# Supplementary Material for "Sources and effects of fluids in continental retrograde shear zones: Insights from the Kuckaus Mylonite Zone, Namibia"

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**Additional Supporting Information (File uploaded separately)**

1. Caption for Table S4

**Introduction** Supporting information includes additional isocon graphs (Figure S1), a table of samples with $\delta^{18}O$, aluminium saturation index, and rocktype (Table S1), a table of bulk rock major- and trace element compositions (Table S2) and a table of changes in element concentrations and mass (Table S3). An additional table to support Figure 11 is provided as a .xlsx file (Table S4).

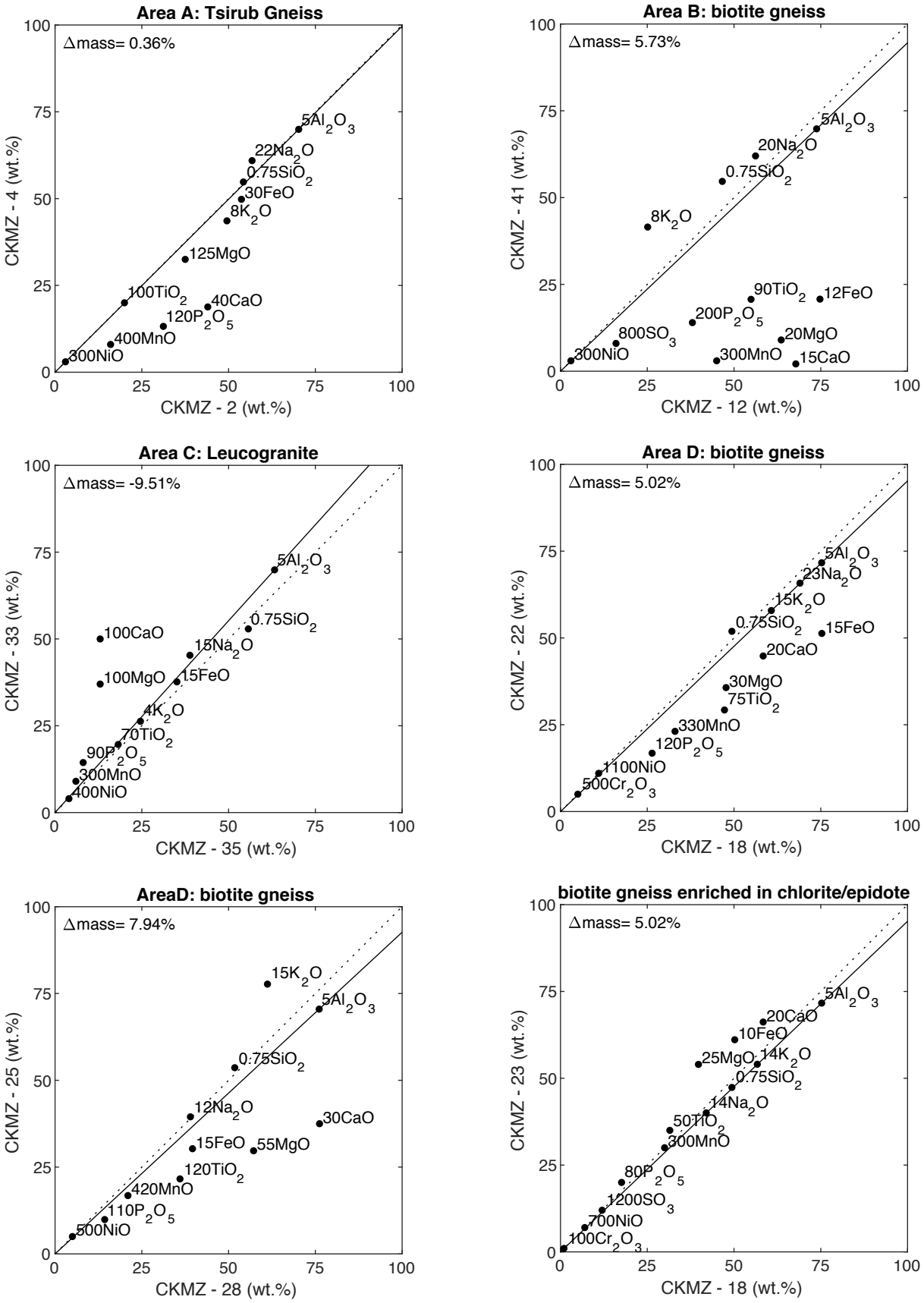


Figure S1: Additional isocon graphs.

**Table S1**

**Whole rock oxygen isotope compositions**

| CKMZ | Area | ASI | $\delta^{18}O$ (‰) | Protolith | Description | Latitude (S), Longitude (E) |
|---|---|---|---|---|---|---|
| 2 | A | 1.08 | 9.8 | Tsirub Gneiss | Migmatitic | 026°48'05.8", 015°57'21.0" |
| 3 | A | 1.22 | 9.6 | Tsirub Gneiss | Protomylonite | 026°48'06.6", 015°57'20.3" |
| 4 | A | 1.24 | 8.9 | Tsirub Gneiss | Ultramylonite | 026°48'07.1", 015°57'20.2" |
| 5 | A | 1.21 | 8.3 | Leucogranite | Brittle deformation | 026°48'06.9", 015°57'19.3" |
| 7 | A | 1.14 | 5.4 | Leucogranite | Brittle deformation | 026°48'07.0", 015°57'19.1" |
| 8 | A | 1.06 | 8.4 | Leucogranite | Mylonite | 026°48'06.4", 015°57'17.7" |
| 9 | A | 0.93 | 9.0 | biotite gneiss | Protomylonite (green) | 026°48'06.7", 015°57'17.7" |
| 10 | A | 1.10 | 10.0 | biotite gneiss | Ultramylonite | 026°48'06.7", 015°57'17.9" |
| 11 | A | 1.15 | 8.8 | biotite gneiss | Protomylonite (pink) | 026°48'07.0", 015°57'18.3" |
| 12 | A | 0.91 | 9.0 | biotite gneiss | Migmatitic | 026°48'06.9", 015°57'16.4" |
| 39 | B | 1.17 | 9.3 | biotite gneiss | Protomylonite | 026°48'29.4", 015°57'48.1" |
| 40 | B | 1.11 | 8.2 | biotite gneiss | Mylonite | 026°48'29.7", 015°57'48.9" |
| 41 | B | 1.27 | 8.8 | biotite gneiss | Ultramylonite | 026°48'28.5", 015°57'48.7" |
| 42 | B | 1.30 | 9.3 | Leucogranite | Ultramylonite | 026°48'28.4", 015°57'48.7" |
| 43 | B | 1.11 | 8.5 | Leucogranite | Mylonite | 026°48'28.6", 015°57'49.0" |
| 44 | B | 1.24 | 10.6 | Leucogranite | Protomylonite | 026°48'28.4", 015°57'49.0" |
| 46 | B | 1.11 | 7.1 | biotite gneiss | Mylonite (pink) | 026°48'29.7", 015°57'50.0" |
| 47 | B | 1.53 | 11.5 | Leucogranite | Undeformed | 026°48'26.3", 015°57'52.4" |
| 31 | C | 1.17 | 13.1 | Tsirub Gneiss | Protomylonite | 026°48'32.4", 015°58'04.3" |
| 32 | C | 1.15 | 11.5 | Tsirub Gneiss | Mylonite | 026°48'32.4", 015°58'04.3" |
| 33 | C | 1.08 | 11.8 | Leucogranite | Ultramylonite | 026°48'32.4", 015°58'04.3" |
| 34 | C | 1.17 | 12.1 | Leucogranite | Mylonite | 026°48'32.4", 015°58'04.3" |
| 35 | C | 1.13 | 12.6 | Leucogranite | Protomylonite | 026°48'32.4", 015°58'04.3" |
| 18 | D | 1.03 | 8.6 | biotite gneiss | Migmatitic | 026°49'12.4", 015°58'30.0" |
| 19 | D | 1.07 | 7.7 | biotite gneiss | Migmatitic | 026°49'12.4", 015°58'30.0" |
| 20 | D | 1.06 | 8.8 | biotite gneiss | Protomylonite | 026°49'12.4", 015°58'30.0" |
| 21 | D | 1.09 | 9.2 | biotite gneiss | Protomylonite | 026°49'12.5", 015°58'29.9" |
| 22 | D | 1.11 | 9.3 | biotite gneiss | Protomylonite | 026°49'12.5", 015°58'29.9" |
| 23 | D | 1.08 | 9.4 | biotite gneiss | Mylonite (green) | 026°49'12.5", 015°58'29.9" |
| 24 | D | 1.03 | 9.4 | biotite gneiss | Ultramylonite | 026°49'12.5", 015°58'29.9" |
| 25 | D | 1.06 | 9.5 | biotite gneiss | Ultramylonite | 026°49'12.5", 015°58'29.9" |
| 26 | D | 1.08 | 9.3 | biotite gneiss | Ultramylonite | 026°49'12.5", 015°58'29.9" |
| 27 | D | 1.09 | 10.0 | biotite gneiss | Mylonite | 026°49'12.5", 015°58'29.9" |
| 28 | D | 1.06 | 9.0 | biotite gneiss | Migmatitic | 026°49'12.6", 015°58'29.9" |
| 29 | D | 1.08 | 9.9 | biotite gneiss | Protomylonite | 026°49'12.6", 015°58'29.9" |

**Quartz oxygen isotope compositions**

| CKMZ | Area | $\delta^{18}O$ (‰) | Host rock | Description | Latitude (S), Longitude (E) |
|---|---|---|---|---|---|
| 6 | A | -1.2 | Leucogranite | Quartz vein | 026°48'07.2", 015°57'19.1" |
| 13 | - | 11.6 | Leucogranite | Quartz vein | 026°48'55.5", 015°58'33.9" |
| 38 | B | 4.2 | biotite gneiss | Quartz vein | 026°48'29.4", 015°57'48.1" |
| 45 | B | 8.4 | biotite gneiss | Quartz vein | 026°48'29.7", 015°57'50.0" |
| 36 | C | 9.8 | Tsirub Gneiss | Quartz vein | 026°48'32.4", 015°58'04.3" |
| 20 | D | 9.0 | biotite gneiss | Quartz vein | 026°49'12.4", 015°58'30.0" |
| 30 | D | 10.3 | biotite gneiss | Quartz vein | 026°48'58.9", 015°58'32.3" |
| 48 | - | 11.2 | Tsirub Gneiss | Quartz vein | 026°48'23.2", 015°57'57.9" |
| 49 | D | 9.0 | biotite gneiss | Quartz vein | 026°48'23.2", 015°57'57.9" |

**Table S2**

| Area | A | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 12 |
| (wt.%) | | | | | | | | | | |
| $SiO_2$ | 72.35 | 74.38 | 73.06 | 77.25 | 75.01 | 72.85 | 63.64 | 70.98 | 73.57 | 62.16 |
| $TiO_2$ | 0.20 | 0.13 | 0.20 | 0.05 | 0.07 | 0.05 | 0.63 | 0.28 | 0.11 | 0.61 |
| $Al_2O_3$ | 14.04 | 13.90 | 13.99 | 12.53 | 12.83 | 15.04 | 14.55 | 13.92 | 13.81 | 14.76 |
| $Fe_2O_3$ | 1.79 | 1.31 | 1.66 | 0.76 | 0.78 | 0.77 | 5.18 | 2.39 | 0.78 | 6.23 |
| MnO | 0.04 | 0.03 | 0.02 | 0.03 | 0.01 | 0.01 | 0.15 | 0.02 | 0.01 | 0.15 |
| MgO | 0.30 | 0.25 | 0.26 | 0.07 | 0.15 | -0.02 | 2.84 | 0.35 | 0.19 | 3.18 |
| CaO | 1.10 | 0.66 | 0.47 | 0.09 | 0.06 | 0.09 | 3.96 | 0.85 | 0.17 | 4.52 |
| $Na_2O$ | 2.58 | 3.37 | 2.77 | 2.84 | 0.28 | 6.49 | 2.76 | 2.44 | 2.24 | 2.81 |
| $K_2O$ | 6.19 | 4.29 | 5.45 | 5.07 | 9.92 | 3.08 | 3.68 | 6.51 | 7.46 | 3.14 |
| $P_2O_5$ | 0.26 | 0.11 | 0.11 | 0.05 | 0.02 | 0.02 | 0.23 | 0.10 | 0.03 | 0.19 |
| $SO_3$ | - | - | - | - | - | - | 0.01 | - | - | 0.02 |
| $Cr_2O_3$ | - | - | - | - | - | - | 0.02 | - | 0.02 | 0.01 |
| NiO | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 |
| $H_2O^-$ | 0.20 | 0.23 | 0.31 | 0.15 | 0.15 | 0.22 | 0.12 | 0.19 | 0.05 | 0.08 |
| LOI | 0.62 | 0.84 | 1.09 | 0.54 | 0.60 | 0.43 | 1.34 | 0.90 | 0.62 | 1.17 |
| Total | 99.67 | 99.52 | 99.41 | 99.45 | 99.90 | 99.04 | 99.12 | 98.95 | 99.08 | 99.04 |
| (ppm) | | | | | | | | | | |
| Zn | 38 | | 25 | | | | | 20 | | 68 |
| Cu | <5 | | <5 | | | | | 16 | | <5 |
| Ni | <5 | | <5 | | | | | <5 | | 14 |
| Mo | <5 | | <5 | | | | | <5 | | <5 |
| Nb | 11 | | 12 | | | | | 12 | | 17 |
| Zr | 125 | | 151 | | | | | 274 | | 182 |
| Y | 17 | | 53 | | | | | 10 | | 51 |
| Sr | 125 | | 143 | | | | | 244 | | 406 |
| Rb | 225 | | 183 | | | | | 181 | | 112 |
| U | <5 | | <5 | | | | | <5 | | <5 |
| Th | 15 | | 37 | | | | | 41 | | 12 |
| Pb | 40 | | 42 | | | | | 42 | | 17 |
| Co | <5 | | <5 | | | | | <5 | | 18 |
| Mn | 270 | | 185 | | | | | 185 | | 1237 |
| Cr | 18 | | 16 | | | | | 15 | | 90 |
| V | 24 | | 19 | | | | | 34 | | 120 |
| F | 393 | | 362 | | | | | 314 | | 881 |
| S | 289 | | 358 | | | | | 275 | | 367 |
| Cl | 142 | | 107 | | | | | 112 | | 168 |
| Sc | 5 | | 6 | | | | | 5 | | 20 |
| Ba | 598 | | 597 | | | | | 1291 | | 950 |

**Table S2 (cont.)**

| Area | B | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample | 39 | 39 | 40 | 41 | 42 | 43 | 44 | 46 | 47 |
| (wt.%) | | | | | | | | | |
| $SiO_2$ | 88.78 | 88.75 | 71.70 | 72.89 | 72.21 | 76.30 | 77.34 | 71.34 | 79.80 |
| $TiO_2$ | 0.14 | 0.13 | 0.29 | 0.23 | 0.28 | 0.14 | 0.13 | 0.07 | 0.30 |
| $Al_2O_3$ | 4.84 | 4.56 | 13.80 | 13.96 | 14.18 | 11.78 | 11.33 | 15.22 | 9.12 |
| $Fe_2O_3$ | 1.43 | 1.34 | 2.36 | 1.73 | 2.28 | 1.22 | 1.62 | 0.61 | 2.56 |
| MnO | 0.02 | 0.02 | 0.03 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 |
| MgO | 0.18 | 0.20 | 0.55 | 0.34 | 0.45 | 0.37 | 0.28 | 0.24 | 0.41 |
| CaO | 0.15 | 0.15 | 0.31 | 0.14 | 0.10 | 0.24 | 0.10 | 0.11 | 0.14 |
| $Na_2O$ | 0.75 | 0.76 | 3.24 | 3.10 | 3.47 | 2.01 | 0.97 | 3.33 | 0.25 |
| $K_2O$ | 2.35 | 2.21 | 6.05 | 5.19 | 4.61 | 6.32 | 6.79 | 7.44 | 4.90 |
| $P_2O_5$ | 0.07 | 0.07 | 0.10 | 0.07 | 0.04 | 0.18 | 0.10 | 0.04 | 0.15 |
| $SO_3$ | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| $Cr_2O_3$ | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NiO | 0.06 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $H_2O^-$ | 0.02 | 0.07 | 0.07 | 0.12 | 0.17 | 0.06 | 0.08 | 0.08 | 0.10 |
| LOI | 0.53 | 0.58 | 0.73 | 1.38 | 1.40 | 0.66 | 0.79 | 0.58 | 1.15 |
| Total | 99.36 | 98.86 | 99.24 | 99.17 | 99.22 | 99.31 | 99.56 | 99.10 | 98.92 |
| (ppm) | | | | | | | | | |
| Zn | 10 | 10 | 26 | 23 | 31 | | | | 42 |
| Cu | 6 | 6 | <5 | <5 | <5 | | | | <5 |
| Ni | <5 | <5 | <5 | <5 | <5 | | | | <5 |
| Mo | <5 | <5 | <5 | <5 | <5 | | | | <5 |
| Nb | <5 | <5 | 13 | 15 | 16 | | | | 18 |
| Zr | 123 | 123 | 278 | 177 | 240 | | | | 151 |
| Y | 8 | 8 | 35 | 39 | 37 | | | | 12 |
| Sr | 46 | 46 | 126 | 89 | 87 | | | | 59 |
| Rb | 73 | 73 | 175 | 250 | 237 | | | | 248 |
| U | <5 | <5 | 8 | <5 | 5 | | | | <5 |
| Th | <5 | <5 | 86 | 42 | 55 | | | | 22 |
| Pb | 16 | 16 | 47 | 27 | 30 | | | | 26 |
| Co | <5 | <5 | <5 | <5 | <5 | | | | <5 |
| Mn | 160 | 160 | 246 | 78 | 114 | | | | 249 |
| Cr | 39 | 39 | 13 | 10 | 13 | | | | 32 |
| V | 19 | 19 | 30 | 27 | 34 | | | | 23 |
| F | 395 | 395 | 369 | 358 | 361 | | | | 465 |
| S | 411 | 411 | 267 | 459 | 308 | | | | 276 |
| Cl | 230 | 230 | 105 | 100 | 97 | | | | 93 |
| Sc | 5 | 5 | 6 | 5 | 6 | | | | <5 |
| Ba | 383 | 383 | 751 | 546 | 638 | | | | 519 |

**Table S2 (cont.)**

| Area | C | | | | |
|---|---|---|---|---|---|
| Sample | 31 | 32 | 33 | 34 | 35 |
| (wt.%) | | | | | |
| $SiO_2$ | 66.36 | 71.58 | 70.52 | 72.25 | 74.25 |
| $TiO_2$ | 0.54 | 0.34 | 0.28 | 0.27 | 0.26 |
| $Al_2O_3$ | 15.03 | 13.53 | 13.98 | 13.59 | 12.65 |
| $Fe_2O_3$ | 4.15 | 2.69 | 2.51 | 2.05 | 2.34 |
| MnO | 0.07 | 0.05 | 0.03 | 0.02 | 0.02 |
| MgO | 1.11 | 0.63 | 0.37 | 0.38 | 0.13 |
| CaO | 1.51 | 0.45 | 0.50 | 0.38 | 0.13 |
| $Na_2O$ | 2.75 | 3.24 | 3.02 | 3.02 | 2.59 |
| $K_2O$ | 5.13 | 5.22 | 6.57 | 5.51 | 6.15 |
| $P_2O_5$ | 0.28 | 0.07 | 0.16 | 0.08 | 0.09 |
| $SO_3$ | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| $Cr_2O_3$ | 0.02 | 0.00 | - | - | 0.00 |
| NiO | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| $H_2O^-$ | 0.19 | 0.18 | 0.12 | 0.24 | 0.12 |
| LOI | 1.79 | 1.29 | 0.81 | 1.08 | 0.76 |
| Total | 98.95 | 99.29 | 98.89 | 98.89 | 99.50 |
| (ppm) | | | | | |
| Zn | 55 | | 28 | | 12 |
| Cu | 19 | | <5 | | <5 |
| Ni | 5 | | <5 | | <5 |
| Mo | <5 | | <5 | | <5 |
| Nb | 29 | | 12 | | 16 |
| Zr | 191 | | 310 | | 134 |
| Y | 29 | | 29 | | 15 |
| Sr | 161 | | 125 | | 69 |
| Rb | 202 | | 219 | | 220 |
| U | <5 | | <5 | | <5 |
| Th | 10 | | 67 | | 25 |
| Pb | 31 | | 38 | | 31 |
| Co | <5 | | <5 | | <5 |
| Mn | 587 | | 206 | | 116 |
| Cr | 53 | | 10 | | 17 |
| V | 55 | | 27 | | 29 |
| F | 661 | | 385 | | 353 |
| S | 329 | | 276 | | 326 |
| Cl | 138 | | 104 | | 122 |
| Sc | 12 | | 5 | | 5 |
| Ba | 742 | | 899 | | 780 |

**Table S2 (cont.)**

| Area | D | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| (wt.%) | | | | | | | | | | | | |
| $SiO_2$ | 65.85 | 68.17 | 69.10 | 61.98 | 69.21 | 63.15 | 68.44 | 71.50 | 70.54 | 70.41 | 69.04 | 68.40 |
| $TiO_2$ | 0.63 | 0.39 | 0.29 | 0.89 | 0.39 | 0.70 | 0.40 | 0.18 | 0.18 | 0.34 | 0.30 | 0.28 |
| $Al_2O_3$ | 15.05 | 14.67 | 15.00 | 14.83 | 14.33 | 15.49 | 14.58 | 14.10 | 14.72 | 14.10 | 15.22 | 15.12 |
| $Fe_2O_3$ | 5.02 | 3.59 | 2.95 | 7.79 | 3.42 | 6.11 | 3.61 | 2.02 | 2.03 | 3.00 | 2.64 | 2.42 |
| MnO | 0.10 | 0.07 | 0.05 | 0.12 | 0.07 | 0.10 | 0.07 | 0.04 | 0.04 | 0.06 | 0.05 | 0.05 |
| MgO | 1.59 | 1.45 | 1.01 | 2.32 | 1.19 | 2.16 | 1.23 | 0.54 | 0.56 | 1.14 | 1.04 | 0.85 |
| CaO | 2.92 | 2.20 | 2.74 | 2.45 | 2.24 | 3.31 | 2.17 | 1.25 | 1.26 | 2.22 | 2.54 | 1.16 |
| $Na_2O$ | 3.00 | 3.19 | 3.29 | 2.62 | 2.86 | 3.30 | 4.66 | 3.29 | 3.31 | 2.96 | 3.25 | 2.50 |
| $K_2O$ | 4.05 | 4.13 | 3.47 | 4.49 | 3.86 | 2.69 | 2.36 | 5.18 | 5.51 | 3.75 | 4.08 | 7.22 |
| $P_2O_5$ | 0.22 | 0.14 | 0.13 | 0.13 | 0.14 | 0.25 | 0.18 | 0.09 | 0.09 | 0.13 | 0.13 | 0.15 |
| $SO_3$ | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | - |
| $Cr_2O_3$ | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.03 | 0.00 | 0.00 | 0.01 | - | 0.00 |
| NiO | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $H_2O^-$ | 0.10 | 0.09 | 0.09 | 0.12 | 0.10 | 0.14 | 0.12 | 0.10 | 0.12 | 0.12 | 0.09 | 0.12 |
| LOI | 0.77 | 1.24 | 1.01 | 1.56 | 1.06 | 1.68 | 1.21 | 0.76 | 0.83 | 1.11 | 1.07 | 0.97 |
| Total | 99.34 | 99.35 | 99.15 | 99.34 | 98.90 | 99.11 | 99.06 | 99.04 | 99.20 | 99.36 | 99.46 | 99.24 |
| (ppm) | | | | | | | | | | | | |
| Zn | 59 | | | | | | 41 | | | | 34 | |
| Cu | 37 | | | | | | 5 | | | | <5 | |
| Ni | 14 | | | | | | <5 | | | | <5 | |
| Mo | <5 | | | | | | <5 | | | | <5 | |
| Nb | 22 | | | | | | 11 | | | | 8 | |
| Zr | 151 | | | | | | 149 | | | | 126 | |
| Y | 54 | | | | | | 16 | | | | 7 | |
| Sr | 372 | | | | | | 297 | | | | 414 | |
| Rb | 176 | | | | | | 115 | | | | 152 | |
| U | <5 | | | | | | <5 | | | | <5 | |
| Th | 17 | | | | | | 11 | | | | 8 | |
| Pb | 17 | | | | | | 12 | | | | 17 | |
| Co | 10 | | | | | | 5 | | | | <5 | |
| Mn | 812 | | | | | | 543 | | | | 399 | |
| Cr | 48 | | | | | | 36 | | | | 27 | |
| V | 91 | | | | | | 54 | | | | 59 | |
| F | 761 | | | | | | 452 | | | | 428 | |
| S | 322 | | | | | | 281 | | | | 282 | |
| Cl | 137 | | | | | | 112 | | | | 113 | |
| Sc | 11 | | | | | | 8 | | | | <5 | |
| Ba | 1195 | | | | | | 684 | | | | 1355 | |

**Table S3**

**Area A** Absolute change in concentration (%) (after Spruzeniece and Piazolo, 2015)

| | Against 2 | | Against 47 | | | Against 12 | | |
|---|---|---|---|---|---|---|---|---|
| Sample | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 |
| $SiO_2$ | 3.8 | 1.3 | -29.5 | -33.2 | -44.6 | 3.8 | 21.0 | 26.5 |
| $TiO_2$ | -32.3 | 0.2 | -88.5 | -82.3 | -89.2 | 4.9 | -51.0 | -80.2 |
| $Al_2O_3$ | | | | | | | | |
| $Fe_2O_3$ | -26.4 | -6.7 | -78.3 | -78.3 | -81.7 | -15.7 | -59.4 | -86.7 |
| MnO | -19.4 | -34.5 | -29.0 | -71.8 | -87.0 | 0.5 | -84.4 | -92.8 |
| MgO | -16.1 | -13.5 | -87.7 | -73.1 | -102.3 | -9.7 | -88.3 | -93.5 |
| CaO | -39.4 | -57.6 | -54.0 | -71.9 | -59.4 | -11.2 | -80.0 | -96.1 |
| $Na_2O$ | 32.3 | 8.1 | 725.6 | -20.2 | 1468.5 | -0.3 | -7.9 | -15.0 |
| $K_2O$ | -30.0 | -11.8 | -24.7 | 44.0 | -61.9 | 18.8 | 119.6 | 153.6 |
| $P_2O_5$ | -54.8 | -56.9 | -74.6 | -93.0 | -92.4 | 20.4 | -42.4 | -82.5 |
| $SO_3$ | | | | | | -62.0 | | |
| $Cr_2O_3$ | | | | | | 60.2 | | 79.2 |
| NiO | -45.8 | -46.3 | -16.3 | -28.5 | -38.9 | 89.8 | -7.1 | 343.5 |
| $H_2O^-$ | 15.3 | 57.9 | 10.3 | 8.9 | 35.6 | 65.9 | 159.1 | -23.3 |
| LOI | 37.9 | 77.4 | -66.1 | -62.8 | -77.4 | 15.9 | -19.0 | -43.9 |
| Zn | | -32.4 | | | | | -69.2 | |
| Cu | | | | | | | | |
| Ni | | | | | | | | |
| Mo | | | | | | | | |
| Nb | | 2.4 | | | | | -25.1 | |
| Zr | | 20.6 | | | | | 60.1 | |
| Y | | 220.1 | | | | | -80.0 | |
| Sr | | 15.0 | | | | | -36.4 | |
| Rb | | -18.5 | | | | | 72.4 | |
| U | | | | | | | | |
| Th | | 156.0 | | | | | 268.5 | |
| Pb | | 5.0 | | | | | 156.1 | |
| Co | | | | | | | | |
| Mn | | -31.4 | | | | | -84.1 | |
| Cr | | -15.6 | | | | | -82.4 | |
| V | | -20.6 | | | | | -69.5 | |
| F | | -7.6 | | | | | -62.2 | |
| S | | 24.5 | | | | | -20.6 | |
| Cl | | -24.3 | | | | | -29.1 | |
| Sc | | 23.5 | | | | | -74.9 | |
| Ba | | 0.2 | | | | | 44.0 | |

Total mass change (%) (after Spruzeniece and Piazolo, 2015)

| Sample | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|
| Mass change (%) | 1.0 | 0.3 | -27.2 | -28.9 | -39.4 | 1.4 | 6.0 | 6.9 |

**Table S3 (cont.)**

**Area B** Absolute change in concentration (%) (after Spruzeniece and Piazolo, 2015)

| | Against 12 | | | Against 47 | | |
|---|---|---|---|---|---|---|
| Sample | 40 | 46 | 41 | 42 | 43 | 44 |
| $SiO_2$ | 23.4 | 11.3 | 24.0 | -41.8 | -26.0 | -22.0 |
| $TiO_2$ | -48.1 | -88.4 | -59.2 | -39.7 | -62.7 | -64.0 |
| $Al_2O_3$ | | | | | | |
| $Fe_2O_3$ | -59.4 | -90.5 | -70.6 | -42.9 | -63.0 | -49.1 |
| MnO | -79.2 | -80.8 | -92.3 | -70.6 | -49.0 | -45.3 |
| MgO | -81.4 | -92.8 | -88.6 | -28.7 | -30.5 | -45.5 |
| CaO | -92.6 | -97.5 | -96.8 | -54.7 | 31.1 | -43.2 |
| $Na_2O$ | 23.3 | 15.0 | 16.5 | 788.8 | 520.7 | 210.6 |
| $K_2O$ | 105.8 | 129.4 | 74.6 | -39.5 | 0.0 | 11.7 |
| $P_2O_5$ | -42.9 | -78.5 | -63.4 | -82.2 | -9.9 | -46.4 |
| $SO_3$ | -120.1 | -93.8 | -47.3 | 94.2 | -180.1 | -72.7 |
| $Cr_2O_3$ | -91.1 | -108.3 | -82.4 | -83.8 | -80.0 | -59.0 |
| NiO | -6.0 | -25.4 | -21.0 | -35.3 | -19.9 | -6.3 |
| $H_2O^-$ | 1.5 | 6.5 | 62.8 | 11.2 | -51.5 | -34.8 |
| LOI | -33.8 | -52.0 | 24.3 | -21.4 | -55.7 | -44.7 |
| Zn | -58.3 | | -64.8 | -51.6 | | |
| Cu | | | | | | |
| Ni | | | | | | |
| Mo | | | | | | |
| Nb | -16.0 | | -4.9 | -40.7 | | |
| Zr | 63.7 | | 2.7 | 2.1 | | |
| Y | -27.6 | | -20.5 | 97.5 | | |
| Sr | -66.9 | | -76.7 | -4.5 | | |
| Rb | 68.0 | | 136.7 | -38.7 | | |
| U | | | | | | |
| Th | 688.2 | | 280.7 | 64.2 | | |
| Pb | 188.2 | | 66.3 | -25.7 | | |
| Co | | | | | | |
| Mn | -78.7 | | -93.3 | -70.5 | | |
| Cr | -84.5 | | -88.5 | -73.2 | | |
| V | -73.4 | | -76.0 | -6.2 | | |
| F | -55.2 | | -57.1 | -50.0 | | |
| S | -22.3 | | 32.3 | -28.1 | | |
| Cl | -32.9 | | -37.1 | -33.4 | | |
| Sc | -67.9 | | -74.5 | | | |
| Ba | -15.5 | | -39.2 | -21.0 | | |

Total mass change (%) (after Spruzeniece and Piazolo, 2015)

| Sample | 40 | 46 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|
| Mass change (%) | 6.9 | -3.0 | 5.7 | -35.7 | -22.6 | -19.5 |

**Table S3 (cont.)**

**Area C** Absolute change in concentration (%) (after Spruzeniece and Piazolo, 2015)

| | Against 31 | | Against 35 | |
|---|---|---|---|---|
| Sample | 32 | 33 | 33 | 34 |
| $SiO_2$ | 19.9 | 14.2 | -14.1 | -9.4 |
| $TiO_2$ | -29.1 | -42.9 | -2.9 | -5.3 |
| $Al_2O_3$ | | | | |
| $Fe_2O_3$ | -27.8 | -34.9 | -3.0 | -18.3 |
| MnO | -29.2 | -56.5 | 61.3 | 5.8 |
| MgO | -37.0 | -64.5 | 155.0 | 173.3 |
| CaO | -67.0 | -64.4 | 249.9 | 174.0 |
| $Na_2O$ | 30.6 | 17.9 | 5.4 | 8.7 |
| $K_2O$ | 13.3 | 37.8 | -3.5 | -16.6 |
| $P_2O_5$ | -72.2 | -37.2 | 60.3 | -17.2 |
| $SO_3$ | 285.5 | -154.3 | -192.1 | 41.0 |
| $Cr_2O_3$ | -87.0 | | | |
| NiO | -41.3 | -49.3 | 7.5 | -6.0 |
| $H_2O^-$ | 0.9 | -33.7 | -8.1 | 86.2 |
| LOI | -19.9 | -51.0 | -2.5 | 33.4 |
| Zn | | -45.5 | 115.6 | |
| Cu | | | | |
| Ni | | | | |
| Mo | | | | |
| Nb | | -53.7 | -30.9 | |
| Zr | | 74.8 | 110.0 | |
| Y | | 7.8 | 76.6 | |
| Sr | | -16.2 | 63.1 | |
| Rb | | 16.1 | -10.0 | |
| U | | | | |
| Th | | 630.6 | 142.7 | |
| Pb | | 29.9 | 12.1 | |
| Co | | | | |
| Mn | | -62.3 | 60.7 | |
| Cr | | -80.3 | -48.9 | |
| V | | -48.1 | -15.7 | |
| F | | -37.4 | -1.4 | |
| S | | -9.9 | -23.5 | |
| Cl | | -18.9 | -22.9 | |
| Sc | | -53.3 | 4.2 | |
| Ba | | 30.3 | 4.2 | |

Total mass change (%) (after Spruzeniece and Piazolo, 2015)

| Sample | 32 | 33 | 33 | 34 |
|---|---|---|---|---|
| Mass change (%) | 11.1 | 7.5 | -9.6 | -6.9 |

**Table S3 (cont.)**

**Area D** Absolute change in concentration (%) (after Spruzeniece and Piazolo, 2015)

| | Against 18 | | | | | Against 28 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 29 |
| $SiO_2$ | 6.2 | 5.3 | -4.5 | 10.3 | -6.8 | 3.5 | 11.8 | 10.0 | 10.0 | -0.3 |
| $TiO_2$ | -36.7 | -54.4 | 43.0 | -35.5 | 7.8 | 38.4 | -35.2 | 22.5 | 22.5 | -6.9 |
| $Al_2O_3$ | | | | | | | | | | |
| $Fe_2O_3$ | -26.6 | -41.1 | 57.4 | -28.5 | 18.2 | 42.8 | -17.5 | 22.7 | 22.7 | -7.7 |
| MnO | -26.0 | -45.6 | 18.1 | -23.5 | -1.4 | 47.6 | -22.2 | 40.3 | 40.3 | 0.7 |
| MgO | -6.4 | -36.3 | 48.4 | -21.0 | 31.9 | 24.2 | -44.0 | 18.3 | 18.3 | -17.5 |
| CaO | -22.5 | -5.7 | -14.9 | -19.3 | 10.3 | -11.0 | -46.9 | -5.9 | -5.9 | -54.2 |
| $Na_2O$ | 9.2 | 9.9 | -11.4 | 0.2 | 6.9 | 49.8 | 9.3 | -1.6 | -1.6 | -22.7 |
| $K_2O$ | 4.5 | -14.0 | 12.3 | 0.1 | -35.5 | -39.5 | 37.1 | -0.8 | -0.8 | 78.0 |
| $P_2O_5$ | -36.9 | -41.0 | -42.8 | -34.7 | 11.2 | 44.9 | -27.7 | 6.9 | 6.9 | 20.2 |
| $SO_3$ | -59.2 | 20.7 | -9.5 | -89.6 | -51.7 | -120.5 | -36.0 | -79.0 | -79.0 | |
| $Cr_2O_3$ | -10.7 | -62.3 | 126.4 | -21.9 | -15.4 | | | | | |
| NiO | -23.4 | -24.6 | -7.8 | -30.6 | -19.4 | 32.0 | 6.7 | 20.3 | 20.3 | 15.1 |
| $H_2O^-$ | -12.1 | -13.1 | 15.4 | -0.8 | 34.7 | 37.8 | 16.8 | 40.1 | 40.1 | 28.6 |
| LOI | 63.9 | 31.1 | 104.9 | 44.5 | 110.9 | 17.6 | -23.8 | 11.6 | 11.6 | -9.0 |
| Zn | | | | | | 26.9 | | | | |
| Cu | | | | | | | | | | |
| Ni | | | | | | | | | | |
| Mo | | | | | | | | | | |
| Nb | | | | | | 50.0 | | | | |
| Zr | | | | | | 22.8 | | | | |
| Y | | | | | | 151.4 | | | | |
| Sr | | | | | | -25.1 | | | | |
| Rb | | | | | | -21.1 | | | | |
| U | | | | | | | | | | |
| Th | | | | | | 50.5 | | | | |
| Pb | | | | | | -26.8 | | | | |
| Co | | | | | | | | | | |
| Mn | | | | | | 41.9 | | | | |
| Cr | | | | | | 39.7 | | | | |
| V | | | | | | -3.7 | | | | |
| F | | | | | | 10.2 | | | | |
| S | | | | | | 4.0 | | | | |
| Cl | | | | | | 3.8 | | | | |
| Sc | | | | | | | | | | |
| Ba | | | | | | -47.4 | | | | |

Total mass change (%) (after Spruzeniece and Piazolo, 2015)

| Sample | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mass change (%) | 2.6 | 0.3 | 1.4 | 5.0 | -2.9 | 4.4 | 7.9 | 3.4 | 7.9 | 0.6 |

**Table S4** This table is available as a .xlsx file and contains para- and orthogneiss whole-rock $\delta^{18}$O values used for Figure 11 (Beckinsale, Evans, Thorpe, Gibbons, & Harmon, 1984; Cartwright & Barnicoat, 2003; Cartwright & Buick, 1999; Cartwright, Valley, & Hazelwood, 1993; Curtis, Harris, Trumbull, De Beer, & Mudzanani, 2013; Eiler & Valley, 1994; Fagereng, Harris, La Grange, & Stevens, 2008; Khan et al., 2019; Lackey, Valley, & Saleeby, 2005; Longstaffe & Schwarcz, 1977; McCaig, Wickham, & Taylor, 1990; Prame & Pohl, 1994; Prochaska, Bechtel, & Klötzli, 1992; Read & Cartwright, 2000; Rehman et al., 2014; Stenvall, Fagereng, & Diener, 2019).

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