <0.01 | - | 0.11 | 0.8 | <0.01 | - | 1.3 | 0.8 | 1.2 | 1.8 | 2.4 | 1.3 |
| Cr | 52 | 0.59 | 0.7 | 0.05 | 0.7 | <0.01 | - | 0.08 | 0.8 | 0.04 | 1.4 | 0.07 | 1.1 |
| Mn | 55 | <0.01 | - | 0.19 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Fe | 57 | 0.14 | 0.7 | 1.4 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Co | 59 | <0.01 | - | 0.54 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ni | 60 | <0.01 | - | 0.14 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Cu | 63 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Zn | 66 | <0.01 | - | 0.10 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ga | 69 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ge | 74 | 0.01 | 1.0 | 0.19 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| As | 75 | <0.01 | - | 0.03 | 0.5 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Se | 82 | <0.01 | - | 0.03 | 2.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Br | 81 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Rb | 85 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sr | 88 | <0.01 | - | 0.18 | 1.6 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Y | 89 | <0.01 | - | 0.18 | 1.2 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Zr | 90 | 0.01 | 0.8 | <0.01 | - | <0.01 | - | 1.8 | 0.8 | 1.4 | 1.4 | 1.4 | 1.1 |
| Nb | 93 | 0.39 | 0.5 | <0.01 | - | <0.01 | - | 2.0 | 0.9 | 2.7 | 1.3 | 2.1 | 1.1 |
| Mo | 98 | 3.8 | 0.4 | <0.01 | - | <0.01 | - | <0.01 | - | 0.03 | 0.8 | <0.01 | - |
| Ru | 101 | 2.1 | 0.5 | <0.01 | - | 1.5 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - |
| Rh | 103 | <0.01 | - | 0.01 | 1.6 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Pd | 105 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ag | 107 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |

*(Table S2 continued)*

| Element | Isotope | $MN^+$ (+14 amu) | | $MO^+$ (+16 amu) | | $MNO^+$ (+30 amu) | | $MO_2^+$ (+32 amu) | | $MN_2O^+$ (+44 amu) | | $MNO_2^+$ (+46 amu) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Cd | 114 | <0.01 | - | 0.31 | 0.8 | <0.01 | - | <0.01 | - | 0.04 | 1.9 | <0.01 | - |
| In | 115 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sn | 118 | <0.01 | - | 9.8 | 0.6 | <0.01 | - | <0.01 | - | 0.01 | 0.9 | <0.01 | - |
| Sb | 121 | 0.03 | 0.5 | 7.8 | 0.7 | <0.01 | - | <0.01 | - | 0.03 | 0.9 | <0.01 | - |
| Te | 128 | 0.19 | 0.9 | 3.5 | 0.9 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| I | 127 | 0.07 | 0.8 | 1.8 | 0.9 | <0.01 | - | <0.01 | - | 0.01 | 1.0 | <0.01 | - |
| Cs | 133 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ba | 138 | 0.01 | 0.8 | 70 | 0.6 | 0.33 | 0.6 | 0.08 | 0.8 | <0.01 | - | <0.01 | - |
| La | 139 | 11 | 0.5 | 51 | 0.5 | 0.06 | 0.5 | 0.06 | 1.0 | <0.01 | - | <0.01 | - |
| Ce | 140 | 16 | 0.4 | 44 | 0.6 | 0.01 | 0.5 | 0.40 | 0.7 | <0.01 | - | <0.01 | - |
| Pr | 141 | 4.8 | 0.6 | 53 | 0.6 | 0.03 | 0.5 | 0.04 | 0.9 | <0.01 | - | <0.01 | - |
| Nd | 143 | 1.5 | 0.5 | 59 | 0.6 | 0.04 | 0.5 | 0.02 | 0.9 | <0.01 | - | <0.01 | - |
| Sm | 147 | 0.05 | 0.7 | 63 | 0.6 | 0.04 | 0.5 | 0.02 | 1.0 | <0.01 | - | <0.01 | - |
| Eu | 153 | <0.01 | - | 68 | 0.7 | 0.09 | 0.7 | 0.03 | 0.9 | <0.01 | - | <0.01 | - |
| Gd | 155 | 2.5 | 0.5 | 66 | 0.6 | 0.04 | 0.5 | 0.13 | 0.9 | <0.01 | - | <0.01 | - |
| Tb | 159 | 2.1 | 0.6 | 68 | 0.7 | 0.02 | 0.4 | 0.62 | 0.8 | <0.01 | - | <0.01 | - |
| Dy | 163 | 0.22 | 0.8 | 66 | 0.8 | <0.01 | - | 0.06 | 0.7 | <0.01 | - | <0.01 | - |
| Ho | 165 | 0.24 | 0.7 | 61 | 0.8 | <0.01 | - | 0.17 | 0.7 | <0.01 | - | <0.01 | - |
| Er | 166 | 0.24 | 0.6 | 62 | 0.7 | <0.01 | - | 0.56 | 0.9 | <0.01 | - | <0.01 | - |
| Tm | 169 | 0.02 | 0.7 | 53 | 0.7 | <0.01 | - | 0.15 | 0.7 | <0.01 | - | <0.01 | - |
| Yb | 174 | <0.01 | - | 48 | 0.8 | <0.01 | - | 0.01 | 0.9 | <0.01 | - | <0.01 | - |
| Lu | 175 | 0.13 | 0.2 | 76 | 0.7 | <0.01 | - | 2.8 | 0.6 | <0.01 | - | <0.01 | - |
| Hf | 180 | 10 | 0.1 | 23 | 0.1 | 1.7 | 0.2 | 81 | 0.5 | <0.01 | - | 0.02 | 0.4 |
| Ta | 181 | 7.7 | 0.1 | 17 | 0.1 | 4.3 | 0.2 | 54 | 0.5 | <0.01 | - | <0.01 | - |
| W | 184 | 8.4 | 0.1 | 19 | 0.2 | 5.0 | 0.2 | 7.8 | 0.3 | <0.01 | - | 0.27 | 0.3 |
| Re | 187 | 3.2 | 0.3 | 3.2 | 0.2 | 0.73 | 0.4 | 1.0 | 0.4 | <0.01 | - | 0.39 | 0.4 |
| Os | 189 | 7.5 | 0.3 | 8.5 | 0.2 | 2.6 | 0.4 | 4.1 | 0.4 | <0.01 | - | 2.4 | 0.4 |
| Ir | 193 | 2.5 | 0.2 | 14 | 0.2 | 0.58 | 0.3 | 9.3 | 0.3 | 0.02 | 0.2 | 2.5 | 0.6 |
| Pt | 195 | 0.44 | 0.7 | 12 | 0.2 | 0.05 | 0.4 | 96 | 0.7 | 0.07 | 0.2 | 0.05 | 0.7 |
| Au | 197 | <0.01 | - | 1.5 | 0.7 | <0.01 | - | <0.01 | - | 1.0 | 0.7 | <0.01 | - |
| Hg | 202 | <0.01 | - | 0.05 | 0.8 | <0.01 | - | <0.01 | - | 0.13 | 1.8 | <0.01 | - |
| Tl | 205 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Pb | 208 | <0.01 | - | 3.4 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Bi | 209 | <0.01 | - | 1.2 | 1.3 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Th | 232 | 22 | 0.2 | 23 | 0.1 | 10 | 0.8 | 63 | 0.7 | <0.01 | - | 0.03 | 0.6 |
| U | 238 | 15 | 0.2 | 27 | 0.2 | 9.8 | 0.9 | 51 | 0.9 | <0.01 | - | <0.01 | - |

*(Table S2 continued)*

| Element | Isotope | $MO_3^+$ (+48 amu) | | $MN_2O_2^+$ (+60 amu) | | $MO_4^+$ (+64 amu) | | $MN_2O.O_2$ (+76 amu) | | $MNO.O_4$ (+94 amu) | | $M(N_2O)_2.O_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Cd | 114 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| In | 115 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sn | 118 | <0.01 | - | 0.01 | 1.0 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sb | 121 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Te | 128 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| I | 127 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Cs | 133 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ba | 138 | <0.01 | - | 0.06 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| La | 139 | <0.01 | - | 0.06 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ce | 140 | <0.01 | - | 0.08 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Pr | 141 | <0.01 | - | 0.09 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Nd | 143 | <0.01 | - | 0.17 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Sm | 147 | <0.01 | - | 0.31 | 1.7 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Eu | 153 | <0.01 | - | 0.33 | 1.6 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Gd | 155 | <0.01 | - | 0.28 | 1.2 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Tb | 159 | <0.01 | - | 0.56 | 1.3 | <0.01 | - | 0.03 | 1.2 | <0.01 | - | <0.01 | - |
| Dy | 163 | <0.01 | - | 0.53 | 1.4 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Ho | 165 | <0.01 | - | 0.81 | 1.4 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - |
| Er | 166 | <0.01 | - | 0.49 | 1.4 | <0.01 | - | 0.02 | 1.0 | <0.01 | - | - | - |
| Tm | 169 | <0.01 | - | 0.58 | 1.5 | <0.01 | - | <0.01 | - | <0.01 | - | - | - |
| Yb | 174 | <0.01 | - | 0.39 | 1.4 | <0.01 | - | <0.01 | - | <0.01 | - | - | - |
| Lu | 175 | <0.01 | - | 0.65 | 1.2 | <0.01 | - | 0.09 | 0.9 | 0.05 | 1.4 | - | - |
| Hf | 180 | 0.02 | 0.4 | <0.01 | - | <0.01 | - | 7.7 | 0.7 | 5.7 | 1.3 | - | - |
| Ta | 181 | 4.9 | 0.4 | <0.01 | - | <0.01 | - | 6.5 | 0.7 | 12 | 1.1 | - | - |
| W | 184 | 29 | 0.4 | 0.03 | 0.3 | <0.01 | - | <0.01 | - | 0.33 | 0.7 | - | - |
| Re | 187 | 3.9 | 0.5 | <0.01 | - | 0.48 | 0.5 | <0.01 | - | 0.06 | 0.9 | - | - |
| Os | 189 | 10 | 0.5 | 0.02 | 0.4 | 50 | 0.9 | 0.06 | 1.0 | <0.01 | - | - | - |
| Ir | 193 | 87 | 0.8 | 0.18 | 0.6 | 0.06 | 1.8 | 0.29 | 1.0 | - | - | - | - |
| Pt | 195 | 0.20 | 0.7 | 0.23 | 0.7 | <0.01 | - | 2.6 | 1.7 | - | - | - | - |
| Au | 197 | <0.01 | - | 0.08 | 1.6 | <0.01 | - | <0.01 | - | - | - | - | - |
| Hg | 202 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | - | - | - | - |
| Tl | 205 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | - | - | - | - |
| Pb | 208 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | - | - | - | - |
| Bi | 209 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | - | - | - | - | - |
| Th | 232 | 0.03 | 1.0 | - | - | - | - | - | - | - | - | - | - |
| U | 238 | - | - | - | - | - | - | - | - | - | - | - | - |

Table S3: Maximum obtained formation of selected product ions for 73 analytes using $O_2$ reaction gas. Flow rates of $O_2$ provided are at the optimum formation using a Perkin Elmer NexION 5000.

| Element | Isotope | $MO^+$ (+16 amu) | | $MO_2^+$ (+32 amu) | | $MO_3^+$ (+48 amu) | | Element | Isotope | $MO^+$ (+16 amu) | | $MO_2^+$ (+32 amu) | | $MO_3^+$ (+48 amu) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Li | 7 | <0.01 | - | <0.01 | - | <0.01 | - | Cd | 114 | 0.02 | 0.3 | <0.01 | - | <0.01 | - |
| Be | 9 | 0.21 | 0.3 | <0.01 | - | <0.01 | - | In | 115 | <0.01 | - | <0.01 | - | <0.01 | - |
| B | 11 | 2.1 | 0.2 | 0.07 | 0.2 | <0.01 | - | Sn | 118 | 0.46 | 0.3 | 0.01 | 0.8 | <0.01 | - |
| Na | 23 | <0.01 | - | <0.01 | - | <0.01 | - | Sb | 121 | 4.8 | 0.5 | <0.01 | - | <0.01 | - |
| Mg | 24 | 0.41 | 0.3 | <0.01 | - | <0.01 | - | Te | 128 | 1.9 | 0.4 | <0.01 | - | <0.01 | - |
| Al | 27 | 0.43 | 0.2 | <0.01 | - | <0.01 | - | I | 127 | 0.51 | 0.5 | <0.01 | - | <0.01 | - |
| Si | 29 | 3.2 | 0.3 | 0.06 | 0.4 | <0.01 | - | Cs | 133 | <0.01 | - | <0.01 | - | <0.01 | - |
| P | 31 | 10 | 0.4 | 0.02 | 0.4 | <0.01 | - | Ba | 138 | 1.8 | 0.4 | 0.07 | 0.6 | <0.01 | - |
| S | 34 | 7.6 | 0.3 | 0.02 | 0.4 | <0.01 | - | La | 139 | 20 | 0.3 | 0.27 | 0.4 | <0.01 | - |
| Cl | 35 | 0.73 | 0.2 | <0.01 | - | <0.01 | - | Ce | 140 | 24 | 0.3 | 0.22 | 0.4 | <0.01 | - |
| K | 39 | <0.01 | - | <0.01 | - | <0.01 | - | Pr | 141 | 25 | 0.3 | 0.11 | 0.4 | <0.01 | - |
| Ca | 44 | 1.1 | 0.3 | 0.04 | 0.4 | <0.01 | - | Nd | 143 | 26 | 0.3 | 0.10 | 0.4 | <0.01 | - |
| Sc | 45 | 8.9 | 0.4 | 0.10 | 0.5 | <0.01 | - | Sm | 147 | 18 | 0.4 | 0.07 | 0.6 | <0.01 | - |
| Ti | 47 | 10 | 0.4 | 0.12 | 0.5 | <0.01 | - | Eu | 153 | 5.0 | 0.4 | 0.08 | 0.7 | <0.01 | - |
| V | 51 | 5.5 | 0.4 | 0.07 | 0.5 | <0.01 | - | Gd | 155 | 21 | 0.3 | 0.23 | 0.4 | <0.01 | - |
| Cr | 52 | 1.5 | 0.3 | <0.01 | - | <0.01 | - | Tb | 159 | 27 | 0.3 | 0.20 | 0.5 | <0.01 | - |
| Mn | 55 | 0.99 | 0.3 | <0.01 | - | <0.01 | - | Dy | 163 | 28 | 0.3 | 0.09 | 0.5 | <0.01 | - |
| Fe | 57 | 1.9 | 0.3 | <0.01 | - | <0.01 | - | Ho | 165 | 27 | 0.3 | 0.12 | 0.5 | <0.01 | - |
| Co | 59 | 1.5 | 0.3 | <0.01 | - | <0.01 | - | Er | 166 | 29 | 0.3 | 0.16 | 0.4 | <0.01 | - |
| Ni | 60 | 0.52 | 0.3 | <0.01 | - | <0.01 | - | Tm | 169 | 21 | 0.4 | 0.08 | 0.5 | <0.01 | - |
| Cu | 63 | 0.06 | 0.3 | <0.01 | - | <0.01 | - | Yb | 174 | 4.3 | 0.5 | 0.05 | 0.7 | <0.01 | - |
| Zn | 66 | 0.11 | 0.3 | <0.01 | - | <0.01 | - | Lu | 175 | 33 | 0.4 | 0.28 | 0.5 | <0.01 | - |
| Ga | 69 | <0.01 | - | <0.01 | - | <0.01 | - | Hf | 180 | 37 | 0.3 | 7.1 | 0.5 | 0.03 | 0.6 |
| Ge | 74 | 2.3 | 0.3 | 0.04 | 0.5 | <0.01 | - | Ta | 181 | 25 | 0.2 | 13 | 0.5 | <0.01 | - |
| As | 75 | 8.3 | 0.4 | <0.01 | - | <0.01 | - | W | 184 | 26 | 0.2 | 15 | 0.5 | 0.10 | 0.7 |
| Se | 82 | 3.6 | 0.4 | <0.01 | - | <0.01 | - | Re | 187 | 12 | 0.4 | 6.9 | 0.7 | 1.5 | 0.9 |
| Br | 81 | 1.2 | 0.3 | <0.01 | - | <0.01 | - | Os | 189 | 13 | 0.4 | 3.9 | 0.8 | 0.07 | 0.9 |
| Rb | 85 | <0.01 | - | <0.01 | - | <0.01 | - | Ir | 193 | 3.6 | 0.5 | 0.07 | 1.0 | <0.01 | - |
| Sr | 88 | 1.0 | 0.3 | 0.04 | 0.5 | <0.01 | - | Pt | 195 | 0.46 | 0.6 | <0.01 | - | <0.01 | - |
| Y | 89 | 13 | 0.3 | 0.20 | 0.4 | <0.01 | - | Au | 197 | 0.04 | 0.4 | <0.01 | - | <0.01 | - |
| Zr | 90 | 17 | 0.3 | 1.7 | 0.5 | 0.01 | 0.9 | Hg | 202 | <0.01 | - | <0.01 | - | <0.01 | - |
| Nb | 93 | 12 | 0.3 | 5.1 | 0.6 | <0.01 | - | Tl | 205 | <0.01 | - | <0.01 | - | <0.01 | - |
| Mo | 98 | 6.7 | 0.3 | 3.6 | 0.7 | <0.01 | - | Pb | 208 | 0.03 | 0.5 | <0.01 | - | <0.01 | - |
| Ru | 101 | 3.1 | 0.4 | 0.03 | 0.6 | <0.01 | - | Bi | 209 | 0.25 | 0.7 | <0.01 | - | <0.01 | - |
| Rh | 103 | 0.46 | 0.4 | <0.01 | - | <0.01 | - | Th | 232 | 39 | 0.2 | 13 | 0.5 | <0.01 | - |
| Pd | 105 | 0.04 | 0.4 | <0.01 | - | <0.01 | - | U | 238 | 31 | 0.1 | 22 | 0.4 | - | - |
| Ag | 107 | <0.01 | - | <0.01 | - | <0.01 | - | | | | | | | | |

Table S4: Comparison of determined limit of detection (LOD) and background equivalence concentration (BEC) for standard mode and mass-shift determinations with $N_2O$ reaction gas using a Perkin Elmer NexION 5000. LODs were calculated based on 3 times the standard deviation of the blank and expressed in ng $g^{-1}$. BECs were calculated by division of the blank signal with the calibration slope and expressed in ng $g^{-1}$. Improvement in LOD and BEC are given as a factor of how much lower these parameters are when compared to standard mode. Values are presented to 2 significant figures.

| Element | Isotope | Standard Mode | | $N_2O$ Mode | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LOD (ng $g^{-1}$) | BEC (ng $g^{-1}$) | Measured Product Ion | Measured Mass | Gas Flow Rate (mL $min^{-1}$) | LOD (ng $g^{-1}$) | LOD Improvement | BEC (ng $g^{-1}$) | BEC Improvement |
| Be | 9 | 0.003 9 | 0.003 4 | $BeO_2$ | 41 | 0.3 | 0.011 | 0.34 | 0.003 8 | 0.90 |
| B | 11 | 0.59 | 5.9 | BO | 27 | 0.1 | 0.29 | 2.0 | 3.7 | 1.6 |
| Mg | 24 | 0.001 7 | 0.016 | MgO | 40 | 0.5 | 0.002 2 | 0.77 | 0.019 | 0.84 |
| Al | 27 | 0.001 6 | 0.019 | AlO | 43 | 0.1 | 0.014 | 0.113 | 0.022 | 0.87 |
| Si | 28 | 19 | 270 | $SiO_2$ | 60 | 0.3 | 0.14 | 130 | 2.1 | 130 |
| Si | 29 | 35 | 610 | SiO | 45 | 0.2 | 51 | 0.68 | 1000 | 0.59 |
| P | 31 | 3.4 | 20 | PO | 47 | 0.4 | 0.062 | 56 | 0.43 | 47 |
| S | 34 | 47 | 1000 | SN | 48 | 0.5 | 1.3 | 35 | 1.9 | 530 |
| Cl | 35 | 7.8 | 210 | ClO | 51 | 0.2 | 28 | 46 | 170 | 120 |
| Ca | 44 | 0.44 | 18 | CaO | 60 | 0.4 | 0.12 | 0.28 | 2.8 | 1.2 |
| Sc | 45 | 0.002 7 | 0.054 | ScO | 61 | 0.4 | 0.000 15 | 3.64 | 0.000 096 | 6.4 |
| Ti | 47 | 0.000 86 | 0.006 3 | TiO | 63 | 0.3 | 0.000 33 | 18 | 0.002 9 | 560 |
| Ti | 47 | 0.000 86 | 0.006 3 | $TiO_2$ | 79 | 0.6 | 0.000 31 | 2.6 | 0.000 36 | 2.2 |
| V | 51 | 0.000 36 | 0.002 1 | VO | 67 | 0.4 | 0.000 18 | 2.7 | 0.000 024 | 18 |
| Cr | 52 | 0.15 | 10 | CrO | 68 | 0.4 | 0.005 4 | 2.0 | 0.002 3 | 88 |
| Mn | 55 | 0.001 3 | 0.015 | MnO | 71 | 0.4 | 0.000 71 | 27 | 0.000 83 | 4500 |
| Fe | 57 | 3.5 | 65 | FeO | 73 | 0.7 | 0.010 | 1.8 | 0.007 8 | 19 |
| Co | 59 | 0.000 79 | 0.004 8 | CoO | 75 | 0.5 | 0.000 25 | 340 | 0.000 092 | 8300 |
| Ni | 60 | 0.002 1 | 0.007 9 | NiO | 76 | 0.4 | 0.009 5 | 3.1 | 0.006 1 | 52 |
| Cu | 63 | 0.000 50 | 0.005 2 | $CuN_2O$ | 107 | 0.5 | 0.007 9 | 0.22 | 0.003 1 | 1.3 |
| Zn | 66 | 0.004 0 | 0.019 | ZnO | 82 | 0.4 | 0.023 | 0.064 | 0.010 | 1.7 |
| Ge | 74 | 0.001 9 | 0.004 8 | GeO | 90 | 0.4 | 0.000 082 | 0.17 | 0.000 011 | 1.9 |
| As | 75 | 0.000 34 | 0.000 53 | AsO | 91 | 0.4 | 0.000 60 | 23 | 0.000 13 | 430 |
| Se | 82 | 0.036 | 0.16 | SeO | 98 | 1.3 | 0.012 | 0.57 | 0.001 7 | 4.1 |
| Br | 81 | 5.0 | 130 | BrO | 97 | 0.5 | 1.5 | 2.9 | 77 | 97 |
| Sr | 88 | 0.000 21 | 0.001 1 | SrO | 104 | 0.5 | 0.000 43 | 3.4 | 0.001 0 | 1.7 |
| Y | 89 | 0.000 033 | 0.000 036 | YO | 105 | 0.4 | 0.000 078 | 0.49 | 0.000 026 | 1.0 |
| Zr | 90 | 0.000 59 | 0.000 29 | $ZrO_2$ | 122 | 0.5 | 0.000 038 | 0.42 | 0.000 026 | 1.4 |
| Nb | 93 | 0.000 12 | 0.000 070 | $NbO_2$ | 125 | 0.5 | 0.000 46 | 16 | 0.000 13 | 11 |
| Mo | 98 | 0.000 33 | 0.000 25 | $MoO_3$ | 146 | 0.4 | 0.001 3 | 0.25 | 0.000 17 | 0.53 |
| Ru | 101 | 0.001 4 | 0.006 7 | $RuO_3$ | 149 | 0.5 | 0.003 5 | 0.25 | 0.000 48 | 1.4 |
| Rh | 103 | 0.000 12 | 0.000 17 | RhO | 119 | 0.6 | 0.002 5 | 0.41 | 0.000 54 | 14 |
| Pd | 105 | 0.000 29 | 0.000 38 | PdO | 121 | 0.6 | 0.066 | 0.049 | 0.014 | 0.32 |
| Ag | 107 | 0.000 51 | 0.001 7 | $AgN_2O$ | 151 | 1.7 | 0.062 | 0.004 4 | 0.008 4 | 0.027 |

*(Table S4 continued)*

| Element | Isotope | Standard Mode | | $N_2O$ DRC Mode | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LOD ($ng\ g^{-1}$) | BEC ($ng\ g^{-1}$) | Measured Product Ion | Measured Mass | Gas Flow Rate ($mL\ min^{-1}$) | LOD ($ng\ g^{-1}$) | LOD Improvement | BEC ($ng\ g^{-1}$) | BEC Improvement |
| Cd | 114 | 0.000 26 | 0.000 23 | CdO | 130 | 0.8 | 0.024 | 0.011 | 0.003 2 | 0.071 |
| Sn | 118 | 0.000 34 | 0.000 50 | SnO | 134 | 0.6 | 0.001 7 | 0.19 | 0.000 53 | 0.95 |
| Sb | 121 | 0.000 72 | 0.000 96 | SbO | 137 | 0.7 | 0.003 8 | 0.19 | 0.001 6 | 0.59 |
| Te | 128 | 0.004 8 | 0.014 | TeO | 144 | 0.9 | 0.007 | 0.69 | 0.001 5 | 9.4 |
| I | 127 | 0.016 | 0.71 | IO | 143 | 0.9 | 0.14 | 0.11 | 0.79 | 0.90 |
| Ba | 138 | 0.000 22 | 0.000 19 | BaO | 154 | 0.6 | 0.000 33 | 0.65 | 0.000 53 | 0.36 |
| La | 139 | 0.000 055 | 0.000 034 | LaO | 155 | 0.5 | 0.000 13 | 0.44 | 0.000 067 | 0.51 |
| Ce | 140 | 0.000 083 | 0.000 040 | CeO | 156 | 0.6 | 0.000 29 | 0.284 | 0.000 12 | 0.34 |
| Pr | 141 | 0.000 015 | 0.000 027 | PrO | 157 | 0.6 | 0.000 059 | 0.26 | 0.000 035 | 0.77 |
| Nd | 143 | 0.000 47 | 0.000 14 | NdO | 159 | 0.6 | 0.000 29 | 1.6 | 0.000 087 | 1.6 |
| Sm | 147 | 0.000 13 | 0.000 029 | SmO | 163 | 0.6 | 0.000 17 | 0.79 | 0.000 023 | 1.3 |
| Eu | 153 | 0.000 032 | 0.000 004 | EuO | 169 | 0.7 | 0.000 047 | 0.68 | 0.000 006 | 0.68 |
| Gd | 155 | 0.000 77 | 0.001 4 | GdO | 171 | 0.6 | 0.001 6 | 0.48 | 0.001 2 | 1.2 |
| Tb | 159 | 0.000 13 | 0.000 29 | TbO | 175 | 0.7 | 0.000 16 | 0.83 | 0.000 25 | 1.1 |
| Dy | 163 | 0.001 5 | 0.001 4 | DyO | 179 | 0.8 | 0.001 3 | 1.2 | 0.000 85 | 1.6 |
| Ho | 165 | 0.000 17 | 0.000 27 | HoO | 181 | 0.8 | 0.000 22 | 0.80 | 0.000 25 | 1.1 |
| Er | 166 | 0.000 81 | 0.000 60 | ErO | 182 | 0.7 | 0.000 47 | 1.7 | 0.000 83 | 0.72 |
| Tm | 169 | 0.000 11 | 0.000 078 | TmO | 185 | 0.7 | 0.000 12 | 0.94 | 0.000 061 | 1.3 |
| Yb | 174 | 0.000 16 | 0.000 067 | YbO | 190 | 0.8 | 0.000 23 | 0.73 | 0.000 031 | 2.2 |
| Lu | 175 | 0.000 11 | 0.000 062 | LuO | 191 | 0.7 | 0.000 051 | 2.3 | 0.000 007 | 9.1 |
| Hf | 180 | 0.000 10 | 0.000 014 | $HfO_2$ | 212 | 0.5 | 0.000 16 | 0.64 | 0.000 035 | 0.40 |
| Ta | 181 | 0.000 094 | 0.000 019 | $TaO_2$ | 213 | 0.5 | 0.000 21 | 0.46 | 0.000 035 | 0.54 |
| W | 184 | 0.000 26 | 0.000 087 | $WO_3$ | 232 | 0.4 | 0.000 26 | 1.0 | 0.000 035 | 2.4 |
| Re | 187 | 0.000 11 | 0.000 044 | $ReO_3$ | 235 | 0.5 | 0.001 2 | 0.093 | 0.000 26 | 0.17 |
| Os | 189 | 0.000 26 | 0.000 051 | $OsO_4$ | 253 | 0.9 | 0.000 25 | 1.0 | 0.000 034 | 1.5 |
| Ir | 193 | 0.000 42 | 0.000 46 | $IrO_3$ | 241 | 0.8 | 0.000 074 | 5.6 | 0.000 023 | 20 |
| Pt | 195 | 0.001 4 | 0.000 85 | $PtO_2$ | 227 | 0.7 | 0.001 1 | 1.3 | 0.001 0 | 0.83 |
| Au | 197 | 0.002 0 | 0.004 4 | AuO | 213 | 0.7 | 0.016 | 0.12 | 0.004 5 | 0.99 |
| Hg | 202 | 0.006 0 | 0.006 1 | $HgN_2O$ | 246 | 1.8 | 0.88 | 0.006 8 | 0.12 | 0.051 |
| Pb | 208 | 0.000 15 | 0.000 020 | PbO | 224 | 1.0 | 0.002 2 | 0.067 | 0.000 30 | 0.067 |
| Bi | 209 | 0.000 049 | 0.000 067 | BiO | 225 | 1.3 | 0.004 1 | 0.012 | 0.000 56 | 0.012 |
| Th | 232 | 0.000 084 | 0.000 026 | $ThO_2$ | 264 | 0.7 | 0.000 10 | 0.842 | 0.000 014 | 1.9 |
| U | 238 | 0.000 063 | 0.000 014 | $UO_2$ | 270 | 0.9 | 0.000 19 | 0.33 | 0.000 053 | 0.26 |

Table S5: Comparison of determined limit of detection (LOD) and background equivalence concentration (BEC) for standard mode and mass-shift determinations with $O_2$ reaction gas using a Perkin Elmer NexION 5000. LODs were calculated based on 3 times the standard deviation of the blank and expressed in ng $g^{-1}$. BECs were calculated by division of the blank signal with the calibration slope and expressed in ng $g^{-1}$. Improvement in LOD and BEC are given as a factor of how much lower these parameters are when compared to standard mode. Values are presented to 2 significant figures.

| Element | Isotope | Standard Mode | | $O_2$ Mode | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LOD (ng $g^{-1}$) | BEC (ng $g^{-1}$) | Measured Product Ion | Measured Mass | Gas Flow Rate (mL $min^{-1}$) | LOD (ng $g^{-1}$) | LOD Improvement | BEC (ng $g^{-1}$) | BEC Improvement |
| Be | 9 | 0.003 9 | 0.003 4 | BeO | 25 | 0.3 | 0.11 | 0.035 | 0.015 | 0.22 |
| B | 11 | 0.59 | 5.9 | BO | 27 | 0.2 | 0.58 | 1.0 | 2.4 | 2.5 |
| Mg | 24 | 0.001 7 | 0.016 | MgO | 40 | 0.3 | 0.073 | 0.023 | 0.069 | 0.22 |
| Al | 27 | 0.001 6 | 0.019 | AlO | 43 | 0.2 | 0.036 | 0.044 | 0.019 | 0.98 |
| Si | 28 | 19 | 270 | SiO | 44 | 0.3 | 0.39 | 18 | 5.9 | 63 |
| Si | 29 | 35 | 610 | SiO | 45 | 0.3 | 2.0 | 48 | 9.7 | 46 |
| P | 31 | 3.4 | 20 | PO | 47 | 0.4 | 0.11 | 31 | 0.4 | 51 |
| S | 34 | 47 | 1000 | SO | 50 | 0.3 | 0.51 | 92 | 3.0 | 330 |
| Cl | 35 | 7.8 | 210 | ClO | 51 | 0.2 | 27 | 0.30 | 73 | 2.8 |
| Ca | 44 | 0.44 | 18 | CaO | 60 | 0.3 | 0.97 | 0.46 | 2.0 | 8.7 |
| Sc | 45 | 0.002 7 | 0.054 | ScO | 61 | 0.4 | 0.000 75 | 3.6 | 0.000 39 | 140 |
| Ti | 47 | 0.000 86 | 0.006 3 | TiO | 63 | 0.4 | 0.000 92 | 0.93 | 0.000 81 | 7.9 |
| V | 51 | 0.000 36 | 0.002 1 | VO | 67 | 0.4 | 0.000 53 | 0.67 | 0.000 072 | 29 |
| Cr | 52 | 0.15 | 10 | CrO | 68 | 0.3 | 0.004 4 | 34 | 0.001 8 | 5700 |
| Mn | 55 | 0.001 3 | 0.015 | MnO | 71 | 0.3 | 0.002 4 | 0.56 | 0.000 93 | 17 |
| Fe | 57 | 3.5 | 65 | FeO | 73 | 0.3 | 0.036 | 98 | 0.015 | 4200 |
| Co | 59 | 0.000 79 | 0.004 8 | CoO | 75 | 0.3 | 0.001 1 | 0.74 | 0.000 23 | 21 |
| Ni | 60 | 0.002 1 | 0.007 9 | NiO | 76 | 0.3 | 0.032 | 0.067 | 0.011 | 0.75 |
| Cu | 63 | 0.000 50 | 0.005 2 | CuO | 79 | 0.3 | 0.045 | 0.011 | 0.006 1 | 0.85 |
| Zn | 66 | 0.004 0 | 0.019 | ZnO | 82 | 0.3 | 0.11 | 0.036 | 0.015 | 1.3 |
| Ge | 74 | 0.001 9 | 0.004 8 | GeO | 90 | 0.3 | 0.002 4 | 0.78 | 0.000 33 | 15 |
| As | 75 | 0.000 34 | 0.000 53 | AsO | 91 | 0.4 | 0.002 1 | 0.16 | 0.000 28 | 1.9 |
| Se | 82 | 0.036 | 0.16 | SeO | 98 | 0.4 | 0.036 | 0.98 | 0.005 | 33 |
| Br | 81 | 5.0 | 130 | BrO | 97 | 0.3 | 4.0 | 1.2 | 21 | 6.3 |
| Sr | 88 | 0.000 21 | 0.001 1 | SrO | 104 | 0.3 | 0.003 4 | 0.062 | 0.001 7 | 0.63 |
| Y | 89 | 0.000 033 | 0.000 036 | YO | 105 | 0.3 | 0.000 094 | 0.35 | 0.000 037 | 0.96 |
| Zr | 90 | 0.000 59 | 0.000 29 | ZrO | 106 | 0.3 | 0.000 44 | 1.4 | 0.000 13 | 2.3 |
| Nb | 93 | 0.000 12 | 0.000 070 | NbO | 109 | 0.3 | 0.000 23 | 0.51 | 0.000 16 | 0.45 |
| Mo | 98 | 0.000 33 | 0.000 25 | MoO | 114 | 0.3 | 0.000 73 | 0.45 | 0.000 099 | 2.5 |
| Ru | 101 | 0.001 4 | 0.006 7 | RuO | 117 | 0.4 | 0.010 | 0.14 | 0.006 2 | 1.1 |
| Rh | 103 | 0.000 12 | 0.000 17 | RhO | 119 | 0.4 | 0.002 9 | 0.042 | 0.000 40 | 0.43 |
| Pd | 105 | 0.000 29 | 0.000 38 | PdO | 121 | 0.4 | 0.19 | 0.001 5 | 0.042 | 0.009 2 |

*(Table S5 continued)*

| Element | Isotope | Standard Mode | | $O_2$ DRC Mode | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LOD (ng $g^{-1}$) | BEC (ng $g^{-1}$) | Measured Product Ion | Measured Mass | Gas Flow Rate (mL $min^{-1}$) | LOD (ng $g^{-1}$) | LOD Improvement | BEC (ng $g^{-1}$) | BEC Improvement |
| Cd | 114 | 0.000 26 | 0.000 23 | CdO | 130 | 0.3 | 0.38 | 0.000 70 | 0.051 | 0.004 5 |
| Sn | 118 | 0.000 34 | 0.000 50 | SnO | 134 | 0.3 | 0.017 | 0.019 | 0.003 7 | 0.13 |
| Sb | 121 | 0.000 72 | 0.000 96 | SbO | 137 | 0.5 | 0.006 6 | 0.11 | 0.001 3 | 0.72 |
| Te | 128 | 0.004 8 | 0.014 | TeO | 144 | 0.4 | 0.010 | 0.47 | 0.001 4 | 10 |
| I | 127 | 0.016 | 0.71 | IO | 143 | 0.5 | 0.21 | 0.076 | 0.28 | 2.6 |
| Ba | 138 | 0.000 22 | 0.000 19 | BaO | 154 | 0.4 | 0.001 6 | 0.14 | 0.000 33 | 0.57 |
| La | 139 | 0.000 055 | 0.000 034 | LaO | 155 | 0.3 | 0.000 19 | 0.30 | 0.000 069 | 0.49 |
| Ce | 140 | 0.000 083 | 0.000 040 | CeO | 156 | 0.3 | 0.000 22 | 0.38 | 0.000 094 | 0.42 |
| Pr | 141 | 0.000 015 | 0.000 027 | PrO | 157 | 0.3 | 0.000 094 | 0.16 | 0.000 050 | 0.54 |
| Nd | 143 | 0.000 47 | 0.000 14 | NdO | 159 | 0.3 | 0.001 4 | 0.34 | 0.000 33 | 0.42 |
| Sm | 147 | 0.000 13 | 0.000 029 | SmO | 163 | 0.4 | 0.000 79 | 0.17 | 0.000 24 | 0.12 |
| Eu | 153 | 0.000 032 | 0.000 004 | EuO | 169 | 0.4 | 0.000 64 | 0.050 | 0.000 087 | 0.050 |
| Gd | 155 | 0.000 77 | 0.001 4 | GdO | 171 | 0.3 | 0.002 9 | 0.27 | 0.001 5 | 0.95 |
| Tb | 159 | 0.000 13 | 0.000 29 | TbO | 175 | 0.3 | 0.000 47 | 0.28 | 0.000 30 | 0.98 |
| Dy | 163 | 0.001 5 | 0.001 4 | DyO | 179 | 0.3 | 0.002 5 | 0.59 | 0.001 5 | 0.90 |
| Ho | 165 | 0.000 17 | 0.000 27 | HoO | 181 | 0.3 | 0.000 50 | 0.35 | 0.000 24 | 1.1 |
| Er | 166 | 0.000 81 | 0.000 60 | ErO | 182 | 0.3 | 0.000 86 | 0.94 | 0.000 65 | 0.92 |
| Tm | 169 | 0.000 11 | 0.000 078 | TmO | 185 | 0.4 | 0.000 21 | 0.53 | 0.000 045 | 1.7 |
| Yb | 174 | 0.000 16 | 0.000 067 | YbO | 190 | 0.5 | 0.002 5 | 0.065 | 0.000 34 | 0.20 |
| Lu | 175 | 0.000 11 | 0.000 062 | LuO | 191 | 0.4 | 0.000 13 | 0.91 | 0.000 047 | 1.3 |
| Hf | 180 | 0.000 10 | 0.000 014 | HfO | 196 | 0.3 | 0.000 35 | 0.29 | 0.000 076 | 0.18 |
| Ta | 181 | 0.000 094 | 0.000 019 | TaO | 197 | 0.2 | 0.000 18 | 0.51 | 0.000 025 | 0.75 |
| W | 184 | 0.000 26 | 0.000 087 | WO | 200 | 0.2 | 0.000 69 | 0.38 | 0.000 094 | 0.92 |
| Re | 187 | 0.000 11 | 0.000 044 | ReO | 203 | 0.4 | 0.000 39 | 0.28 | 0.000 054 | 0.82 |
| Os | 189 | 0.000 26 | 0.000 051 | OsO | 205 | 0.4 | 0.001 3 | 0.20 | 0.000 40 | 0.13 |
| Ir | 193 | 0.000 42 | 0.000 46 | IrO | 209 | 0.5 | 0.002 5 | 0.17 | 0.001 3 | 0.36 |
| Pt | 195 | 0.001 4 | 0.000 85 | PtO | 211 | 0.6 | 0.031 | 0.045 | 0.004 3 | 0.20 |
| Au | 197 | 0.002 0 | 0.004 4 | AuO | 213 | 0.4 | 0.30 | 0.006 5 | 0.041 | 0.11 |
| Pb | 208 | 0.000 15 | 0.000 020 | PbO | 224 | 0.5 | 0.50 | 0.000 30 | 0.067 | 0.000 30 |
| Bi | 209 | 0.000 049 | 0.000 067 | BiO | 225 | 0.7 | 0.020 | 0.002 5 | 0.002 7 | 0.002 5 |
| Th | 232 | 0.000 084 | 0.000 026 | ThO | 248 | 0.2 | 0.000 16 | 0.52 | 0.000 022 | 1.2 |
| U | 238 | 0.000 063 | 0.000 014 | UO | 254 | 0.1 | 0.000 33 | 0.19 | 0.000 065 | 0.21 |

Table S6: Comparison of determined limit of detection (LOD) and background equivalence concentration (BEC) for standard mode and on-mass determinations with $N_2O$ using a Perkin Elmer NexION 5000. LODs were calculated based on 3 times the standard deviation of the blank and expressed in ng $g^{-1}$. BECs were calculated by division of the blank signal with the calibration slope and expressed in ng $g^{-1}$. Improvement in LOD and BEC are given as a factor of how much lower these parameters are when compared to standard mode. Values are presented to 2 significant figures.

| Element | Isotope | Standard Mode | | $N_2O$ DRC Mode | | | | |
|---|---|---|---|---|---|---|---|---|
| | | LOD (ng $g^{-1}$) | BEC (ng $g^{-1}$) | Gas Flow Rate (mL $min^{-1}$) | LOD (ng $g^{-1}$) | LOD Improvement | BEC (ng $g^{-1}$) | BEC Improvement |
| Na | 23 | 0.12 | 4.4 | 0.4 | 0.23 | 0.53 | 3.9 | 1.1 |
| Al | 27 | 0.001 6 | 0.019 | 0.3 | 0.003 9 | 0.41 | 0.017 | 1.1 |
| K | 39 | 0.88 | 32 | 0.5 | 0.037 | 23 | 3.6 | 9.1 |
| Cr | 52 | 0.15 | 10 | 0.3 | 0.000 80 | 180 | 0.001 8 | 5600 |
| Mn | 55 | 0.001 3 | 0.015 | 0.4 | 0.000 31 | 4.2 | 0.000 94 | 16 |
| Fe | 57 | 3.5 | 65 | 0.2 | 0.058 | 60 | 0.53 | 120 |
| Co | 59 | 0.000 79 | 0.004 8 | 0.3 | 0.000 52 | 1.5 | 0.001 2 | 4.0 |
| Ni | 60 | 0.002 1 | 0.007 9 | 0.3 | 0.002 3 | 0.92 | 0.006 3 | 1.3 |
| Cu | 63 | 0.000 50 | 0.005 2 | 0.3 | 0.000 62 | 0.81 | 0.003 4 | 1.5 |
| Zn | 66 | 0.004 | 0.019 | 0.4 | 0.004 2 | 0.96 | 0.023 | 0.85 |
| Ga | 69 | 0.000 63 | 0.001 3 | 0.5 | 0.000 92 | 0.69 | 0.000 90 | 1.5 |
| Se | 82 | 0.036 | 0.16 | 0.5 | 0.010 | 3.6 | 0.006 4 | 25 |
| Rb | 85 | 0.000 43 | 0.001 5 | 0.5 | 0.000 36 | 1.2 | 0.001 6 | 0.96 |
| Mo | 98 | 0.000 33 | 0.000 25 | 0.4 | 0.000 40 | 0.81 | 0.000 28 | 0.90 |
| Ru | 101 | 0.001 4 | 0.006 7 | 0.4 | 0.000 38 | 3.8 | 0.000 28 | 24 |
| Rh | 103 | 0.000 12 | 0.000 17 | 0.4 | 0.000 078 | 1.6 | 0.000 087 | 2.0 |
| Pd | 105 | 0.000 29 | 0.000 38 | 0.4 | 0.000 23 | 1.2 | 0.000 15 | 2.6 |
| Ag | 107 | 0.000 51 | 0.001 7 | 0.5 | 0.000 97 | 0.53 | 0.001 4 | 1.2 |
| Cd | 114 | 0.000 26 | 0.000 23 | 0.6 | 0.000 43 | 0.61 | 0.000 22 | 1.0 |
| In | 115 | 0.000 037 | 0.000 009 | 0.6 | 0.000 052 | 0.71 | 0.000 011 | 0.81 |
| Sn | 118 | 0.000 34 | 0.000 50 | 0.5 | 0.000 70 | 0.48 | 0.000 42 | 1.2 |
| Sb | 121 | 0.000 72 | 0.000 96 | 0.5 | 0.000 41 | 1.8 | 0.000 20 | 4.7 |
| Te | 128 | 0.004 8 | 0.014 | 0.7 | 0.004 9 | 1.0 | 0.013 | 1.1 |
| I | 127 | 0.016 | 0.71 | 0.6 | 0.025 | 0.63 | 0.93 | 0.77 |
| Cs | 133 | 0.000 098 | 0.000 088 | 0.6 | 0.000 22 | 0.46 | 0.000 052 | 1.7 |
| Tm | 169 | 0.000 11 | 0.000 078 | 0.5 | 0.000 30 | 0.37 | 0.000 11 | 0.72 |
| Yb | 174 | 0.000 16 | 0.000 067 | 0.6 | 0.000 18 | 0.90 | 0.000 039 | 1.7 |
| Re | 187 | 0.000 11 | 0.000 044 | 0.8 | 0.000 10 | 1.1 | 0.000 020 | 2.2 |
| Au | 197 | 0.002 0 | 0.004 4 | 0.6 | 0.000 77 | 2.6 | 0.000 39 | 11 |
| Hg | 202 | 0.006 0 | 0.006 1 | 0.8 | 0.004 5 | 1.3 | 0.001 1 | 5.7 |
| Tl | 205 | 0.000 46 | 0.000 31 | 0.8 | 0.000 83 | 0.56 | 0.000 79 | 0.40 |
| Pb | 208 | 0.000 15 | 0.000 020 | 0.8 | 0.000 078 | 1.9 | 0.000 27 | 0.076 |
| Bi | 209 | 0.000 049 | 0.000 007 | 0.9 | 0.000 092 | 0.53 | 0.000 047 | 0.14 |

Table S7: Maximum obtained formation of product ions resulting from charge transfer reactions for selected elements. Flow rates of $N_2O$ provided are at the optimum formation using a Perkin Elmer NexION 5000.

| Element | Isotope | $NO^+$ ($m/z$ = 30) | | $O_2^+$ ($m/z$ = 32) | | $N_2O^+$ ($m/z$ = 44) | |
|---|---|---|---|---|---|---|---|
| | | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) | Formation (%) | Flow Rate (mL $min^{-1}$) |
| Be | 9 | 0.28 | 0.4 | 0.01 | 0.7 | 0.12 | 0.9 |
| B | 11 | 5.5 | 0.4 | 3.2 | 1.2 | 19 | 0.3 |
| Al | 27 | 0.01 | 1.1 | <0.01 | - | 0.01 | 0.2 |
| Si | 29 | 7.3 | 0.3 | 28 | 0.7 | 23 | 0.4 |
| P | 31 | 16 | 0.4 | 1.9 | 0.9 | 12 | 0.3 |
| S | 34 | 12 | 0.5 | 6.2 | 1.3 | 5.5 | 0.4 |
| Cl | 35 | 0.88 | 0.1 | 0.76 | 0.5 | 50 | 0.1 |
| Ge | 74 | <0.01 | - | <0.01 | - | 0.19 | 0.2 |
| As | 75 | 0.04 | 0.2 | <0.01 | - | 0.57 | 0.2 |
| Se | 82 | 0.02 | 0.2 | <0.01 | - | 0.12 | 0.1 |
| Br | 81 | 0.07 | 0.1 | <0.01 | - | 0.60 | 0.1 |