Thalénite-(Y) from Golden Horn batholith, Washington State, and comparison with new analyses from the White Cloud pegmatite, Pikes Peak batholith, Colorado, USA.

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**Supplementary material**

**Microprobe Analysis**

Analytical conditions on the JEOL-8600 microprobe were 25 kV and 20 nA with a 5 μm beam diameter. Details on selected X-ray lines, backgrounds, standards and counting times are listed in Table S1. Background positions were chosen to avoid interferences, and all analyses were corrected for major peak interferences (see detail in Allaz *et al.*, 2013). A new microprobe JEOL JXA-8230 with large-area monochromators and new standards (Table S2) became available only after completion of the project. This new instrument and its state-of-the-art software from Probe Software notably allowed for more precise determination of interference correction factors and better matrix correction, which ultimately lead to more accurate results. The 3-fold increase in X-ray intensity collected on large area monochromators permit to decrease the acceleration voltage to 15 keV to gain higher spatial resolution without cutting on the precision. The beam current was increased to 50 nA to further improve precision. The Mean Atomic Number background correction method (MAN; Donovan and Tingle, 1996) was used to shorten the total analysis time and to eliminate problems of background interferences. Similar results were obtained in comparison measurements of several hundred analysis points on the White Cloud samples using a new microprobe JEOL JXA-8230 with large-area monochromators with new standards. A similar analytical setup was used, with the main difference that the mean atomic number (MAN) background correction was used on all elements (Donovan and Tingle, 1996).

New analyses (Table S7) in the White Cloud samples yield much higher precision and accuracy. Unfortunately, the crystal fragment for the XRD work were extracted from the samples after the EMP analysis, and we were thus not able to repeat the analyses of Golden Horn samples on the new microprobe. However, from the analysis of different remaining sample areas using the new instrument we could confirm that the Si content is 3 apfu within the statistical error (2.98 ± 0.03). We have therefore renormalized the old EMP results in Table 1 to Si=3 apfu. This also corrects the apparent value of <3 apfu for the sum of 3+ and 2+ cations (Na is negligible) and REE + (U,Th) + (Ca,Mn,Sr) = 3 apfu within the measurement uncertainty.

Most analyses reveal a high F-content, which exceeds the full-site occupancy (average ~1.15 apfu). This discrepancy is likely due to the imprecise measurement (low count-rate) of F K, beam damage effect, or inaccuracy in the interference correction from Ce M. We decided to recalculate the wt.% of F assuming full (OH,F)-site occupancy (1 apfu). This assumption does not affect the results presented here. Note that EMPA analysis of fluorine is still not a routine task (Stromer *et al.*, 1993; Raudsepp, 1995; Ottolini *et al.*, 2000; Goldoff *et al.*, 2012).

High Si-content on data obtained on the JEOL-8600 microprobe are likely due to quartz or other micron-sized silicate-rich inclusions. Effect of these inclusions is more likely to occur with analyses performed on the JEOL-8600 microprobe due to the higher acceleration voltage used and the resulting larger analytical volume (spatial resolution in thalenite-(Y) is ca. 2 µm at 15 keV, versus ca. 5 µm at 25 keV). We also note an increase in totals for the analyses of White Cloud sample regions with particularly high Yb content, the cause of which remains unclear; it could be related to inaccuracy on the matrix correction or due to the nature of the sample (higher susceptibility to beam damage, presence of inclusion, etc.).

Tables S5 and S6 show all raw element wt. % data for the Golden Horn and White Cloud EMPA points respectively; this data is presented in the manuscript and was acquired on the JEOL-8600 microprobe. Table S7 shows White Cloud data taken with the newer, JEOL JXA-8230 microprobe, and shows improved precision and accuracy. Table S8 shows the element wt. % for sample WC01 11 taken on the JEOL-8600 microprobe and includes the calculated oxide wt. % and apfu for both fixed Si = 3 (apfu) and unfixed Si.

# References

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**Table S1**. JEOL-8600 EMPA standards used for wavelength-dispersive compositional mapping and quantitative microanalyses of thalenite.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Element/Line** | **SP** | **Crystal** | **Peak [mm]** | **Time peak [s]** | **Time bkg [s]** | **Bkg - [mm]** | **Bkg +** | **Standard** | **Source of standard** | **Detection Limit (99%, ppm)** | **Interference correction** |
| Ba La | 1 | PET | 88.715 | 40 | 40 | -5.00 | 4.00 | Barite #4 | CM Taylor | 398 | - |
| Ca Ka | 1 | PET | 107.453 | 30 | 30 | -3.50 | 8.50 | Wilberforce apatite | USGS | 117 | - |
| U Mb | 1 | PET | 118.852 | 60 | 60 | -2.75 | 1.95 | U metal | Unknown | 567 | Th |
| Th Ma | 1 | PET | 132.391 | 60 | 60 | -4.00 | 4.00 | ThO2 | CM Taylor | 759 | - |
| S Ka | 1 | PET | 171.968 | 40 | 40 | -6.00 | 7.00 | Barite #4 | CM Taylor | 172 | - |
| P Ka | 1 | PET | 197.171 | 40 | 40 | -5.00 | 5.00 | CePO4 - USNM 168484 | Smithsonian Institute | 203 | - |
| Y La | 1 | PET | 206.588 | 40 | 40 | -5.00 | 8.00 | YPO4 - USNM 168499 | Smithsonian Institute | 567 | - |
| Sr La | 1 | PET | 219.883 | 40 | 40 | -10.50 | 1.50 | Strontianite - NMNH #R10065 | Smithsonian Institute | 460 | - |
| Si Ka | 2 | TAP | 77.304 | 10 | 10 | -5.00 | 5.00 | Garnet P-130 | CalTech | 292 | - |
| Al Ka | 2 | TAP | 90.576 | 10 | 10 | -7.50 | 7.50 | Garnet P-130 | CalTech | 252 | - |
| Mg Ka | 2 | TAP | 107.488 | 50 | 50 | -2.00 | 9.00 | Springwater Olivine - USNM #2566 | Smithsonian Institute | 114 | - |
| Na Ka | 2 | TAP | 129.516 | 50 | 50 | -8.30 | 7.00 | Amelia Albite #AS5010-AB | SPI | 170 | - |
| F Ka | 2 | TAP | 199.290 | 60 | 60 | -6.00 | 5.00 | Fluorite | CM Taylor | 1468 | Ce |
| Dy La | 3 | LIF | 132.500 | 40 | 40 | -3.00 | 7.25 | DyPO4 - USNM 168485 | Smithsonian Institute | 431 | Eu |
| Eu Lb | 3 | LIF | 133.320 | 40 | 40 | -3.80 | 6.45 | EuPO4 - USNM 168487 | Smithsonian Institute | 784 | Dy |
| Fe Ka | 3 | LIF | 134.399 | 40 | 40 | -4.90 | 4.70 | Garnet P-130 | CalTech | 164 | Pr, Nd, Sm, Th |
| Tb La | 3 | LIF | 137.165 | 40 | 40 | -7.65 | 7.18 | TbPO4 - USNM 168496 | Smithsonian Institute | 424 | - |
| Sm Lb | 3 | LIF | 138.738 | 40 | 40 | -9.20 | 5.60 | SmPO4 | JM Montel & P. Goncalves | 779 | Tb |
| Mn Ka | 3 | LIF | 145.955 | 40 | 40 | -1.45 | 9.85 | Garnet P-130 | CalTech | 156 | Pr, Nd, Eu |
| Nd La | 3 | LIF | 164.668 | 40 | 40 | -3.00 | 4.00 | NdPO4 | JM Montel & P. Goncalves | 487 | Ce |
| La La | 3 | LIF | 185.238 | 40 | 40 | -3.90 | 3.00 | LaPO4 | JM Montel & P. Goncalves | 698 | - |
| Lu La | 4 | LIF | 112.158 | 40 | 40 | -4.00 | 4.00 | LuPO4 - USNM 168491 | Smithsonian Institute | 376 | Ho, Dy |
| Ho Lb | 4 | LIF | 114.125 | 40 | 40 | -2.75 | 3.40 | HoPO4 - USNM 168489 | Smithsonian Institute | 700 | Eu, Yb |
| Yb La | 4 | LIF | 115.835 | 40 | 40 | -4.30 | 1.65 | YbPO4 - USNM 168498 | Smithsonian Institute | 383 | Sm, Eu, Ho, Dy, Tb |
| Tm La | 4 | LIF | 119.670 | 40 | 40 | -2.15 | 9.80 | TmPO4 - USNM 168497 | Smithsonian Institute | 378 | Sm, Gd, Dy |
| Er La | 4 | LIF | 123.695 | 40 | 40 | -6.15 | 5.80 | ErPO4 - USNM 168486 | Smithsonian Institute | 391 | Tb |
| Gd Lb | 4 | LIF | 128.035 | 40 | 40 | -10.45 | 1.50 | GdPO4 - USNM 168488 | Smithsonian Institute | 731 | Ho |
| Pr Lb | 4 | LIF | 156.740 | 40 | 40 | -1.20 | 4.90 | PrPO4 | JM Montel & P. Goncalves | 827 | - |
| Ce La | 4 | LIF | 177.841 | 40 | 40 | -4.20 | 3.40 | CePO4 - USNM 168484 | Smithsonian Institute | 589 | - |
| Ti Ka | 4 | LIF | 190.884 | 30 | 30 | -4.00 | 4.00 | Ilmenite - USNM #96189 | Smithsonian Institute | 244 | - |

**Table S2**. JEOL JXA-8230 EMPA standards used for wavelength-dispersive compositional mapping and quantitative microanalyses of thalenite.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Element/Line** | **SP** | **Crystal** | **Peak [mm]** | **Time peak [s]** | **Background** | **Standard** | **Source of standard** | **Detection Limit (99%, ppm)** | **Interference correction** |
| Si ka | 1 | TAP | 77.259 | 90 | MAN# | Almandine NY | Astimex Standard, Ltd. | 34 | Y |
| Al ka | 1 | TAP | 90.523 | 90 | MAN# | Almandine NY | Astimex Standard, Ltd. | 32 | Tm, Er |
| Y la | 2 | TAPL | 70.055 | 60 | MAN# | YPO4 | D. Harlov, GFZ Potsdam | 60 | - |
| Mg ka | 2 | TAPL | 107.576 | 40 | MAN# | Diopside | Astimex Standard, Ltd. | 18 | - |
| F ka | 2 | TAPL | 199.401 | 40 | MAN# | F-Apatite | D. Harlov, GFZ Potsdam | 134 | Ce, Ho |
| Ca ka | 3 | PETL | 107.492 | 30 | MAN# | F-Apatite | D. Harlov, GFZ Potsdam | 39 | - |
| U mb | 3 | PETL | 118.925 | 30 | MAN# | UO2 | I. Steele, USA | 252 | - |
| Th ma | 3 | PETL | 132.461 | 30 | MAN# | ThO2 | I. Steele, USA | 171 | - |
| S ka | 3 | PETL | 171.985 | 30 | MAN# | Barite | Astimex Standard, Ltd. | 42 | - |
| P ka | 3 | PETL | 197.170 | 30 | MAN# | CePO4 | D. Harlov, GFZ Potsdam | 45 | - |
| Eu lb | 4 | LIFL | 133.582 | 30 | MAN# | EuPO4 | D. Harlov, GFZ Potsdam | 497 | Dy, Fe |
| Fe ka | 4 | LIFL | 134.659 | 30 | MAN# | Almandine NY | Astimex Standard, Ltd. | 101 | - |
| Tb la | 4 | LIFL | 137.435 | 30 | MAN# | TbPO4 | D. Harlov, GFZ Potsdam | 282 | Sm |
| Sm lb | 4 | LIFL | 138.994 | 30 | MAN# | SmPO4 | D. Harlov, GFZ Potsdam | 494 | Tb, Fe |
| Pr lb | 4 | LIFL | 157.091 | 30 | MAN# | PrPO4 | D. Harlov, GFZ Potsdam | 489 | - |
| Nd la | 4 | LIFL | 164.864 | 30 | MAN# | NdPO4 | D. Harlov, GFZ Potsdam | 270 | Ce, La |
| Ce la | 4 | LIFL | 178.138 | 30 | MAN# | CePO4 | D. Harlov, GFZ Potsdam | 290 | - |
| La la | 4 | LIFL | 185.383 | 30 | MAN# | LaPO4 | D. Harlov, GFZ Potsdam | 331 | - |
| Lu la | 5 | LIFL | 112.515 | 30 | MAN# | LuPO4 | D. Harlov, GFZ Potsdam | 347 | Ho, Dy |
| Ho lb | 5 | LIFL | 114.454 | 30 | MAN# | HoPO4 | D. Harlov, GFZ Potsdam | 573 | Yb, Lu, Eu |
| Yb la | 5 | LIFL | 116.166 | 30 | MAN# | YbPO4 | D. Harlov, GFZ Potsdam | 327 | Eu, Tb, Dy, Sm |
| Tm la | 5 | LIFL | 119.998 | 30 | MAN# | TmPO4 | D. Harlov, GFZ Potsdam | 299 | Sm, Dy |
| Er la | 5 | LIFL | 124.035 | 30 | MAN# | ErPO4 | D. Harlov, GFZ Potsdam | 286 | Fe, Tb |
| Gd lb | 5 | LIFL | 128.363 | 30 | MAN# | GdPO4 | D. Harlov, GFZ Potsdam | 493 | Ho |
| Dy la | 5 | LIFL | 132.698 | 30 | MAN# | DyPO4 | D. Harlov, GFZ Potsdam | 267 | Mn, Eu |
| Mn ka | 5 | LIFL | 146.121 | 30 | MAN# | Rhodonite | Astimex Standard, Ltd. | 100 | - |
| Ti ka | 5 | LIFL | 191.138 | 30 | MAN# | Rutile | Astimex Standard, Ltd. | 108 | - |
| **Measured but NOT detected** | | |  |  |  |  |  |  |  |
| As la | 1 | TAP | 105.098 | 90 | MAN# | Arsenopyrite | Astimex Standard, Ltd. | 90 | Tb, Dy, Sm, Mn |
| Sr la | 2 | TAPL | 74.576 | 60 | MAN# | Celestite | Astimex Standard, Ltd. | 51 | Lu, Si, Ta, Er |
| Na ka | 2 | TAPL | 129.590 | 40 | MAN# | Albite Amelia | Astimex Standard, Ltd. | 28 | Ho |
| K kb | 3 | PETL | 110.506 | 30 | MAN# | Orthoclase | Astimex Standard, Ltd. | 323 | U, Tm, Ca |
| Cl ka | 3 | PETL | 151.428 | 30 | MAN# | Pyromorphite (MJJ) | JM Montel & P. Goncalves | 33 |  |
| Pb ma | 3 | PETL | 169.250 | 30 | MAN# | Pyromorphite (MJJ) | JM Montel & P. Goncalves | 235 | Y, Th, La, Nb |
| Nb la | 3 | PETL | 183.341 | 30 | MAN# | LiNbO3 | S. Kuehn, USA | 161 |  |
| Ta la | 4 | LIFL | 105.822 | 30 | MAN# | LiTaO3 | S. Kuehn, USA | 470 | Er, Tm, Tb |
| # Mean Atomic Number background correction (Donovan and Tingle, 1996) | | | | | | |  |  |  |

**Table S3**. Electrostatic potential for anion/cation sites in the White Cloud thalenite XRD refinement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **formula unit** | **e\*\*2/a** | **kcal/mole** | **ev** | **potential(V)** |
| Y1 | -6.42 | -2132.96 | -92.54 | -30.85 |
| Y2 | -6.56 | -2177.22 | -94.46 | -31.49 |
| Y3 | -6.19 | -2056.11 | -89.21 | -29.74 |
| Si1 | -13.47 | -4473.86 | -194.11 | -48.53 |
| Si2 | -13.57 | -4504.83 | -195.45 | -48.86 |
| Si3 | -13.53 | -4491.29 | -194.86 | -48.72 |
| O1 | -3.67 | -1219.58 | -52.91 | 26.46 |
| O2 | -3.60 | -1196.41 | -51.91 | 25.95 |
| O3 | -3.63 | -1206.15 | -52.33 | 26.17 |
| O4 | -4.20 | -1395.14 | -60.53 | 30.27 |
| O5 | -3.67 | -1219.93 | -52.93 | 26.47 |
| O6 | -3.49 | -1159.10 | -50.29 | 25.15 |
| O7 | -4.17 | -1385.03 | -60.09 | 30.05 |
| O8 | -3.58 | -1187.90 | -51.54 | 25.77 |
| O9 | -3.58 | -1190.08 | -51.63 | 25.82 |
| O10 | -3.59 | -1192.63 | -51.74 | 25.87 |
| F | -0.71 | -235.82 | -10.23 | 10.23 |

**Table S4**. Refinement position, displacement and occupancy parameters for the various samples as collected from XRD analysis

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Y3Si3O10Fa | Golden Horn | WC-G5 | WCX5 | WCX7 | RS104 |  | Y3Si3O10F | Golden Horn | WC-G5 | WCX5 | WCX7 | RS104 |
| **Y1** |  |  |  |  |  |  | **O4** |  |  |  |  |  |  |
| *x* | 0.29994(6) | 0.30069(9) | 0.30056(16) | 0.3010(2) | 0.3005(2) | 0.3011(3) | *x* | 0.3428(5) | 0.3438(8) | 0.3446(13) | 0.3436(17) | 0.3437(17) | 0.349(2) |
| *y* | 0.40243(4) | 0.40234(7) | 0.40200(11) | 0.40177(12) | 0.40254(12) | 0.40145(17) | *y* | 0.3241(4) | 0.3235(6) | 0.3241(9) | 0.3231(11) | 0.3239(10) | 0.3264(15) |
| *z* | 0.49603(4) | 0.49639(7) | 0.49635(11) | 0.49643(15) | 0.49679(14) | 0.4958(2) | *z* | 0.2318(4) | 0.2311(6) | 0.2300(9) | 0.2293(13) | 0.2274(13) | 0.2279(17) |
| Ueq |  | 0.0145(2) | 0.0214(5) | 0.0224(5) | 0.0194(5) | 0.0295(8) | Ueq |  | 0.0143(14) | 0.020(3) | 0.026(3) | 0.023(3) | 0.037(6) |
| SOF |  | 0.563(5) | 0.581(7) | 0.582(9) | 0.578(7) | 0.602(10) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Y2** |  |  |  |  |  |  | **O5** |  |  |  |  |  |  |
| *x* | 0.40413(6) | 0.40488(9) | 0.40507(15) | 0.40499(18) | 0.40596(19) | 0.4049(3) | *x* | 0.2697(5) | 0.2682(8) | 0.2672(13) | 0.2685(18) | 0.2637(17) | 0.268(2) |
| *y* | 0.26968(4) | 0.27048(6) | 0.27023(11) | 0.26977(11) | 0.27036(11) | 0.26915(15) | *y* | 0.3186(4) | 0.3189(6) | 0.3181(9) | 0.3187(11) | 0.3193(10) | 0.3204(15) |
| *z* | 0.81174(4) | 0.81139(6) | 0.81181(11) | 0.81209(13) | 0.81171(13) | 0.81291(19) | *z* | 0.9840(4) | 0.9828(6) | 0.9836(9) | 0.9815(13) | 0.9777(12) | 0.9851(14) |
| Ueq |  | 0.0139(2) | 0.0193(5) | 0.0191(4) | 0.0177(4) | 0.0271(7) | Ueq |  | 0.0136(14) | 0.020(3) | 0.025(3) | 0.024(3) | 0.026(5) |
| SOF |  | 0.585(5) | 0.611(7) | 0.615(9) | 0.615(8) | 0.651(11) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Y3** |  |  |  |  |  |  | **O6** |  |  |  |  |  |  |
| *x* | 0.26328(6) | 0.26297(9) | 0.26252(15) | 0.26268(19) | 0.2627(2) | 0.2627(3) | *x* | 0.0176(5) | 0.0172(8) | 0.0149(12) | 0.0161(15) | 0.0151(16) | 0.018(2) |
| *y* | 0.03243(3) | 0.03231(6) | 0.03330(12) | 0.03357(12) | 0.03283(12) | 0.03483(18) | *y* | 0.2288(3) | 0.2271(5) | 0.2250(9) | 0.2275(10) | 0.2256(9) | 0.2261(14) |
| *z* | 0.51828(4) | 0.51790(7) | 0.51731(11) | 0.51648(15) | 0.51801(15) | 0.5157(2) | *z* | 0.1207(4) | 0.1206(5) | 0.1235(9) | 0.1208(12) | 0.1219(12) | 0.1217(16) |
| Ueq |  | 0.0152(2) | 0.0222(5) | 0.0211(5) | 0.0204(5) | 0.0323(8) | Ueq |  | 0.0112(13) | 0.018(3) | 0.018(3) | 0.015(3) | 0.024(5) |
| SOF |  | 0.572(5) | 0.593(7) | 0.570(9) | 0.576(7) | 0.620(11) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Si1** |  |  |  |  |  |  | **O7** |  |  |  |  |  |  |
| *x* | 0.0235(2) | 0.0241(3) | 0.0243(6) | 0.0219(7) | 0.0225(7) | 0.0226(10) | *x* | 0.3198(5) | 0.3196(8) | 0.3200(14) | 0.3191(17) | 0.3222(19) | 0.317(2) |
| *y* | 0.0860(1) | 0.0861(2) | 0.0851(4) | 0.0850(4) | 0.0856(4) | 0.0841(6) | *y* | 0.1106(3) | 0.1089(6) | 0.1105(9) | 0.1104(10) | 0.1097(10) | 0.1124(12) |
| *z* | 0.7411(1) | 0.7408(2) | 0.7413(4) | 0.7408(5) | 0.7406(5) | 0.7424(7) | *z* | 0.1250(4) | 0.1231(6) | 0.1249(10) | 0.1255(12) | 0.1254(12) | 0.1284(17) |
| Ueq |  | 0.0111(8) | 0.0174(17) | 0.0168(17) | 0.0161(17) | 0.019(3) | Ueq |  | 0.0141(14) | 0.022(3) | 0.021(3) | 0.027(3) | 0.026(5) |
| SOF |  | 0.996(15) | 1.00(2) | 0.99(3) | 0.99(2) | 0.99(3) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Si2** |  |  |  |  |  |  | **O8** |  |  |  |  |  |  |
| *x* | 0.2328(2) | 0.2325(3) | 0.2326(6) | 0.2326(7) | 0.2331(7) | 0.2331(9) | *x* | 0.1856(5) | 0.1864(8) | 0.1864(12) | 0.1878(16) | 0.1895(17) | 0.190(2) |
| *y* | 0.2459(1) | 0.2449(2) | 0.2446(4) | 0.2450(4) | 0.2446(4) | 0.2452(5) | *y* | 0.3946(3) | 0.3947(5) | 0.3951(8) | 0.3940(9) | 0.3953(9) | 0.3937(13) |
| *z* | 0.1120(1) | 0.1110(2) | 0.1106(4) | 0.1099(5) | 0.1099(5) | 0.1105(7) | *z* | 0.6931(4) | 0.6920(6) | 0.6909(8) | 0.6907(12) | 0.6920(11) | 0.6908(15) |
| Ueq |  | 0.0109(8) | 0.0174(16) | 0.0151(17) | 0.0121(16) | 0.018(3) | Ueq |  | 0.0113(13) | 0.011(2) | 0.017(3) | 0.016(3) | 0.023(4) |
| SOF |  | 0.994(15) | 1.02(2) | 0.96(3) | 0.96(2) | 1.01(3) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Si3** |  |  |  |  |  |  | **O9** |  |  |  |  |  |  |
| *x* | 0.4940(2) | 0.4942(3) | 0.4946(5) | 0.4944(6) | 0.4938(7) | 0.4964(9) | *x* | 0.4652(5) | 0.4678(8) | 0.4661(13) | 0.4681(16) | 0.4658(16) | 0.472(2) |
| *y* | 0.0389(1) | 0.0380(2) | 0.0386(4) | 0.0388(4) | 0.0381(4) | 0.0383(5) | *y* | 0.0219(3) | 0.0219(5) | 0.0206(10) | 0.0230(10) | 0.0210(10) | 0.0198(12) |
| *z* | 0.2088(1) | 0.2083(2) | 0.2087(4) | 0.2085(5) | 0.2087(5) | 0.2095(7) | *z* | 0.3612(40 | 0.3615(6) | 0.3617(9) | 0.3583(13) | 0.3623(11) | 0.3643(14) |
| Ueq |  | 0.0106(8) | 0.0154(17) | 0.0157(17) | 0.0120(17) | 0.021(3) | Ueq |  | 0.0123(13) | 0.020(3) | 0.022(3) | 0.017(3) | 0.015(4) |
| SOF |  | 0.985(14) | 0.99(2) | 0.99(3) | 0.94(2) | 1.04(3) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **O1** |  |  |  |  |  |  | **O10** |  |  |  |  |  |  |
| *x* | 0.0136(5) | 0.0116(8) | 0.0126(13) | 0.0108(16) | 0.0108(16) | 0.014(2) | *x* | 0.0238(6) | 0.0239(8) | 0.0226(13) | 0.0254(16) | 0.0238(16) | 0.026(2) |
| *y* | 0.1446(3) | 0.0256(5) | 0.0245(9) | 0.0241(10) | 0.0242(9) | 0.0247(13) | *y* | 0.4131(3) | 0.4119(6) | 0.4119(10) | 0.4141(10) | 0.4121(10) | 0.4138(13) |
| *z* | 0.6970(4) | 0.3606(6) | 0.3620(9) | 0.3620(12) | 0.3632(11) | 0.3575(14) | *z* | 0.3705(4 | 0.3704(6) | 0.3700(9) | 0.3719(12) | 0.3700(11) | 0.3726(15) |
| Ueq |  | 0.0126(13) | 0.020(3) | 0.019(3) | 0.015(3) | 0.020(4) | Ueq |  | 0.0149(14) | 0.020(3) | 0.020(3) | 0.017(3) | 0.023(4) |
| SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **O2** |  |  |  |  |  |  | **F** |  |  |  |  |  |  |
| x | 0.0404(5) | 0.0409(8) | 0.0392(13) | 0.0366(16) | 0.0397(15) | 0.040(2) | x | 0.1941(5) | 0.1951(7) | 0.1945(12) | 0.1918(16) | 0.1939(17) | 0.195(2) |
| y | 0.0504(3) | 0.0507(6) | 0.0490(9) | 0.0486(10) | 0.0494(9) | 0.0479(13) | y | 0.2166(3) | 0.2164(5) | 0.2162(8) | 0.2173(9) | 0.2166(8) | 0.2166(11) |
| z | 0.8914(4) | 0.8914(5) | 0.8904(9) | 0.8888(12) | 0.8885(11) | 0.8891(16) | z | 0.4394(3) | 0.4383(5) | 0.4395(8) | 0.4406(12) | 0.4368(12) | 0.4412(14) |
| Ueq |  | 0.0129(14) | 0.018(3) | 0.019(3) | 0.014(3) | 0.024(5) | Ueq |  | 0.0187(12) | 0.028(2) | 0.031(3) | 0.035(3) | 0.030(4) |
| SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **O3** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| x | 0.2059(5) | 0.2070(8) | 0.2047(14) | 0.2070(17) | 0.2058(17) | 0.208(2) |  |  |  |  |  |  |  |
| y | 0.1446(3) | 0.1445(5) | 0.1444(9) | 0.1422(10) | 0.1422(9) | 0.1403(13) | |  |  |  |  |  |  |
| z | 0.6970(4) | 0.6975(6) | 0.6991(10) | 0.6998(13) | 0.6976(11) | 0.6991(15) | |  |  |  |  |  |  |
| Ueq |  | 0.0118(13) | 0.022(3) | 0.025(3) | 0.017(3) | 0.020(4) |  |  |  |  |  |  |  |
| SOF |  | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) | 1 (fixed) |  |  |  |  |  |  |  |
| a Schleid and Müller-Bunz (1998) | | | | | | | | | | | | | |

**Table S5**. Full, raw elemental wt-% Golden Horn data collected by the JEOL-8600 microprobe and used as the basis for the data and tables within the manuscript

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **F** | **Na** | **Mg** | **Al** | **Si** | **P** | **S** | **Ca** | **Ti** | **Mn** | **Fe** | **Sr** | **Ba** | **Th** | **U** |
| #1 1 | 3.98 | 0.03 | < 0.01 | < 0.01 | 15.05 | 0.10 | < 0.01 | 0.39 | 0.09 | 0.03 | 0.11 | < 0.02 | < 0.02 | < 0.02 | 0.04 |
| #1 2 | 3.89 | 0.03 | < 0.01 | < 0.01 | 15.03 | 0.10 | < 0.01 | 0.40 | 0.09 | 0.03 | 0.10 | < 0.02 | < 0.02 | < 0.02 | 0.06 |
| #1 3 | 3.94 | 0.02 | < 0.01 | < 0.01 | 15.02 | 0.09 | 0.01 | 0.25 | 0.03 | 0.02 | 0.05 | < 0.02 | < 0.02 | 0.16 | 0.49 |
| #1 4 | 3.84 | 0.01 | < 0.01 | < 0.01 | 15.01 | 0.09 | 0.01 | 0.23 | 0.03 | 0.01 | 0.04 | < 0.02 | < 0.02 | 0.20 | 0.55 |
| #1 5 | 3.83 | < 0.01 | < 0.01 | < 0.01 | 15.43 | 0.10 | < 0.01 | 0.35 | 0.09 | < 0.01 | 0.02 | < 0.02 | < 0.02 | 0.03 | 0.28 |
| #1 6 | 3.91 | < 0.01 | < 0.01 | < 0.01 | 15.43 | 0.10 | < 0.01 | 0.34 | 0.09 | < 0.01 | 0.02 | < 0.02 | < 0.02 | 0.07 | 0.30 |
| #1 7 | 3.75 | < 0.01 | < 0.01 | < 0.01 | 15.54 | 0.09 | < 0.01 | 0.33 | 0.15 | 0.01 | 0.02 | < 0.02 | < 0.02 | 0.06 | 0.31 |
| #1 8 | 4.13 | 0.04 | < 0.01 | < 0.01 | 15.21 | 0.11 | 0.01 | 0.44 | 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| #1 9 | 4.13 | 0.03 | < 0.01 | < 0.01 | 15.16 | 0.12 | 0.01 | 0.44 | < 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| #1 10 | 4.01 | 0.04 | < 0.01 | < 0.01 | 15.21 | 0.12 | 0.01 | 0.43 | 0.02 | < 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | 0.02 |
| #1 11 | 4.11 | 0.04 | < 0.01 | < 0.01 | 15.26 | 0.10 | < 0.01 | 0.43 | 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | 0.02 |
| #1 12 | 3.98 | 0.03 | < 0.01 | < 0.01 | 15.20 | 0.11 | 0.01 | 0.43 | 0.02 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| #1 13 | 4.02 | 0.04 | < 0.01 | < 0.01 | 15.26 | 0.12 | < 0.01 | 0.43 | 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | 0.03 | 0.04 |
| #1 14 | 4.09 | 0.03 | < 0.01 | < 0.01 | 15.27 | 0.11 | 0.02 | 0.41 | 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| #1 15 | 3.90 | 0.03 | < 0.01 | < 0.01 | 15.06 | 0.09 | 0.02 | 0.38 | 0.01 | 0.02 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| #1 16 | 4.10 | 0.04 | < 0.01 | < 0.01 | 15.04 | 0.11 | 0.01 | 0.43 | 0.01 | < 0.01 | 0.01 | < 0.02 | < 0.02 | < 0.02 | 0.03 |
| #1 17 | 3.93 | 0.04 | < 0.01 | < 0.01 | 15.18 | 0.11 | 0.01 | 0.43 | 0.01 | 0.01 | 0.02 | < 0.02 | < 0.02 | < 0.02 | 0.03 |
| #1 18 | 4.18 | 0.03 | < 0.01 | < 0.01 | 15.07 | 0.11 | 0.01 | 0.23 | 0.03 | < 0.01 | 0.05 | < 0.02 | < 0.02 | 0.12 | 0.44 |
| #1 19 | 4.23 | 0.03 | < 0.01 | < 0.01 | 15.15 | 0.12 | 0.01 | 0.24 | 0.03 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.13 | 0.38 |
| #1 20 | 4.11 | 0.02 | < 0.01 | < 0.01 | 15.09 | 0.10 | 0.01 | 0.22 | 0.05 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.14 | 0.46 |
| #1 21 | 4.14 | 0.01 | < 0.01 | < 0.01 | 15.08 | 0.11 | < 0.01 | 0.21 | 0.03 | 0.01 | 0.04 | 0.03 | < 0.02 | 0.13 | 0.47 |
| #1 22 | 4.12 | 0.01 | < 0.01 | < 0.01 | 15.17 | 0.10 | 0.01 | 0.21 | 0.04 | 0.02 | 0.05 | < 0.02 | < 0.02 | 0.13 | 0.47 |
| #1 23 | 4.09 | 0.03 | < 0.01 | < 0.01 | 15.10 | 0.10 | 0.01 | 0.22 | 0.04 | 0.02 | 0.05 | < 0.02 | < 0.02 | 0.15 | 0.40 |
| #1 24 | 3.97 | 0.02 | < 0.01 | < 0.01 | 15.14 | 0.08 | < 0.01 | 0.20 | 0.03 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.13 | 0.40 |
| #1 25 | 3.99 | 0.02 | < 0.01 | < 0.01 | 15.08 | 0.10 | < 0.01 | 0.20 | 0.04 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.11 | 0.41 |
| #1 26 | 4.11 | 0.02 | < 0.01 | < 0.01 | 15.29 | 0.12 | < 0.01 | 0.21 | 0.03 | 0.02 | 0.05 | < 0.02 | < 0.02 | 0.10 | 0.42 |
| #1 27 | 4.09 | 0.03 | < 0.01 | < 0.01 | 15.31 | 0.10 | 0.01 | 0.21 | 0.04 | 0.02 | 0.06 | < 0.02 | < 0.02 | 0.08 | 0.39 |
| #1 28 | 3.95 | 0.03 | < 0.01 | < 0.01 | 15.15 | 0.09 | 0.01 | 0.22 | 0.04 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.11 | 0.35 |
| #1 29 | 4.05 | 0.02 | < 0.01 | < 0.01 | 15.20 | 0.10 | < 0.01 | 0.20 | 0.04 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.11 | 0.37 |
| #1 30 | 4.02 | 0.02 | < 0.01 | < 0.01 | 15.16 | 0.10 | 0.01 | 0.16 | 0.03 | < 0.01 | 0.04 | < 0.02 | < 0.02 | 0.07 | 0.39 |
| #1 31 | 4.08 | 0.02 | < 0.01 | < 0.01 | 15.22 | 0.11 | 0.01 | 0.15 | 0.02 | 0.02 | 0.04 | < 0.02 | < 0.02 | 0.16 | 0.50 |
| #1 32 | 4.10 | 0.01 | < 0.01 | < 0.01 | 15.32 | 0.11 | 0.01 | 0.15 | 0.03 | 0.01 | 0.04 | < 0.02 | < 0.02 | 0.09 | 0.48 |
| #1 33 | 4.06 | 0.01 | < 0.01 | < 0.01 | 15.36 | 0.12 | < 0.01 | 0.19 | 0.02 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.03 | 0.19 |
| #1 34 | 4.08 | 0.01 | < 0.01 | < 0.01 | 15.34 | 0.13 | 0.01 | 0.16 | 0.03 | 0.02 | 0.04 | < 0.02 | < 0.02 | 0.10 | 0.43 |
| #1 35 | 3.97 | 0.01 | < 0.01 | < 0.01 | 15.36 | 0.13 | 0.01 | 0.19 | 0.03 | 0.02 | 0.05 | < 0.02 | < 0.02 | < 0.02 | 0.04 |
| #1 36 | 3.89 | < 0.01 | < 0.01 | < 0.01 | 15.24 | 0.14 | 0.01 | 0.16 | 0.02 | 0.02 | 0.07 | < 0.02 | < 0.02 | < 0.02 | 0.05 |
| #2 1 | 4.03 | 0.04 | < 0.01 | < 0.01 | 15.58 | 0.20 | 0.02 | 0.47 | 0.01 | < 0.01 | 0.02 | < 0.03 | < 0.03 | < 0.04 | 0.05 |
| #2 2 | 3.78 | < 0.01 | < 0.01 | < 0.01 | 15.37 | 0.18 | < 0.01 | 0.40 | < 0.01 | < 0.01 | 0.02 | < 0.04 | < 0.03 | < 0.04 | < 0.04 |
| #2 3 | 3.96 | 0.03 | < 0.01 | < 0.01 | 15.52 | 0.20 | < 0.01 | 0.44 | 0.01 | < 0.01 | 0.03 | < 0.03 | < 0.03 | < 0.04 | < 0.04 |
| #2 4 | 4.07 | < 0.01 | < 0.01 | < 0.01 | 15.77 | 0.18 | < 0.01 | 0.21 | 0.03 | < 0.01 | 0.05 | < 0.04 | < 0.03 | 0.09 | 0.48 |
| #2 5 | 4.22 | 0.02 | < 0.01 | < 0.01 | 15.74 | 0.21 | < 0.01 | 0.24 | 0.03 | 0.02 | 0.06 | < 0.03 | < 0.03 | < 0.04 | 0.04 |
| #2 6 | 4.00 | 0.02 | < 0.01 | < 0.01 | 15.57 | 0.15 | 0.01 | 0.22 | 0.03 | < 0.01 | 0.06 | < 0.03 | < 0.03 | 0.09 | 0.24 |
| #2 7 | 3.83 | < 0.01 | < 0.01 | < 0.01 | 15.10 | 0.13 | < 0.01 | 0.15 | 0.02 | < 0.01 | 0.03 | < 0.04 | < 0.03 | 0.18 | 0.48 |
| #2 8 | 3.90 | 0.03 | < 0.01 | < 0.01 | 15.22 | 0.15 | < 0.01 | 0.36 | 0.07 | 0.05 | 0.13 | < 0.04 | < 0.03 | < 0.05 | < 0.04 |
| #2 9 | 3.82 | < 0.01 | < 0.01 | < 0.01 | 15.42 | 0.19 | 0.01 | 0.10 | 0.02 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.04 | 0.07 |
| #2 10 | 3.69 | < 0.01 | < 0.01 | < 0.01 | 14.99 | 0.18 | < 0.01 | 0.25 | 0.06 | 0.02 | 0.06 | < 0.03 | < 0.03 | < 0.04 | 0.05 |
| #2 11 | 3.92 | < 0.01 | < 0.01 | < 0.01 | 14.71 | 0.11 | < 0.01 | 0.24 | 0.06 | 0.01 | 0.06 | < 0.02 | < 0.02 | < 0.02 | 0.04 |
| #2 12 | 3.87 | < 0.01 | < 0.01 | < 0.01 | 14.78 | 0.11 | < 0.01 | 0.24 | 0.05 | 0.01 | 0.06 | < 0.02 | < 0.02 | < 0.02 | 0.05 |
| #2 13 | 4.04 | 0.01 | < 0.01 | < 0.01 | 14.78 | 0.12 | < 0.01 | 0.19 | 0.04 | 0.01 | 0.04 | < 0.02 | < 0.02 | 0.07 | 0.34 |
| #2 14 | 4.03 | 0.01 | < 0.01 | < 0.01 | 14.95 | 0.10 | < 0.01 | 0.16 | 0.03 | < 0.01 | 0.03 | < 0.02 | < 0.02 | 0.13 | 0.56 |
| #2 15 | 4.01 | 0.02 | < 0.01 | < 0.01 | 14.91 | 0.09 | 0.01 | 0.14 | 0.02 | 0.01 | 0.04 | < 0.02 | < 0.02 | 0.16 | 0.56 |
| #2 16 | 3.99 | 0.02 | < 0.01 | < 0.01 | 15.03 | 0.09 | 0.01 | 0.20 | 0.04 | 0.02 | 0.04 | < 0.02 | < 0.02 | 0.10 | 0.42 |
| #2 17 | 4.05 | 0.02 | < 0.01 | < 0.01 | 15.05 | 0.09 | < 0.01 | 0.21 | 0.04 | 0.01 | 0.05 | < 0.02 | < 0.02 | 0.12 | 0.45 |
| #2 18 | 4.02 | 0.03 | < 0.01 | < 0.01 | 15.00 | 0.11 | < 0.01 | 0.25 | 0.06 | 0.02 | 0.06 | < 0.02 | < 0.02 | 0.08 | 0.26 |
| #2 19 | 4.05 | 0.02 | < 0.01 | < 0.01 | 14.87 | 0.07 | 0.01 | 0.21 | 0.04 | 0.01 | 0.03 | < 0.02 | < 0.02 | 0.15 | 0.45 |
| #2 20 | 3.92 | 0.03 | < 0.01 | < 0.01 | 14.96 | 0.10 | < 0.01 | 0.36 | 0.08 | 0.04 | 0.15 | < 0.02 | < 0.02 | < 0.02 | 0.08 |
| #2 21 | 3.76 | < 0.01 | < 0.01 | < 0.01 | 15.45 | 0.11 | < 0.01 | 0.35 | 0.12 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | 0.06 | 0.30 |
| #2 22 | 3.76 | < 0.01 | < 0.01 | < 0.01 | 15.47 | 0.09 | < 0.01 | 0.34 | 0.11 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | 0.06 | 0.32 |
| #3 1 | 3.89 | < 0.02 | < 0.01 | < 0.01 | 14.31 | 0.24 | < 0.01 | 0.24 | < 0.02 | 0.04 | 0.07 | 0.00 | < 0.04 | < 0.06 | 0.08 |
| #3 2 | 3.63 | < 0.01 | < 0.01 | < 0.01 | 15.00 | 0.16 | < 0.01 | 0.28 | 0.07 | 0.03 | 0.08 | 0.00 | < 0.03 | < 0.05 | 0.06 |
| #3 3 | 3.75 | < 0.01 | < 0.01 | < 0.01 | 14.76 | 0.18 | < 0.01 | 0.27 | 0.06 | 0.02 | 0.07 | 0.00 | < 0.03 | < 0.05 | 0.05 |
| #3 4 | 3.85 | 0.01 | < 0.01 | < 0.01 | 14.98 | 0.18 | < 0.01 | 0.24 | 0.03 | 0.02 | 0.07 | 0.00 | < 0.03 | < 0.04 | 0.04 |
| #3 5 | 3.74 | 0.02 | < 0.01 | < 0.01 | 15.08 | 0.19 | < 0.01 | 0.25 | 0.02 | 0.02 | 0.07 | 0.00 | < 0.03 | < 0.04 | 0.06 |
| #3 6 | 3.95 | 0.01 | < 0.01 | < 0.01 | 14.96 | 0.17 | < 0.01 | 0.23 | 0.03 | 0.02 | 0.09 | 0.00 | < 0.03 | < 0.04 | 0.06 |
| #3 7 | 4.44 | < 0.02 | < 0.01 | < 0.01 | 15.34 | 0.13 | 0.01 | 0.15 | 0.03 | 0.02 | 0.01 | 0.00 | < 0.03 | 0.14 | 0.76 |
| #3 8 | 4.40 | < 0.01 | < 0.01 | < 0.01 | 15.30 | 0.18 | < 0.01 | 0.17 | 0.04 | < 0.01 | < 0.01 | 0.00 | < 0.03 | 0.13 | 0.63 |
| #3 9 | 4.32 | < 0.01 | < 0.01 | < 0.01 | 15.39 | 0.20 | < 0.01 | 0.19 | 0.02 | 0.03 | 0.06 | 0.00 | < 0.03 | < 0.04 | < 0.04 |
| #3 10 | 4.17 | < 0.01 | < 0.01 | < 0.01 | 15.15 | 0.20 | < 0.01 | 0.19 | 0.03 | 0.01 | 0.07 | 0.00 | 0.04 | < 0.04 | < 0.04 |
| #3 11 | 3.95 | < 0.01 | < 0.01 | < 0.01 | 15.21 | 0.19 | < 0.01 | 0.20 | 0.02 | 0.02 | 0.09 | 0.00 | < 0.03 | < 0.04 | < 0.04 |
| #3 12 | 3.93 | < 0.01 | < 0.01 | < 0.01 | 14.89 | 0.13 | < 0.01 | 0.16 | 0.02 | 0.01 | 0.06 | 0.00 | < 0.03 | < 0.04 | < 0.04 |
| #4 1 | 3.97 | 0.03 | < 0.01 | < 0.01 | 15.03 | 0.10 | < 0.01 | 0.36 | 0.08 | 0.04 | 0.15 | < 0.02 | < 0.02 | < 0.02 | 0.06 |
| #4 2 | 3.99 | 0.03 | < 0.01 | < 0.01 | 14.99 | 0.11 | < 0.01 | 0.37 | 0.09 | 0.04 | 0.13 | < 0.02 | < 0.02 | < 0.02 | 0.07 |
| #4 3 | 3.82 | 0.03 | < 0.01 | < 0.01 | 15.00 | 0.08 | < 0.01 | 0.37 | 0.06 | 0.04 | 0.13 | < 0.02 | < 0.02 | < 0.02 | 0.04 |
| #4 4 | 4.00 | 0.03 | < 0.01 | < 0.01 | 15.12 | 0.09 | < 0.01 | 0.38 | 0.08 | 0.03 | 0.13 | < 0.02 | < 0.02 | < 0.02 | 0.05 |
| #4 5 | 4.02 | 0.03 | < 0.01 | < 0.01 | 15.11 | 0.10 | < 0.01 | 0.40 | 0.08 | 0.03 | 0.13 | < 0.02 | < 0.02 | < 0.02 | 0.05 |

**Table S5 conti.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Y** | **La** | **Ce** | **Pr** | **Nd** | **Sm** | **Eu** | **Gd** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** | **O** | **O=F** | **TOTAL** |
| #1 1 | 35.97 | < 0.03 | 0.07 | 0.11 | 0.04 | 0.73 | 0.24 | 3.45 | 1.03 | 4.77 | 0.78 | 4.03 | 0.32 | < 0.03 | < 0.02 | 29.42 | -1.68 | 99.09 |
| #1 2 | 35.96 | < 0.03 | 0.06 | 0.12 | 0.03 | 0.59 | 0.25 | 3.49 | 1.08 | 4.69 | 0.78 | 4.01 | 0.33 | < 0.03 | < 0.02 | 29.38 | -1.64 | 98.88 |
| #1 3 | 35.80 | 0.10 | 0.35 | 0.22 | 0.03 | 0.79 | 0.25 | 3.25 | 0.99 | 4.57 | 0.74 | 3.77 | 0.29 | < 0.03 | < 0.02 | 29.31 | -1.66 | 98.90 |
| #1 4 | 35.66 | 0.08 | 0.37 | 0.23 | 0.05 | 0.71 | 0.26 | 3.26 | 1.03 | 4.46 | 0.72 | 3.75 | 0.32 | < 0.03 | < 0.02 | 29.24 | -1.62 | 98.56 |
| #1 5 | 36.63 | 0.08 | 0.60 | 0.80 | 0.09 | 2.41 | 0.60 | 4.64 | 0.96 | 2.77 | 0.33 | 1.36 | 0.10 | < 0.03 | < 0.02 | 29.98 | -1.61 | 99.87 |
| #1 6 | 36.59 | 0.06 | 0.64 | 0.86 | 0.08 | 2.55 | 0.62 | 4.76 | 1.00 | 2.73 | 0.30 | 1.33 | 0.07 | < 0.03 | < 0.02 | 30.02 | -1.65 | 100.25 |
| #1 7 | 36.15 | 0.08 | 0.73 | 0.99 | 0.06 | 2.84 | 0.66 | 4.87 | 0.96 | 2.82 | 0.32 | 1.37 | 0.05 | 0.05 | < 0.02 | 30.17 | -1.58 | 100.81 |
| #1 8 | 38.53 | < 0.03 | 0.02 | 0.06 | 0.05 | 0.57 | 0.20 | 3.22 | 1.01 | 4.63 | 0.76 | 3.92 | 0.33 | 0.03 | < 0.02 | 30.13 | -1.74 | 101.70 |
| #1 9 | 38.76 | < 0.03 | 0.03 | 0.06 | 0.05 | 0.53 | 0.22 | 3.21 | 1.01 | 4.57 | 0.74 | 3.65 | 0.30 | < 0.03 | < 0.02 | 30.10 | -1.74 | 101.42 |
| #1 10 | 38.66 | < 0.03 | 0.04 | 0.05 | < 0.03 | 0.53 | 0.22 | 3.23 | 1.06 | 4.63 | 0.76 | 3.77 | 0.29 | < 0.03 | < 0.02 | 30.15 | -1.69 | 101.59 |
| #1 11 | 38.47 | < 0.03 | 0.03 | 0.04 | 0.03 | 0.58 | 0.22 | 3.22 | 1.02 | 4.72 | 0.78 | 3.80 | 0.28 | < 0.03 | < 0.02 | 30.14 | -1.73 | 101.60 |
| #1 12 | 38.58 | < 0.03 | 0.03 | 0.06 | 0.04 | 0.53 | 0.21 | 3.13 | 1.04 | 4.66 | 0.76 | 3.65 | 0.29 | < 0.03 | < 0.02 | 30.09 | -1.68 | 101.21 |
| #1 13 | 38.54 | < 0.03 | 0.02 | 0.07 | 0.04 | 0.55 | 0.22 | 3.10 | 1.02 | 4.66 | 0.73 | 3.58 | 0.26 | < 0.03 | < 0.02 | 30.12 | -1.69 | 101.18 |
| #1 14 | 37.92 | < 0.03 | 0.03 | 0.08 | 0.04 | 0.53 | 0.20 | 3.02 | 1.00 | 4.87 | 0.86 | 4.27 | 0.31 | 0.03 | < 0.02 | 30.10 | -1.72 | 101.51 |
| #1 15 | 35.66 | < 0.03 | 0.03 | 0.05 | < 0.03 | 0.48 | 0.19 | 2.93 | 1.01 | 5.46 | 1.10 | 6.11 | 0.46 | < 0.03 | < 0.02 | 29.55 | -1.64 | 100.91 |
| #1 16 | 38.79 | < 0.03 | 0.04 | 0.09 | 0.05 | 0.53 | 0.22 | 3.12 | 1.03 | 4.58 | 0.68 | 3.03 | 0.17 | < 0.03 | < 0.02 | 29.83 | -1.73 | 100.22 |
| #1 17 | 38.61 | < 0.03 | 0.04 | 0.07 | 0.04 | 0.58 | 0.21 | 3.11 | 1.03 | 4.60 | 0.70 | 3.27 | 0.20 | < 0.03 | < 0.02 | 30.00 | -1.65 | 100.59 |
| #1 18 | 37.99 | 0.08 | 0.34 | 0.22 | < 0.03 | 0.73 | 0.22 | 3.10 | 1.00 | 4.59 | 0.75 | 3.71 | 0.30 | < 0.03 | < 0.02 | 29.90 | -1.76 | 101.44 |
| #1 19 | 38.10 | 0.08 | 0.31 | 0.22 | 0.03 | 0.67 | 0.23 | 3.07 | 1.02 | 4.59 | 0.74 | 3.65 | 0.29 | 0.03 | < 0.02 | 30.03 | -1.78 | 101.67 |
| #1 20 | 37.97 | 0.06 | 0.40 | 0.25 | < 0.03 | 0.69 | 0.23 | 3.10 | 1.00 | 4.62 | 0.74 | 3.56 | 0.29 | < 0.03 | < 0.02 | 29.92 | -1.73 | 101.36 |
| #1 21 | 37.88 | 0.07 | 0.42 | 0.27 | < 0.03 | 0.70 | 0.24 | 3.15 | 1.03 | 4.65 | 0.74 | 3.57 | 0.26 | < 0.03 | < 0.02 | 29.90 | -1.74 | 101.39 |
| #1 22 | 38.06 | 0.08 | 0.42 | 0.30 | < 0.03 | 0.75 | 0.24 | 3.08 | 1.01 | 4.61 | 0.77 | 3.60 | 0.24 | 0.04 | < 0.02 | 30.05 | -1.73 | 101.82 |
| #1 23 | 36.67 | 0.05 | 0.33 | 0.21 | 0.03 | 0.59 | 0.21 | 2.90 | 1.02 | 5.07 | 0.94 | 4.98 | 0.40 | < 0.03 | < 0.02 | 29.80 | -1.72 | 101.66 |
| #1 24 | 35.18 | 0.06 | 0.28 | 0.18 | 0.04 | 0.60 | 0.21 | 2.83 | 0.99 | 5.51 | 1.17 | 6.54 | 0.52 | < 0.03 | < 0.02 | 29.68 | -1.67 | 102.16 |
| #1 25 | 36.84 | 0.05 | 0.30 | 0.19 | < 0.03 | 0.68 | 0.22 | 2.98 | 1.03 | 5.18 | 0.94 | 4.43 | 0.31 | < 0.03 | < 0.02 | 29.75 | -1.68 | 101.24 |
| #1 26 | 38.32 | 0.07 | 0.51 | 0.31 | 0.05 | 0.83 | 0.26 | 3.15 | 1.00 | 4.53 | 0.68 | 3.06 | 0.21 | < 0.03 | < 0.02 | 30.19 | -1.73 | 101.79 |
| #1 27 | 37.73 | 0.08 | 0.44 | 0.28 | < 0.03 | 0.72 | 0.24 | 3.16 | 1.06 | 4.73 | 0.75 | 3.52 | 0.25 | < 0.03 | < 0.02 | 30.13 | -1.72 | 101.71 |
| #1 28 | 36.76 | 0.06 | 0.34 | 0.21 | 0.04 | 0.73 | 0.23 | 3.05 | 1.02 | 5.10 | 0.89 | 4.54 | 0.32 | < 0.03 | < 0.02 | 29.82 | -1.66 | 101.45 |
| #1 29 | 36.99 | 0.08 | 0.36 | 0.26 | < 0.03 | 0.84 | 0.25 | 3.18 | 1.02 | 4.90 | 0.83 | 4.25 | 0.29 | < 0.03 | < 0.02 | 29.92 | -1.71 | 101.61 |
| #1 30 | 36.02 | 0.08 | 0.41 | 0.26 | < 0.03 | 0.67 | 0.22 | 3.04 | 1.03 | 5.06 | 0.98 | 5.52 | 0.35 | < 0.03 | < 0.02 | 29.75 | -1.69 | 101.69 |
| #1 31 | 37.85 | 0.11 | 0.42 | 0.28 | 0.07 | 0.84 | 0.29 | 3.41 | 1.06 | 4.42 | 0.66 | 3.08 | 0.17 | < 0.03 | < 0.02 | 29.99 | -1.72 | 101.26 |
| #1 32 | 38.37 | 0.12 | 0.56 | 0.37 | < 0.03 | 1.02 | 0.31 | 3.49 | 1.01 | 4.10 | 0.59 | 2.58 | 0.13 | < 0.03 | < 0.02 | 30.17 | -1.73 | 101.44 |
| #1 33 | 39.76 | 0.03 | 0.26 | 0.23 | 0.05 | 0.86 | 0.32 | 3.60 | 1.01 | 3.81 | 0.52 | 2.31 | 0.12 | < 0.03 | < 0.02 | 30.39 | -1.71 | 101.61 |
| #1 34 | 39.05 | 0.11 | 0.54 | 0.40 | < 0.03 | 1.00 | 0.32 | 3.56 | 0.99 | 3.64 | 0.48 | 2.18 | 0.12 | < 0.03 | < 0.02 | 30.29 | -1.72 | 101.29 |
| #1 35 | 40.14 | < 0.03 | 0.11 | 0.14 | 0.06 | 0.84 | 0.34 | 3.63 | 1.02 | 3.62 | 0.46 | 2.14 | 0.10 | < 0.03 | < 0.02 | 30.40 | -1.67 | 101.13 |
| #1 36 | 39.59 | < 0.03 | 0.13 | 0.17 | 0.05 | 0.90 | 0.35 | 3.81 | 1.03 | 3.53 | 0.44 | 2.02 | 0.11 | < 0.03 | < 0.02 | 30.13 | -1.64 | 100.24 |
| #2 1 | 37.63 | < 0.05 | < 0.03 | < 0.04 | 0.07 | 0.71 | 0.21 | 3.05 | 0.96 | 4.67 | 0.75 | 3.60 | 0.27 | 0.07 | < 0.04 | 30.41 | -1.70 | 101.09 |
| #2 2 | 34.72 | < 0.05 | 0.04 | 0.06 | 0.06 | 0.59 | 0.17 | 2.87 | 1.02 | 5.39 | 1.09 | 6.32 | 0.49 | < 0.06 | < 0.04 | 29.80 | -1.59 | 100.79 |
| #2 3 | 38.25 | < 0.05 | < 0.03 | 0.08 | 0.12 | 0.69 | 0.23 | 3.26 | 1.03 | 4.43 | 0.65 | 2.81 | 0.11 | < 0.05 | < 0.03 | 30.35 | -1.67 | 100.53 |
| #2 4 | 36.63 | 0.12 | 0.45 | 0.28 | 0.08 | 0.73 | 0.27 | 3.16 | 1.12 | 4.74 | 0.80 | 3.74 | 0.22 | < 0.05 | < 0.04 | 30.49 | -1.71 | 102.00 |
| #2 5 | 38.47 | < 0.05 | 0.07 | 0.10 | 0.10 | 0.65 | 0.23 | 3.25 | 1.14 | 4.64 | 0.67 | 3.05 | 0.15 | < 0.05 | < 0.04 | 30.70 | -1.78 | 102.02 |
| #2 6 | 36.30 | < 0.05 | 0.18 | 0.18 | 0.06 | 0.71 | 0.25 | 3.12 | 1.12 | 5.21 | 0.86 | 4.59 | 0.30 | < 0.05 | < 0.04 | 30.25 | -1.68 | 101.83 |
| #2 7 | 31.20 | 0.06 | 0.28 | 0.26 | 0.14 | 0.97 | 0.29 | 3.62 | 1.20 | 5.88 | 1.17 | 6.79 | 0.46 | < 0.05 | < 0.04 | 28.92 | -1.61 | 99.54 |
| #2 8 | 32.64 | < 0.05 | 0.07 | 0.10 | 0.14 | 0.64 | 0.21 | 3.31 | 1.14 | 5.86 | 1.18 | 6.66 | 0.44 | < 0.05 | < 0.04 | 29.33 | -1.64 | 99.97 |
| #2 9 | 37.99 | < 0.05 | 0.22 | 0.32 | 0.14 | 1.45 | 0.43 | 4.55 | 1.13 | 3.84 | 0.51 | 2.37 | < 0.03 | 0.10 | < 0.04 | 30.28 | -1.61 | 101.36 |
| #2 10 | 37.73 | < 0.05 | 0.10 | 0.16 | < 0.05 | 1.08 | 0.37 | 4.67 | 1.21 | 4.38 | 0.59 | 2.70 | < 0.04 | < 0.05 | < 0.04 | 29.84 | -1.55 | 100.56 |
| #2 11 | 37.99 | < 0.03 | 0.10 | 0.18 | 0.06 | 1.02 | 0.36 | 4.46 | 1.23 | 4.28 | 0.58 | 2.58 | 0.05 | < 0.03 | < 0.02 | 29.41 | -1.65 | 99.79 |
| #2 12 | 37.72 | < 0.03 | 0.11 | 0.16 | 0.11 | 1.00 | 0.36 | 4.42 | 1.21 | 4.26 | 0.59 | 2.57 | 0.06 | < 0.03 | < 0.02 | 29.40 | -1.63 | 99.51 |
| #2 13 | 37.40 | 0.06 | 0.40 | 0.31 | 0.05 | 1.15 | 0.35 | 4.14 | 1.13 | 4.13 | 0.57 | 2.50 | 0.06 | < 0.03 | < 0.02 | 29.38 | -1.70 | 99.56 |
| #2 14 | 36.18 | 0.10 | 0.61 | 0.38 | < 0.03 | 1.09 | 0.34 | 4.06 | 1.19 | 4.66 | 0.71 | 3.10 | 0.11 | < 0.03 | < 0.02 | 29.44 | -1.70 | 100.27 |
| #2 15 | 36.05 | 0.10 | 0.41 | 0.29 | 0.07 | 0.94 | 0.30 | 3.73 | 1.11 | 5.03 | 0.77 | 3.53 | 0.16 | < 0.03 | < 0.02 | 29.38 | -1.69 | 100.16 |
| #2 16 | 35.68 | 0.08 | 0.39 | 0.25 | 0.03 | 0.80 | 0.25 | 3.37 | 1.11 | 5.21 | 0.89 | 4.43 | 0.28 | < 0.03 | < 0.02 | 29.48 | -1.68 | 100.55 |
| #2 17 | 36.68 | 0.10 | 0.48 | 0.28 | 0.04 | 0.86 | 0.26 | 3.37 | 1.06 | 4.82 | 0.74 | 3.45 | 0.22 | < 0.03 | < 0.02 | 29.61 | -1.71 | 100.34 |
| #2 18 | 37.09 | 0.05 | 0.25 | 0.20 | 0.07 | 0.79 | 0.27 | 3.49 | 1.09 | 4.74 | 0.69 | 3.01 | 0.18 | < 0.03 | < 0.02 | 29.56 | -1.69 | 99.67 |
| #2 19 | 34.01 | 0.07 | 0.28 | 0.17 | 0.05 | 0.65 | 0.21 | 2.98 | 1.03 | 5.55 | 1.14 | 6.46 | 0.51 | < 0.03 | < 0.02 | 29.10 | -1.71 | 100.45 |
| #2 20 | 35.89 | < 0.03 | 0.09 | 0.13 | < 0.03 | 0.70 | 0.27 | 3.58 | 1.11 | 4.93 | 0.77 | 3.77 | 0.24 | < 0.03 | < 0.02 | 29.33 | -1.65 | 98.87 |
| #2 21 | 36.44 | 0.11 | 0.70 | 0.94 | 0.07 | 2.69 | 0.64 | 4.79 | 1.02 | 2.73 | 0.32 | 1.35 | 0.06 | < 0.03 | < 0.02 | 30.08 | -1.58 | 100.52 |
| #2 22 | 36.23 | 0.09 | 0.73 | 0.95 | 0.07 | 2.74 | 0.65 | 4.90 | 1.01 | 2.77 | 0.32 | 1.37 | 0.03 | < 0.03 | < 0.02 | 30.04 | -1.58 | 100.48 |
| #3 1 | 36.79 | < 0.07 | 0.04 | < 0.06 | < 0.06 | 0.45 | 0.22 | 3.31 | 1.16 | 5.01 | 0.83 | 4.00 | 0.26 | < 0.07 | < 0.04 | 28.86 | -1.64 | 98.16 |
| #3 2 | 35.53 | < 0.05 | 0.09 | 0.09 | 0.05 | 0.49 | 0.24 | 3.55 | 1.13 | 5.18 | 0.86 | 4.55 | 0.34 | < 0.05 | < 0.04 | 29.36 | -1.53 | 99.25 |
| #3 3 | 35.73 | < 0.05 | 0.08 | 0.12 | 0.11 | 0.43 | 0.24 | 3.56 | 1.18 | 4.96 | 0.79 | 4.13 | 0.28 | < 0.05 | < 0.04 | 29.07 | -1.58 | 98.24 |
| #3 4 | 36.54 | < 0.05 | 0.06 | 0.12 | < 0.05 | 0.30 | 0.20 | 3.28 | 1.22 | 4.88 | 0.78 | 4.05 | 0.30 | < 0.05 | < 0.03 | 29.42 | -1.62 | 98.97 |
| #3 5 | 36.53 | < 0.05 | 0.05 | 0.09 | 0.05 | 0.31 | 0.21 | 3.37 | 1.14 | 4.76 | 0.74 | 4.08 | 0.35 | < 0.05 | < 0.03 | 29.54 | -1.57 | 99.10 |
| #3 6 | 36.28 | < 0.05 | 0.04 | 0.11 | 0.06 | 0.20 | 0.25 | 3.50 | 1.23 | 4.72 | 0.74 | 4.17 | 0.38 | < 0.05 | < 0.03 | 29.36 | -1.66 | 98.90 |
| #3 7 | 36.22 | 0.16 | 0.84 | 0.52 | 0.06 | 0.76 | 0.40 | 4.29 | 1.26 | 4.43 | 0.63 | 2.80 | 0.12 | < 0.05 | < 0.04 | 29.98 | -1.87 | 101.65 |
| #3 8 | 37.57 | 0.15 | 0.77 | 0.55 | 0.05 | 0.99 | 0.37 | 4.05 | 1.06 | 3.66 | 0.47 | 2.11 | 0.09 | < 0.05 | < 0.04 | 30.07 | -1.85 | 100.97 |
| #3 9 | 39.29 | < 0.05 | 0.08 | 0.15 | < 0.05 | 0.51 | 0.32 | 3.64 | 1.06 | 3.72 | 0.49 | 2.33 | 0.18 | < 0.05 | < 0.03 | 30.29 | -1.82 | 100.46 |
| #3 10 | 37.91 | < 0.05 | 0.05 | 0.09 | < 0.05 | 0.46 | 0.30 | 3.78 | 1.15 | 4.31 | 0.61 | 2.88 | 0.15 | < 0.05 | < 0.03 | 29.80 | -1.76 | 99.60 |
| #3 11 | 37.82 | < 0.05 | 0.06 | 0.06 | < 0.05 | 0.30 | 0.28 | 3.65 | 1.17 | 4.18 | 0.58 | 2.86 | 0.12 | < 0.05 | < 0.03 | 29.78 | -1.66 | 98.87 |
| #3 12 | 33.67 | < 0.05 | 0.04 | 0.09 | < 0.05 | 0.21 | 0.26 | 3.48 | 1.24 | 5.58 | 1.11 | 6.89 | 0.52 | 0.07 | < 0.04 | 29.00 | -1.65 | 99.72 |
| #4 1 | 36.67 | < 0.03 | 0.09 | 0.13 | 0.06 | 0.82 | 0.27 | 3.51 | 1.04 | 4.68 | 0.72 | 3.30 | 0.23 | < 0.03 | < 0.02 | 29.51 | -1.67 | 99.18 |
| #4 2 | 36.50 | < 0.03 | 0.07 | 0.10 | 0.05 | 0.68 | 0.25 | 3.50 | 1.12 | 4.90 | 0.78 | 3.60 | 0.21 | < 0.03 | < 0.02 | 29.49 | -1.68 | 99.40 |
| #4 3 | 33.44 | < 0.03 | 0.05 | 0.09 | 0.05 | 0.54 | 0.21 | 3.20 | 1.08 | 5.64 | 1.15 | 6.67 | 0.53 | < 0.03 | < 0.02 | 29.13 | -1.61 | 99.76 |
| #4 4 | 36.18 | < 0.03 | 0.09 | 0.12 | < 0.03 | 0.72 | 0.23 | 3.45 | 1.06 | 4.85 | 0.80 | 3.95 | 0.30 | < 0.03 | < 0.02 | 29.56 | -1.68 | 99.54 |
| #4 5 | 36.45 | < 0.03 | 0.08 | 0.13 | < 0.03 | 0.74 | 0.25 | 3.49 | 1.04 | 4.78 | 0.77 | 3.90 | 0.31 | < 0.03 | < 0.02 | 29.63 | -1.69 | 99.85 |

**Table S6**. Full, raw elemental wt-% White Cloud data collected by the JEOL-8600 microprobe and used as the basis for the data and tables within the manuscript

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **F** | **Na** | **Mg** | **Al** | **Si** | **P** | **S** | **Ca** | **Ti** | **Mn** | **Fe** | **Sr** | **Ba** | **Th** | **U** |
| WC01 1 | 3.44 | 0.04 | < 0.01 | 0.12 | 15.53 | 0.02 | < 0.02 | 0.23 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 2 | 3.77 | < 0.02 | < 0.01 | < 0.03 | 15.06 | 0.02 | < 0.02 | 0.26 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.08 | 0.07 |
| WC01 3 | 3.19 | < 0.02 | < 0.01 | < 0.03 | 15.31 | < 0.02 | < 0.02 | 0.03 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.08 | < 0.05 |
| WC01 4 | 3.40 | < 0.02 | < 0.01 | 0.04 | 15.43 | < 0.02 | < 0.02 | 0.04 | < 0.03 | < 0.02 | < 0.02 | < 0.06 | < 0.04 | < 0.08 | < 0.06 |
| WC01 5 | 3.31 | < 0.02 | < 0.01 | 0.07 | 15.44 | < 0.02 | < 0.02 | 0.04 | < 0.03 | < 0.02 | 0.02 | < 0.06 | < 0.04 | < 0.08 | < 0.06 |
| WC01 6 | 3.78 | < 0.02 | < 0.01 | < 0.02 | 15.98 | < 0.02 | < 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 7 | 3.59 | < 0.02 | < 0.01 | < 0.03 | 16.05 | < 0.02 | < 0.02 | 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.08 | < 0.05 |
| WC01 8 | 3.12 | < 0.02 | < 0.01 | < 0.03 | 16.05 | < 0.02 | < 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 9 | 3.19 | < 0.02 | < 0.01 | < 0.03 | 15.95 | < 0.02 | < 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 10 | 3.34 | < 0.02 | < 0.01 | < 0.03 | 15.90 | < 0.02 | 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.08 | < 0.05 |
| WC01 11 | 3.35 | < 0.02 | < 0.01 | < 0.03 | 15.67 | < 0.02 | < 0.02 | 0.15 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 12 | 3.65 | < 0.02 | < 0.01 | < 0.03 | 15.53 | 0.02 | < 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.08 | < 0.05 |
| WC01 13 | 3.28 | < 0.02 | < 0.01 | < 0.03 | 15.58 | < 0.02 | < 0.02 | 0.02 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 14 | 3.20 | < 0.02 | < 0.01 | 0.04 | 14.94 | < 0.02 | < 0.02 | 0.03 | < 0.03 | < 0.02 | < 0.02 | < 0.06 | < 0.04 | 0.09 | < 0.06 |
| WC01 15 | 3.27 | < 0.02 | < 0.01 | 0.06 | 14.94 | < 0.02 | < 0.02 | 0.05 | < 0.03 | < 0.02 | 0.02 | < 0.06 | < 0.04 | < 0.08 | < 0.06 |
| WC01 16 | 3.37 | < 0.02 | < 0.01 | < 0.02 | 15.92 | 0.03 | < 0.02 | 0.18 | < 0.02 | < 0.02 | < 0.02 | < 0.04 | < 0.04 | < 0.07 | < 0.05 |
| WC01 17 | 3.60 | < 0.02 | < 0.01 | < 0.03 | 15.43 | 0.03 | < 0.02 | 0.07 | < 0.03 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC01 18 | 3.53 | < 0.02 | < 0.01 | < 0.03 | 15.88 | 0.02 | < 0.02 | 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.05 | < 0.04 | < 0.07 | < 0.05 |
| WC02 1 | 3.32 | 0.03 | < 0.01 | < 0.01 | 14.40 | < 0.01 | 0.01 | 0.35 | 0.02 | 0.06 | 0.06 | < 0.02 | < 0.03 | < 0.05 | < 0.06 |
| WC02 2 | 2.76 | 0.03 | < 0.01 | 0.18 | 15.11 | < 0.02 | < 0.01 | 0.90 | 0.03 | 0.05 | 0.27 | < 0.03 | < 0.03 | < 0.07 | < 0.07 |
| WC02 3 | 3.47 | < 0.02 | < 0.01 | 0.26 | 15.35 | < 0.02 | < 0.01 | 0.92 | < 0.03 | 0.08 | 0.49 | < 0.03 | < 0.04 | < 0.07 | < 0.07 |
| WC02 4 | 3.12 | 0.03 | < 0.01 | 0.23 | 15.30 | < 0.02 | 0.02 | 0.84 | < 0.03 | 0.06 | 0.35 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 5 | 3.20 | 0.03 | < 0.01 | 0.11 | 14.92 | < 0.02 | 0.02 | 0.68 | < 0.03 | 0.02 | 0.15 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 6 | 3.19 | < 0.02 | < 0.01 | < 0.01 | 14.68 | < 0.02 | 0.04 | 0.71 | < 0.03 | 0.04 | 0.06 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 7 | 3.20 | < 0.02 | < 0.01 | < 0.01 | 15.04 | < 0.02 | 0.03 | 0.57 | < 0.03 | 0.02 | 0.02 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 8 | 3.86 | < 0.02 | < 0.01 | < 0.01 | 15.57 | < 0.02 | < 0.01 | 0.08 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 9 | 4.28 | < 0.02 | < 0.01 | < 0.01 | 15.72 | < 0.02 | < 0.01 | 0.06 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 10 | 3.41 | 0.09 | < 0.01 | < 0.01 | 14.84 | < 0.02 | 0.02 | 0.14 | < 0.03 | < 0.01 | 0.07 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 11 | 3.36 | 0.09 | < 0.01 | < 0.01 | 14.75 | < 0.02 | < 0.01 | 0.23 | < 0.03 | < 0.01 | 0.09 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 12 | 3.55 | 0.05 | < 0.01 | < 0.01 | 15.20 | < 0.02 | < 0.01 | 0.23 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | 0.10 |
| WC02 13 | 4.17 | < 0.02 | < 0.01 | < 0.01 | 15.16 | < 0.02 | 0.06 | 0.08 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.08 | 0.09 |
| WC02 14 | 4.02 | 0.03 | < 0.01 | < 0.01 | 15.39 | < 0.02 | < 0.01 | 0.15 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 15 | 3.85 | < 0.02 | < 0.01 | < 0.01 | 15.44 | < 0.02 | < 0.01 | 0.17 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 16 | 3.71 | < 0.02 | < 0.01 | < 0.01 | 15.47 | < 0.02 | 0.02 | 0.13 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 17 | 3.53 | 0.03 | < 0.01 | < 0.01 | 15.38 | < 0.02 | < 0.01 | 0.19 | 0.04 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 18 | 3.35 | 0.03 | < 0.01 | < 0.01 | 15.17 | < 0.02 | 0.03 | 0.52 | < 0.03 | < 0.01 | 0.17 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 19 | 3.46 | 0.02 | < 0.01 | < 0.01 | 15.56 | 0.02 | < 0.01 | 0.23 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 20 | 3.45 | 0.03 | < 0.01 | < 0.01 | 15.06 | < 0.02 | 0.02 | 0.42 | < 0.03 | < 0.01 | 0.03 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 21 | 4.31 | < 0.02 | < 0.01 | < 0.01 | 14.26 | < 0.02 | < 0.01 | 0.43 | < 0.03 | < 0.01 | 0.02 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 22 | 3.83 | < 0.02 | < 0.01 | < 0.01 | 15.59 | < 0.02 | < 0.01 | 0.09 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 23 | 4.19 | < 0.02 | < 0.01 | < 0.01 | 15.59 | < 0.02 | < 0.01 | 0.08 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 24 | 4.13 | < 0.02 | < 0.01 | < 0.01 | 15.51 | < 0.02 | < 0.02 | 0.09 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | 0.09 |
| WC02 25 | 4.27 | < 0.02 | < 0.01 | < 0.01 | 15.67 | < 0.02 | < 0.01 | 0.08 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 26 | 4.25 | < 0.02 | < 0.01 | < 0.01 | 15.63 | < 0.02 | < 0.01 | 0.09 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 27 | 4.12 | < 0.02 | < 0.01 | < 0.01 | 15.60 | < 0.02 | < 0.01 | 0.10 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | 0.07 | < 0.08 |
| WC02 28 | 3.80 | < 0.02 | < 0.01 | < 0.01 | 14.67 | < 0.02 | 0.02 | 0.42 | < 0.03 | 0.02 | 0.02 | < 0.03 | < 0.03 | 0.07 | 0.08 |
| WC02 29 | 3.85 | 0.04 | < 0.01 | < 0.01 | 13.83 | < 0.02 | 0.12 | 0.55 | < 0.03 | 0.03 | 0.32 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 30 | 3.33 | 0.02 | < 0.01 | < 0.01 | 14.90 | < 0.02 | 0.05 | 0.69 | < 0.03 | < 0.01 | 0.14 | < 0.03 | < 0.04 | < 0.07 | 0.11 |
| WC02 31 | 3.24 | < 0.02 | < 0.01 | < 0.01 | 14.88 | < 0.02 | 0.04 | 0.72 | < 0.03 | < 0.01 | 0.24 | < 0.03 | < 0.04 | < 0.07 | 0.10 |
| WC02 32 | 3.69 | 0.02 | < 0.01 | < 0.01 | 15.11 | < 0.02 | < 0.01 | 0.32 | < 0.03 | 0.07 | 0.10 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 33 | 3.72 | 0.06 | < 0.01 | < 0.01 | 15.12 | < 0.02 | < 0.01 | 0.24 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | 0.11 | < 0.08 |
| WC02 34 | 4.13 | 0.02 | < 0.01 | < 0.01 | 15.28 | < 0.02 | < 0.01 | 0.18 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 35 | 3.58 | < 0.02 | < 0.01 | < 0.01 | 15.29 | < 0.02 | < 0.01 | 0.16 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 36 | 3.88 | < 0.02 | < 0.01 | < 0.01 | 15.50 | < 0.02 | < 0.01 | 0.15 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.07 |
| WC02 37 | 3.96 | < 0.02 | < 0.01 | < 0.01 | 15.31 | < 0.02 | < 0.01 | 0.15 | < 0.03 | < 0.01 | 0.27 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 38 | 3.73 | < 0.02 | < 0.01 | < 0.01 | 15.11 | < 0.02 | < 0.01 | 0.19 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 39 | 4.03 | < 0.02 | < 0.01 | < 0.01 | 15.26 | < 0.02 | < 0.01 | 0.14 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 40 | 3.74 | < 0.02 | < 0.01 | < 0.01 | 15.11 | < 0.02 | < 0.01 | 0.23 | < 0.03 | < 0.01 | 0.02 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 41 | 3.82 | < 0.02 | < 0.01 | < 0.01 | 15.22 | < 0.02 | < 0.01 | 0.18 | < 0.03 | < 0.01 | 0.02 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 42 | 3.50 | < 0.02 | < 0.01 | < 0.01 | 15.07 | < 0.02 | < 0.01 | 0.14 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 43 | 3.75 | < 0.02 | < 0.01 | 0.01 | 15.08 | < 0.02 | 0.02 | 0.05 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 44 | 4.10 | < 0.02 | < 0.01 | < 0.01 | 15.05 | < 0.02 | < 0.01 | 0.03 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 45 | 3.84 | < 0.02 | < 0.01 | < 0.01 | 15.07 | < 0.02 | < 0.01 | 0.03 | < 0.03 | < 0.01 | < 0.01 | 0.03 | < 0.03 | < 0.07 | < 0.08 |
| WC02 46 | 4.01 | 0.03 | < 0.01 | < 0.01 | 15.33 | 0.02 | < 0.01 | 0.24 | < 0.03 | < 0.01 | 0.32 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 47 | 3.80 | < 0.02 | < 0.01 | < 0.01 | 15.42 | < 0.02 | < 0.01 | 0.03 | < 0.03 | < 0.01 | < 0.02 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |
| WC02 48 | 3.70 | < 0.02 | < 0.01 | < 0.01 | 15.64 | < 0.02 | < 0.01 | 0.11 | < 0.03 | < 0.01 | < 0.01 | < 0.03 | < 0.04 | < 0.07 | < 0.08 |

**Table S6 cont.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Y** | **La** | **Ce** | **Pr** | **Nd** | **Sm** | **Eu** | **Gd** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** | **O** | **TOTAL** |
| WC01 1 | 35.15 | < 0.07 | 0.07 | < 0.08 | 0.19 | 0.50 | 0.17 | 1.30 | 0.52 | 4.11 | 0.93 | 3.67 | 0.71 | 5.38 | 0.37 | 28.56 | 101.00 |
| WC01 2 | 33.85 | < 0.07 | 0.15 | < 0.08 | 0.26 | 0.46 | 0.25 | 1.18 | 0.48 | 4.01 | 0.97 | 3.62 | 0.65 | 5.55 | 0.38 | 27.51 | 98.50 |
| WC01 3 | 30.25 | < 0.07 | < 0.06 | < 0.08 | 0.09 | 0.10 | 0.29 | 0.45 | 0.23 | 3.04 | 0.96 | 5.24 | 1.21 | 11.56 | 1.02 | 27.76 | 100.72 |
| WC01 4 | 24.14 | < 0.08 | < 0.06 | < 0.09 | 0.14 | 0.14 | 0.16 | 0.35 | 0.15 | 1.83 | 0.72 | 5.56 | 1.78 | 19.72 | 2.57 | 27.37 | 103.53 |
| WC01 5 | 23.62 | < 0.08 | < 0.06 | < 0.09 | 0.11 | < 0.08 | < 0.08 | 0.40 | 0.11 | 1.75 | 0.66 | 5.42 | 1.85 | 20.73 | 3.85 | 27.57 | 104.97 |
| WC01 6 | 35.14 | < 0.07 | < 0.06 | < 0.08 | 0.13 | 0.30 | 0.26 | 1.61 | 0.47 | 3.75 | 0.96 | 3.73 | 0.69 | 5.24 | 0.79 | 28.71 | 101.56 |
| WC01 7 | 35.35 | < 0.07 | < 0.06 | < 0.08 | 0.17 | 0.31 | 0.29 | 1.80 | 0.52 | 4.36 | 0.97 | 3.75 | 0.69 | 5.06 | 0.73 | 29.02 | 102.65 |
| WC01 8 | 35.31 | < 0.07 | < 0.06 | < 0.09 | 0.15 | 0.45 | 0.29 | 1.76 | 0.51 | 4.36 | 1.00 | 3.65 | 0.64 | 5.01 | 0.74 | 29.18 | 102.24 |
| WC01 9 | 31.32 | < 0.07 | < 0.06 | < 0.08 | 0.17 | 0.35 | 0.25 | 0.92 | 0.33 | 3.67 | 0.99 | 4.87 | 1.14 | 10.06 | 1.50 | 28.76 | 103.48 |
| WC01 10 | 30.82 | < 0.08 | < 0.06 | < 0.08 | 0.14 | 0.29 | 0.24 | 0.81 | 0.35 | 3.52 | 1.01 | 4.97 | 1.24 | 10.52 | 1.64 | 28.66 | 103.48 |
| WC01 11 | 36.27 | < 0.07 | < 0.06 | < 0.08 | 0.09 | 0.30 | 0.33 | 1.14 | 0.52 | 4.52 | 1.07 | 3.76 | 0.65 | 4.99 | 0.74 | 28.94 | 102.50 |
| WC01 12 | 35.46 | < 0.07 | < 0.06 | < 0.08 | 0.08 | 0.30 | 0.35 | 1.29 | 0.46 | 4.19 | 1.05 | 3.81 | 0.69 | 5.15 | 0.77 | 28.35 | 101.18 |
| WC01 13 | 35.45 | < 0.07 | < 0.06 | < 0.08 | 0.06 | 0.25 | 0.30 | 1.31 | 0.49 | 4.17 | 1.09 | 3.76 | 0.71 | 5.31 | 0.70 | 28.61 | 101.10 |
| WC01 14 | 24.47 | < 0.08 | < 0.06 | < 0.08 | 0.16 | < 0.08 | 0.11 | 0.49 | 0.11 | 2.21 | 0.71 | 5.54 | 1.72 | 18.98 | 3.28 | 27.08 | 103.14 |
| WC01 15 | 23.41 | < 0.07 | 0.08 | < 0.09 | 0.16 | 0.10 | 0.10 | 0.47 | 0.11 | 2.02 | 0.69 | 5.42 | 1.82 | 20.77 | 3.70 | 27.01 | 104.21 |
| WC01 16 | 35.60 | < 0.07 | < 0.06 | < 0.08 | 0.12 | 0.40 | 0.29 | 1.20 | 0.45 | 4.05 | 1.00 | 3.76 | 0.70 | 5.40 | 0.82 | 29.10 | 102.39 |
| WC01 17 | 32.09 | 0.08 | 0.69 | 0.12 | 1.97 | 1.97 | 0.09 | 3.00 | 0.68 | 4.53 | 0.91 | 3.21 | 0.59 | 3.88 | 0.48 | 28.09 | 101.49 |
| WC01 18 | 34.30 | < 0.07 | < 0.06 | < 0.08 | 0.23 | 0.98 | 0.20 | 2.52 | 0.71 | 4.90 | 1.02 | 3.44 | 0.60 | 4.07 | 0.57 | 28.69 | 101.66 |
| WC02 1 | 33.41 | < 0.05 | 0.07 | < 0.06 | 0.26 | 0.64 | 0.22 | 1.76 | 0.50 | 3.86 | 0.87 | 3.34 | 0.55 | 4.85 | 0.78 | 26.80 | 96.17 |
| WC02 2 | 31.62 | < 0.07 | 0.06 | < 0.08 | 0.38 | 0.64 | 0.20 | 1.61 | 0.40 | 3.62 | 0.80 | 3.31 | 0.58 | 5.29 | 0.86 | 27.86 | 96.58 |
| WC02 3 | 31.70 | < 0.07 | 0.15 | < 0.08 | 0.41 | 0.58 | 0.19 | 1.53 | 0.46 | 3.60 | 0.75 | 3.38 | 0.59 | 5.56 | 0.87 | 28.06 | 98.39 |
| WC02 4 | 32.08 | < 0.07 | 0.12 | < 0.08 | 0.44 | 0.63 | 0.28 | 1.58 | 0.37 | 3.53 | 0.82 | 3.39 | 0.61 | 5.53 | 0.88 | 28.15 | 98.35 |
| WC02 5 | 32.31 | < 0.07 | 0.22 | < 0.08 | 0.72 | 0.79 | 0.15 | 1.70 | 0.38 | 3.53 | 0.82 | 3.23 | 0.60 | 5.23 | 0.83 | 27.49 | 97.14 |
| WC02 6 | 32.89 | < 0.07 | 0.22 | 0.12 | 0.73 | 0.81 | 0.25 | 1.75 | 0.44 | 3.61 | 0.85 | 3.28 | 0.57 | 5.17 | 0.79 | 27.35 | 97.56 |
| WC02 7 | 33.01 | < 0.07 | 0.21 | < 0.08 | 0.66 | 0.80 | 0.14 | 1.82 | 0.42 | 3.74 | 0.80 | 3.32 | 0.55 | 5.27 | 0.82 | 27.68 | 98.12 |
| WC02 8 | 34.24 | < 0.07 | 0.23 | 0.10 | 0.73 | 0.86 | 0.25 | 1.71 | 0.42 | 3.66 | 0.86 | 3.42 | 0.57 | 5.44 | 0.86 | 28.07 | 100.93 |
| WC02 9 | 34.25 | < 0.07 | 0.26 | 0.10 | 0.85 | 0.97 | 0.19 | 1.92 | 0.46 | 3.82 | 0.93 | 3.35 | 0.54 | 4.75 | 0.70 | 28.03 | 101.18 |
| WC02 10 | 32.71 | < 0.07 | 0.27 | 0.18 | 0.97 | 0.94 | 0.21 | 2.23 | 0.54 | 3.98 | 0.81 | 3.41 | 0.57 | 4.89 | 0.74 | 27.27 | 98.31 |
| WC02 11 | 32.60 | 0.07 | 0.33 | < 0.08 | 0.98 | 1.07 | 0.25 | 2.10 | 0.55 | 3.95 | 0.85 | 3.35 | 0.53 | 4.80 | 0.74 | 27.14 | 97.80 |
| WC02 12 | 33.12 | 0.08 | 0.36 | 0.13 | 1.06 | 1.09 | 0.20 | 2.23 | 0.52 | 4.01 | 0.81 | 3.32 | 0.50 | 4.68 | 0.71 | 27.70 | 99.65 |
| WC02 13 | 36.12 | 0.07 | 0.36 | 0.09 | 1.04 | 1.11 | 0.17 | 2.24 | 0.52 | 3.93 | 0.78 | 3.19 | 0.50 | 4.53 | 0.72 | 28.12 | 103.06 |
| WC02 14 | 33.76 | < 0.07 | 0.21 | 0.13 | 0.87 | 1.01 | 0.24 | 2.15 | 0.56 | 4.08 | 0.90 | 3.35 | 0.53 | 4.63 | 0.69 | 27.79 | 100.48 |
| WC02 15 | 34.31 | < 0.07 | 0.12 | < 0.09 | 0.22 | 0.29 | 0.21 | 0.75 | 0.39 | 3.69 | 1.01 | 4.26 | 0.73 | 6.02 | 0.91 | 27.90 | 100.25 |
| WC02 16 | 33.43 | 0.08 | 0.37 | 0.11 | 0.93 | 0.99 | 0.28 | 2.03 | 0.47 | 3.96 | 0.86 | 3.33 | 0.56 | 4.69 | 0.69 | 27.90 | 100.01 |
| WC02 17 | 34.14 | < 0.07 | 0.15 | < 0.08 | 0.38 | 0.49 | 0.30 | 1.37 | 0.47 | 4.00 | 0.89 | 3.56 | 0.55 | 5.03 | 0.77 | 27.93 | 99.20 |
| WC02 18 | 32.98 | < 0.07 | 0.27 | 0.11 | 0.70 | 0.77 | 0.22 | 1.73 | 0.46 | 3.65 | 0.84 | 3.32 | 0.55 | 5.03 | 0.80 | 27.75 | 98.45 |
| WC02 19 | 35.00 | 0.07 | 0.09 | < 0.08 | 0.20 | 0.37 | 0.23 | 1.45 | 0.45 | 3.86 | 0.84 | 3.48 | 0.58 | 5.28 | 0.83 | 28.33 | 100.33 |
| WC02 20 | 33.29 | < 0.07 | 0.28 | < 0.08 | 0.71 | 0.74 | 0.22 | 1.86 | 0.47 | 3.67 | 0.82 | 3.31 | 0.61 | 5.49 | 0.89 | 27.66 | 99.01 |
| WC02 21 | 33.42 | 0.08 | 0.52 | 0.24 | 1.42 | 1.08 | 0.17 | 1.99 | 0.45 | 3.47 | 0.82 | 3.29 | 0.58 | 5.45 | 0.86 | 26.58 | 99.46 |
| WC02 22 | 33.75 | < 0.07 | 0.45 | 0.13 | 1.10 | 1.05 | 0.25 | 2.03 | 0.49 | 3.80 | 0.88 | 3.46 | 0.54 | 5.10 | 0.77 | 28.14 | 101.45 |
| WC02 23 | 33.72 | < 0.07 | 0.39 | 0.10 | 1.12 | 1.01 | 0.17 | 1.97 | 0.48 | 3.80 | 0.89 | 3.34 | 0.59 | 5.13 | 0.77 | 27.90 | 101.24 |
| WC02 24 | 33.78 | < 0.07 | 0.44 | 0.12 | 1.13 | 1.05 | 0.16 | 2.01 | 0.53 | 3.79 | 0.82 | 3.44 | 0.54 | 5.03 | 0.75 | 27.90 | 101.31 |
| WC02 25 | 33.79 | 0.10 | 0.49 | 0.12 | 1.05 | 0.97 | 0.22 | 1.91 | 0.51 | 3.73 | 0.90 | 3.39 | 0.60 | 5.20 | 0.78 | 28.03 | 101.80 |
| WC02 26 | 34.04 | 0.08 | 0.41 | < 0.08 | 1.14 | 0.98 | 0.19 | 1.83 | 0.46 | 3.78 | 0.87 | 3.33 | 0.60 | 5.22 | 0.83 | 28.03 | 101.79 |
| WC02 27 | 33.92 | 0.08 | 0.46 | < 0.08 | 1.05 | 0.94 | 0.25 | 1.84 | 0.49 | 3.66 | 0.86 | 3.42 | 0.56 | 5.33 | 0.83 | 28.03 | 101.61 |
| WC02 28 | 33.28 | 0.12 | 0.45 | 0.12 | 1.03 | 0.94 | 0.27 | 1.91 | 0.46 | 3.71 | 0.83 | 3.45 | 0.54 | 5.14 | 0.78 | 27.16 | 99.30 |
| WC02 29 | 33.66 | 0.09 | 0.47 | < 0.08 | 0.98 | 0.97 | 0.23 | 1.81 | 0.47 | 3.73 | 0.84 | 3.41 | 0.56 | 5.12 | 0.78 | 26.61 | 98.46 |
| WC02 30 | 32.39 | 0.07 | 0.42 | 0.13 | 1.00 | 0.88 | 0.18 | 1.70 | 0.49 | 3.71 | 0.86 | 3.37 | 0.59 | 5.26 | 0.83 | 27.57 | 98.69 |
| WC02 31 | 32.95 | < 0.07 | 0.38 | 0.19 | 0.90 | 0.87 | 0.24 | 1.64 | 0.48 | 3.64 | 0.91 | 3.37 | 0.57 | 5.18 | 0.81 | 27.78 | 99.14 |
| WC02 32 | 33.92 | < 0.07 | 0.15 | < 0.08 | 0.26 | 0.44 | 0.26 | 1.19 | 0.50 | 3.88 | 0.93 | 3.55 | 0.59 | 5.31 | 0.78 | 27.54 | 98.63 |
| WC02 33 | 34.49 | < 0.07 | 0.09 | < 0.08 | 0.21 | 0.49 | 0.22 | 1.56 | 0.47 | 4.06 | 0.86 | 3.54 | 0.59 | 5.26 | 0.81 | 27.66 | 99.55 |
| WC02 34 | 34.89 | < 0.06 | 0.09 | < 0.08 | 0.21 | 0.55 | 0.27 | 1.56 | 0.49 | 4.06 | 0.83 | 3.65 | 0.58 | 5.21 | 0.83 | 27.76 | 100.60 |
| WC02 35 | 35.45 | < 0.07 | 0.11 | < 0.08 | 0.28 | 0.52 | 0.22 | 1.58 | 0.54 | 4.22 | 0.89 | 3.40 | 0.57 | 4.77 | 0.70 | 28.05 | 100.35 |
| WC02 36 | 35.70 | < 0.07 | < 0.06 | < 0.08 | 0.18 | 0.38 | 0.22 | 1.42 | 0.46 | 3.93 | 0.91 | 3.50 | 0.55 | 4.85 | 0.68 | 28.09 | 100.42 |
| WC02 37 | 33.84 | < 0.07 | 0.13 | < 0.09 | 0.52 | 0.73 | 0.36 | 1.85 | 0.51 | 4.10 | 0.85 | 3.35 | 0.55 | 4.76 | 0.72 | 27.70 | 99.67 |
| WC02 38 | 34.57 | < 0.07 | 0.08 | < 0.08 | 0.37 | 0.59 | 0.26 | 2.03 | 0.49 | 4.12 | 0.78 | 3.49 | 0.53 | 4.95 | 0.73 | 27.62 | 99.61 |
| WC02 39 | 35.58 | < 0.07 | 0.06 | < 0.08 | 0.20 | 0.43 | 0.19 | 1.59 | 0.49 | 4.03 | 0.88 | 3.45 | 0.51 | 4.82 | 0.70 | 27.72 | 100.09 |
| WC02 40 | 34.51 | < 0.07 | 0.07 | 0.12 | 0.35 | 0.57 | 0.31 | 1.50 | 0.51 | 4.06 | 0.92 | 3.46 | 0.54 | 4.92 | 0.70 | 27.59 | 99.22 |
| WC02 41 | 35.29 | < 0.07 | 0.09 | < 0.08 | 0.22 | 0.36 | 0.26 | 1.33 | 0.47 | 3.89 | 0.89 | 3.56 | 0.58 | 5.07 | 0.76 | 27.80 | 99.82 |
| WC02 42 | 35.64 | < 0.07 | < 0.06 | < 0.08 | 0.14 | 0.37 | 0.24 | 1.22 | 0.45 | 4.06 | 0.86 | 3.52 | 0.55 | 4.91 | 0.72 | 27.73 | 99.11 |
| WC02 43 | 34.56 | < 0.07 | 0.25 | 0.10 | 0.77 | 0.81 | 0.18 | 1.85 | 0.44 | 3.71 | 0.87 | 3.45 | 0.54 | 5.40 | 0.84 | 27.74 | 100.43 |
| WC02 44 | 34.52 | < 0.07 | 0.13 | < 0.08 | 0.66 | 0.80 | 0.30 | 1.93 | 0.43 | 3.72 | 0.80 | 3.36 | 0.62 | 5.24 | 0.79 | 27.41 | 99.90 |
| WC02 45 | 35.38 | < 0.07 | < 0.06 | < 0.08 | 0.22 | 0.71 | 0.28 | 1.99 | 0.52 | 3.99 | 0.91 | 3.42 | 0.56 | 5.01 | 0.76 | 27.69 | 100.40 |
| WC02 46 | 34.32 | < 0.07 | 0.08 | < 0.08 | 0.23 | 0.34 | 0.30 | 1.09 | 0.38 | 3.84 | 0.91 | 3.63 | 0.57 | 5.35 | 0.83 | 27.78 | 99.60 |
| WC02 47 | 32.00 | < 0.07 | 0.53 | 0.21 | 1.65 | 1.85 | 0.40 | 3.19 | 0.75 | 5.01 | 1.00 | 3.26 | 0.42 | 3.70 | 0.52 | 27.83 | 101.58 |
| WC02 48 | 34.86 | < 0.07 | 0.47 | 0.10 | 1.38 | 1.28 | 0.30 | 2.62 | 0.62 | 4.36 | 0.82 | 2.84 | 0.35 | 2.79 | 0.41 | 28.32 | 100.98 |

**Table S7**. Full, raw elemental wt-% White Cloud data collected by the JEOL JXA-8230 microprobe

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Si** | **Al** | **Mg** | **Na** | **Sr** | **F** | **Ca** | **K** | **U** | **Th** | **Cl** | **S** | **P** | **Ti** | **Fe** | **Ta** | **Nb** | **As** | **Pb** |
| WC01 1a | 14.37 | 0.01 | 0.00 | <0.01 | <0.01 | 2.51 | 0.11 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 2 | 14.37 | 0.00 | 0.00 | <0.01 | <0.01 | 2.54 | 0.02 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 3 | 13.87 | 0.04 | 0.00 | <0.01 | <0.01 | 2.35 | 0.13 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 4 | 14.16 | 0.01 | <0.01 | <0.01 | <0.01 | 2.63 | 0.03 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 5 | 14.37 | 0.01 | <0.01 | <0.01 | <0.01 | 2.60 | 0.09 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 6 | 13.93 | 0.02 | 0.01 | <0.01 | <0.01 | 2.32 | 0.20 | <0.03 | <0.03 | <0.02 | 0.01 | <0.01 | 0.03 | <0.01 | 0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 7 | 14.37 | 0.00 | 0.00 | <0.01 | <0.01 | 2.41 | 0.12 | <0.03 | <0.03 | <0.02 | 0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.04 |
| WC01 8 | 13.60 | 0.05 | 0.01 | 0.05 | <0.01 | 1.70 | 0.72 | <0.03 | <0.03 | <0.02 | 0.32 | <0.01 | 0.03 | <0.01 | 0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 9 | 13.51 | 0.01 | 0.01 | 0.01 | <0.01 | 1.66 | 0.47 | <0.03 | 0.03 | <0.02 | 0.04 | <0.01 | 0.03 | <0.01 | 0.02 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 10 | 14.00 | 0.01 | 0.00 | <0.01 | <0.01 | 2.05 | 0.36 | <0.03 | <0.03 | <0.02 | 0.01 | <0.01 | 0.03 | <0.01 | 0.02 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 11 | 14.37 | 0.01 | 0.00 | <0.01 | <0.01 | 2.66 | 0.31 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 12 | 13.91 | 0.02 | 0.01 | <0.01 | <0.01 | 1.95 | 0.38 | <0.03 | <0.03 | <0.02 | 0.15 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 13 | 14.51 | 0.02 | 0.01 | 0.05 | <0.01 | 2.46 | 0.26 | <0.03 | 0.03 | <0.02 | 0.21 | <0.01 | 0.04 | <0.01 | 0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 14 | 14.49 | 0.05 | 0.01 | 0.02 | <0.01 | 2.62 | 0.14 | <0.03 | 0.03 | <0.02 | 0.11 | <0.01 | 0.04 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 15 | 14.49 | 0.01 | 0.01 | 0.03 | <0.01 | 2.57 | 0.16 | <0.03 | 0.03 | 0.02 | 0.14 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.05 |
| WC01 16 | 14.08 | 0.05 | 0.01 | 0.03 | <0.01 | 2.33 | 0.39 | <0.03 | 0.04 | <0.02 | 0.18 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.06 |
| WC01 17 | 14.39 | 0.05 | 0.00 | 0.02 | <0.01 | 2.55 | 0.23 | <0.03 | <0.03 | <0.02 | 0.12 | <0.01 | 0.04 | <0.01 | 0.02 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 18 | 14.44 | 0.04 | 0.01 | 0.05 | <0.01 | 2.57 | 0.17 | <0.03 | 0.03 | <0.02 | 0.16 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 19 | 14.19 | 0.07 | 0.01 | 0.03 | <0.01 | 2.55 | 0.22 | <0.03 | 0.03 | <0.02 | 0.15 | <0.01 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 20 | 13.79 | 0.05 | 0.01 | 0.02 | <0.01 | 2.47 | 0.31 | <0.03 | 0.06 | <0.02 | 0.12 | 0.01 | 0.04 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 21 | 13.60 | 0.06 | 0.01 | 0.02 | <0.01 | 2.49 | 0.29 | <0.03 | <0.03 | <0.02 | 0.09 | 0.00 | 0.03 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 22 | 14.14 | 0.02 | 0.00 | 0.02 | <0.01 | 2.44 | 0.36 | <0.03 | 0.03 | <0.02 | 0.14 | <0.01 | 0.03 | <0.01 | 0.04 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 23 | 13.92 | 0.04 | 0.01 | 0.05 | <0.01 | 2.21 | 0.50 | <0.03 | 0.03 | <0.02 | 0.16 | 0.01 | 0.04 | <0.01 | 0.08 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 24 | 13.84 | 0.08 | 0.01 | 0.07 | <0.01 | 2.34 | 0.51 | <0.03 | 0.03 | <0.02 | 0.27 | 0.02 | 0.04 | <0.01 | 0.23 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 25 | 13.61 | 0.07 | 0.01 | 0.08 | <0.01 | 2.12 | 0.54 | <0.03 | 0.03 | <0.02 | 0.34 | 0.02 | 0.03 | <0.01 | 0.29 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 26 | 13.97 | 0.06 | 0.01 | 0.04 | <0.01 | 2.49 | 0.36 | <0.03 | 0.04 | <0.02 | 0.12 | 0.01 | 0.04 | <0.01 | 0.12 | <0.05 | <0.02 | <0.01 | 0.04 |
| WC01 27 | 13.67 | 0.08 | 0.01 | 0.05 | <0.01 | 2.33 | 0.52 | <0.03 | 0.06 | <0.02 | 0.09 | 0.03 | 0.04 | <0.01 | 0.24 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 28 | 13.87 | 0.02 | 0.01 | 0.06 | <0.01 | 2.53 | 0.19 | <0.03 | 0.05 | <0.02 | 0.10 | 0.00 | 0.04 | <0.01 | 0.13 | <0.05 | <0.02 | <0.01 | 0.04 |
| WC01 29 | 13.91 | 0.09 | 0.01 | 0.07 | <0.01 | 2.36 | 0.45 | <0.03 | 0.04 | <0.02 | 0.14 | 0.02 | 0.04 | <0.01 | 0.46 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 30 | 14.28 | 0.13 | 0.01 | 0.02 | <0.01 | 2.29 | 0.50 | <0.03 | 0.04 | <0.02 | 0.02 | 0.01 | 0.04 | <0.01 | 0.19 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 31 | 14.13 | 0.12 | 0.02 | 0.04 | <0.01 | 2.42 | 0.53 | <0.03 | 0.06 | <0.02 | 0.10 | 0.02 | 0.03 | <0.01 | 0.24 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 32 | 13.74 | 0.10 | 0.01 | 0.02 | <0.01 | 2.31 | 0.54 | <0.03 | <0.03 | <0.02 | 0.03 | 0.01 | 0.04 | <0.01 | 0.21 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 33 | 13.84 | 0.17 | 0.01 | 0.11 | <0.01 | 1.97 | 0.72 | <0.03 | 0.03 | <0.02 | 0.22 | 0.03 | 0.04 | <0.01 | 0.42 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 34 | 13.74 | 0.16 | 0.01 | 0.09 | <0.01 | 1.98 | 0.66 | <0.03 | <0.03 | <0.02 | 0.22 | 0.03 | 0.03 | <0.01 | 0.35 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 35 | 14.10 | 0.14 | 0.02 | 0.05 | <0.01 | 2.35 | 0.56 | <0.03 | 0.05 | <0.02 | 0.07 | 0.02 | 0.04 | <0.01 | 0.25 | <0.05 | <0.02 | <0.01 | 0.05 |
| WC01 36 | 14.04 | 0.13 | 0.01 | 0.07 | <0.01 | 2.25 | 0.59 | <0.03 | <0.03 | <0.02 | 0.14 | 0.03 | 0.03 | <0.01 | 0.28 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 37 | 13.33 | 0.19 | 0.01 | 0.09 | <0.01 | 1.79 | 0.68 | <0.03 | 0.04 | <0.02 | 0.28 | 0.06 | 0.03 | <0.01 | 0.26 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 38 | 13.64 | 0.25 | 0.01 | 0.10 | <0.01 | 1.70 | 0.73 | <0.03 | 0.03 | <0.02 | 0.28 | 0.03 | 0.04 | <0.01 | 0.38 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 39 | 13.83 | 0.22 | 0.01 | 0.12 | <0.01 | 1.76 | 0.80 | <0.03 | 0.07 | <0.02 | 0.28 | 0.03 | 0.03 | <0.01 | 0.40 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 40 | 13.88 | 0.18 | 0.01 | 0.10 | <0.01 | 1.83 | 0.69 | <0.03 | 0.03 | <0.02 | 0.23 | 0.03 | 0.03 | <0.01 | 0.39 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 41 | 13.73 | 0.17 | 0.01 | 0.07 | <0.01 | 1.58 | 0.65 | <0.03 | 0.03 | <0.02 | 0.40 | 0.03 | 0.03 | <0.01 | 0.57 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 42 | 13.62 | 0.18 | 0.01 | 0.07 | <0.01 | 1.61 | 0.62 | <0.03 | <0.03 | <0.02 | 0.39 | 0.03 | 0.04 | <0.01 | 0.50 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 43 | 13.64 | 0.18 | 0.01 | 0.08 | <0.01 | 1.67 | 0.61 | <0.03 | 0.04 | <0.02 | 0.33 | 0.03 | 0.03 | <0.01 | 0.40 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 44 | 13.40 | 0.20 | 0.01 | 0.08 | <0.01 | 1.80 | 0.63 | <0.03 | 0.06 | <0.02 | 0.34 | 0.04 | 0.03 | <0.01 | 1.02 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 45 | 13.53 | 0.19 | 0.01 | 0.06 | <0.01 | 1.53 | 0.65 | <0.03 | <0.03 | <0.02 | 0.45 | 0.03 | 0.03 | <0.01 | 0.51 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 46 | 13.41 | 0.20 | 0.01 | 0.08 | <0.01 | 1.72 | 0.61 | <0.03 | 0.04 | <0.02 | 0.37 | 0.03 | 0.03 | <0.01 | 0.58 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 47 | 13.51 | 0.06 | 0.01 | 0.04 | <0.01 | 2.11 | 0.42 | <0.03 | 0.03 | <0.02 | 0.11 | 0.01 | 0.03 | <0.01 | 0.08 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 48 | 13.63 | 0.08 | 0.00 | 0.02 | <0.01 | 2.05 | 0.46 | <0.03 | <0.03 | <0.02 | 0.12 | 0.01 | 0.03 | <0.01 | 0.04 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 49 | 13.91 | 0.13 | 0.00 | 0.02 | <0.01 | 2.16 | 0.46 | <0.03 | <0.03 | <0.02 | 0.07 | 0.01 | 0.04 | <0.01 | 0.10 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 50 | 13.85 | <0.01 | 0.01 | 0.07 | <0.01 | 2.24 | 0.44 | <0.03 | 0.05 | <0.02 | 0.20 | <0.01 | 0.04 | <0.01 | 0.08 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 51 | 13.89 | 0.00 | 0.01 | 0.01 | <0.01 | 1.87 | 0.68 | <0.03 | 0.04 | <0.02 | <0.01 | <0.01 | 0.04 | <0.01 | 0.12 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 52 | 13.74 | <0.01 | 0.01 | <0.01 | <0.01 | 1.88 | 0.88 | <0.03 | <0.03 | <0.02 | <0.01 | 0.01 | 0.03 | <0.01 | 0.05 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 53 | 13.71 | 0.01 | 0.01 | 0.01 | <0.01 | 2.05 | 0.83 | <0.03 | 0.03 | <0.02 | 0.00 | <0.01 | 0.04 | <0.01 | 0.23 | <0.05 | <0.02 | <0.01 | 0.04 |
| WC01 54 | 14.07 | 0.00 | 0.01 | 0.11 | <0.01 | 2.45 | 0.11 | <0.03 | 0.06 | <0.02 | 0.10 | <0.01 | 0.04 | <0.01 | 0.04 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 55 | 13.99 | <0.01 | 0.01 | 0.12 | <0.01 | 2.28 | 0.13 | <0.03 | 0.05 | <0.02 | 0.16 | <0.01 | 0.03 | <0.01 | 0.03 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 56 | 14.02 | 0.01 | 0.01 | 0.10 | <0.01 | 2.20 | 0.18 | <0.03 | 0.06 | <0.02 | 0.24 | <0.01 | 0.03 | <0.01 | 0.03 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 57 | 13.66 | <0.01 | 0.02 | 0.03 | <0.01 | 2.14 | 0.59 | <0.03 | 0.04 | <0.02 | 0.07 | 0.01 | 0.03 | <0.01 | 0.17 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 58 | 13.65 | 0.09 | 0.00 | 0.03 | <0.01 | 1.96 | 0.52 | <0.03 | 0.04 | <0.02 | 0.03 | 0.01 | 0.04 | <0.01 | 0.11 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 59 | 13.58 | 0.12 | 0.01 | 0.00 | <0.01 | 1.90 | 0.57 | <0.03 | <0.03 | <0.02 | <0.01 | 0.01 | 0.04 | <0.01 | 0.09 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 60 | 13.74 | 0.16 | 0.00 | <0.01 | <0.01 | 1.80 | 0.65 | <0.03 | 0.05 | <0.02 | <0.01 | 0.02 | 0.04 | <0.01 | 0.12 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 61 | 14.15 | 0.34 | 0.00 | 0.04 | <0.01 | 1.65 | 0.87 | <0.03 | <0.03 | <0.02 | 0.14 | 0.01 | 0.03 | <0.01 | 0.45 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 62 | 14.13 | 0.30 | 0.01 | 0.05 | <0.01 | 1.80 | 0.81 | <0.03 | <0.03 | <0.02 | 0.11 | 0.01 | 0.03 | <0.01 | 0.45 | <0.05 | <0.02 | 0.01 | <0.02 |
| WC01 63 | 14.22 | 0.33 | 0.01 | 0.04 | <0.01 | 1.82 | 0.87 | <0.03 | <0.03 | <0.02 | 0.13 | <0.01 | 0.03 | <0.01 | 0.49 | <0.05 | <0.02 | <0.01 | 0.02 |
| WC01 64 | 14.25 | 0.33 | 0.00 | 0.04 | <0.01 | 1.83 | 0.86 | <0.03 | <0.03 | <0.02 | 0.13 | 0.01 | 0.04 | <0.01 | 0.56 | <0.05 | <0.02 | <0.01 | 0.05 |
| WC01 65 | 14.23 | 0.31 | 0.01 | 0.06 | <0.01 | 1.82 | 0.85 | <0.03 | 0.04 | <0.02 | 0.10 | 0.01 | 0.03 | <0.01 | 0.42 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 66 | 14.30 | 0.30 | 0.01 | 0.03 | <0.01 | 1.95 | 0.79 | <0.03 | <0.03 | <0.02 | 0.13 | 0.01 | 0.04 | <0.01 | 0.48 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 67 | 13.99 | 0.26 | 0.01 | 0.02 | <0.01 | 1.87 | 0.72 | <0.03 | <0.03 | <0.02 | 0.04 | 0.01 | 0.04 | <0.01 | 0.41 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 68 | 14.17 | 0.27 | 0.00 | 0.03 | <0.01 | 1.96 | 0.69 | <0.03 | 0.03 | <0.02 | 0.02 | 0.01 | 0.04 | <0.01 | 0.25 | <0.05 | <0.02 | <0.01 | 0.02 |
| WC01 69 | 13.97 | 0.19 | 0.00 | 0.02 | <0.01 | 2.05 | 0.53 | <0.03 | 0.05 | <0.02 | 0.02 | 0.00 | 0.04 | <0.01 | 0.21 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 70 | 13.92 | 0.21 | 0.01 | 0.01 | <0.01 | 1.99 | 0.58 | <0.03 | <0.03 | <0.02 | 0.01 | 0.01 | 0.03 | <0.01 | 0.05 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 71 | 13.73 | 0.12 | 0.01 | 0.03 | <0.01 | 2.15 | 0.39 | <0.03 | <0.03 | <0.02 | 0.09 | <0.01 | 0.04 | <0.01 | 0.06 | <0.05 | <0.02 | <0.01 | 0.03 |
| WC01 72 | 13.81 | 0.24 | 0.01 | 0.01 | <0.01 | 1.88 | 0.65 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.04 | <0.01 | 0.14 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 73 | 13.83 | 0.20 | 0.01 | 0.01 | <0.01 | 2.18 | 0.51 | <0.03 | <0.03 | <0.02 | 0.00 | 0.01 | 0.04 | <0.01 | 0.12 | <0.05 | <0.02 | <0.01 | 0.04 |
| WC01 74 | 13.70 | 0.04 | 0.01 | 0.03 | <0.01 | 2.67 | 0.24 | <0.03 | 0.04 | <0.02 | 0.09 | <0.01 | 0.04 | <0.01 | 0.03 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 75 | 14.73 | 0.01 | 0.01 | <0.01 | <0.01 | 2.66 | 0.05 | <0.03 | <0.03 | <0.02 | 0.01 | <0.01 | 0.04 | <0.01 | <0.01 | <0.05 | <0.02 | 0.01 | 0.04 |
| WC01 76 | 14.68 | <0.01 | 0.00 | <0.01 | <0.01 | 2.73 | 0.03 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.04 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 77 | 14.69 | <0.01 | 0.00 | <0.01 | <0.01 | 2.69 | 0.04 | <0.03 | <0.03 | 0.02 | <0.01 | <0.01 | 0.04 | <0.01 | 0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC01 78 | 14.81 | <0.01 | 0.00 | <0.01 | <0.01 | 2.79 | 0.04 | <0.03 | <0.03 | <0.02 | <0.01 | <0.01 | 0.04 | <0.01 | <0.01 | <0.05 | <0.02 | <0.01 | <0.02 |
| WC02 1 | 14.59 | 0.09 | 0.00 | <0.01 | <0.01 | 1.93 | 0.32 | <0.05 | <0.04 | <0.03 | 0.01 | <0.01 | 0.04 | 0.03 | 0.06 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 2 | 14.70 | 0.09 | 0.02 | <0.01 | <0.01 | 2.12 | 0.21 | <0.05 | <0.04 | <0.03 | 0.02 | <0.01 | 0.04 | <0.02 | 0.04 | <0.07 | <0.03 | <0.01 | 0.05 |
| WC02 3 | 14.58 | 0.05 | 0.01 | <0.01 | <0.01 | 2.03 | 0.15 | <0.05 | <0.04 | <0.03 | 0.04 | <0.01 | 0.04 | <0.02 | 0.04 | <0.07 | <0.03 | <0.01 | 0.04 |
| WC02 4 | 14.64 | 0.05 | <0.01 | <0.01 | <0.01 | 2.03 | 0.11 | <0.05 | <0.04 | <0.03 | 0.01 | <0.01 | 0.04 | <0.02 | 0.02 | <0.07 | <0.03 | <0.01 | 0.05 |
| WC02 5 | 14.45 | 0.08 | 0.01 | <0.01 | <0.01 | 2.00 | 0.31 | <0.05 | <0.04 | <0.03 | 0.01 | 0.01 | 0.03 | 0.03 | 0.03 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 6 | 13.57 | 0.09 | 0.01 | <0.01 | <0.01 | 1.72 | 0.34 | <0.05 | <0.04 | <0.03 | 0.01 | <0.01 | 0.02 | <0.02 | 0.22 | <0.08 | <0.03 | <0.01 | <0.04 |
| WC02 7 | 14.19 | 0.04 | 0.01 | 0.01 | <0.01 | 2.06 | 0.16 | <0.05 | <0.04 | <0.03 | 0.06 | <0.01 | 0.04 | <0.02 | 0.03 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 8 | 14.52 | 0.10 | 0.01 | <0.01 | <0.01 | 2.04 | 0.28 | <0.05 | <0.04 | <0.03 | <0.01 | <0.01 | 0.04 | <0.02 | 0.07 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 9 | 14.31 | 0.08 | 0.01 | <0.01 | <0.01 | 1.94 | 0.43 | <0.05 | <0.04 | <0.03 | <0.01 | <0.01 | 0.04 | <0.02 | 0.13 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 10 | 14.02 | 0.10 | 0.01 | <0.01 | <0.01 | 1.97 | 0.26 | <0.05 | <0.04 | <0.03 | 0.01 | <0.01 | 0.03 | <0.02 | 0.03 | <0.08 | <0.03 | <0.01 | 0.06 |
| WC02 11 | 14.42 | 0.02 | 0.01 | 0.01 | <0.01 | 2.73 | 0.30 | <0.05 | <0.04 | 0.07 | 0.05 | <0.01 | 0.03 | <0.02 | 0.04 | <0.07 | <0.03 | <0.01 | 0.04 |
| WC02 12 | 14.65 | <0.01 | 0.01 | <0.01 | <0.01 | 2.80 | 0.22 | <0.05 | <0.04 | <0.03 | <0.01 | <0.01 | 0.04 | <0.02 | 0.02 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 13 | 14.38 | 0.02 | 0.00 | 0.01 | <0.01 | 2.94 | 0.18 | <0.05 | <0.04 | <0.03 | 0.06 | <0.01 | 0.07 | <0.02 | <0.02 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 14 | 14.34 | 0.01 | 0.01 | <0.01 | <0.01 | 2.63 | 0.04 | <0.05 | <0.04 | <0.03 | <0.01 | <0.01 | 0.04 | <0.02 | <0.02 | <0.07 | <0.03 | <0.01 | 0.05 |
| WC02 15 | 14.61 | 0.01 | 0.01 | <0.01 | <0.01 | 2.60 | 0.05 | <0.05 | <0.04 | <0.03 | <0.01 | <0.01 | 0.04 | <0.02 | <0.02 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 16 | 14.40 | 0.01 | 0.00 | 0.00 | <0.01 | 2.74 | 0.07 | <0.05 | <0.04 | <0.03 | 0.02 | <0.01 | 0.04 | <0.02 | <0.02 | <0.07 | <0.03 | <0.01 | <0.04 |
| WC02 17 | 14.43 | 0.01 | 0.00 | <0.01 | <0.01 | 2.50 | 0.02 | <0.05 | <0.04 | 0.05 | <0.01 | <0.01 | 0.04 | <0.02 | <0.02 | <0.07 | <0.03 | 0.02 | 0.05 |

**Table S7 cont.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Y** | **La** | **Ce** | **Pr** | **Nd** | **Sm** | **Eu** | **Gd** | **Mn** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** | **O** | **TOTAL** |
| WC01 1a | 30.45 | <0.03 | 0.04 | <0.05 | 0.08 | 0.12 | <0.05 | 0.42 | <0.01 | 0.18 | 2.72 | 0.93 | 5.10 | 1.37 | 13.27 | 2.33 | 27.32 | 101.37 |
| WC01 2 | 31.88 | <0.03 | <0.03 | <0.05 | <0.03 | 0.12 | <0.05 | 0.49 | <0.01 | 0.24 | 3.09 | 0.98 | 5.29 | 1.29 | 11.61 | 1.93 | 27.46 | 101.37 |
| WC01 3 | 27.80 | <0.03 | <0.03 | <0.05 | <0.03 | 0.07 | <0.05 | 0.41 | 0.05 | 0.15 | 2.39 | 0.85 | 5.55 | 1.61 | 15.56 | 2.62 | 26.53 | 100.04 |
| WC01 4 | 29.23 | <0.03 | <0.03 | <0.05 | <0.03 | <0.05 | <0.05 | 0.25 | <0.01 | 0.14 | 2.41 | 0.93 | 5.97 | 1.68 | 14.87 | 2.36 | 26.98 | 101.69 |
| WC01 5 | 27.80 | <0.03 | <0.03 | <0.05 | 0.06 | 0.13 | <0.05 | 0.31 | <0.01 | 0.16 | 2.30 | 0.84 | 5.69 | 1.70 | 16.85 | 2.93 | 27.21 | 103.08 |
| WC01 6 | 27.17 | <0.03 | 0.06 | <0.05 | 0.08 | 0.09 | <0.05 | 0.19 | <0.01 | 0.14 | 2.33 | 0.91 | 5.55 | 1.74 | 17.56 | 2.98 | 26.79 | 102.17 |
| WC01 7 | 30.93 | <0.03 | <0.03 | <0.05 | 0.03 | 0.15 | <0.05 | 0.21 | <0.01 | 0.16 | 2.57 | 1.00 | 5.58 | 1.50 | 13.44 | 2.13 | 27.57 | 102.25 |
| WC01 8 | 23.17 | <0.03 | <0.03 | <0.05 | 0.05 | 0.06 | <0.05 | 0.37 | 0.03 | 0.12 | 1.88 | 0.64 | 5.03 | 1.79 | 20.69 | 3.95 | 26.20 | 100.47 |
| WC01 9 | 26.42 | <0.03 | <0.03 | <0.05 | <0.03 | <0.05 | <0.05 | 0.16 | <0.01 | 0.14 | 2.20 | 0.85 | 5.52 | 1.77 | 17.48 | 3.03 | 26.42 | 99.80 |
| WC01 10 | 28.01 | <0.03 | <0.03 | <0.05 | <0.03 | 0.08 | <0.05 | 0.27 | <0.01 | 0.10 | 2.19 | 0.87 | 5.63 | 1.69 | 16.63 | 2.76 | 27.08 | 101.82 |
| WC01 11 | 29.92 | <0.03 | <0.03 | <0.05 | <0.03 | 0.07 | <0.05 | 0.28 | <0.01 | 0.17 | 2.41 | 0.89 | 5.64 | 1.54 | 14.32 | 2.37 | 27.37 | 102.37 |
| WC01 12 | 27.20 | <0.03 | <0.03 | <0.05 | <0.03 | 0.09 | <0.05 | 0.21 | 0.03 | 0.11 | 2.06 | 0.83 | 5.49 | 1.71 | 16.79 | 2.88 | 26.75 | 100.59 |
| WC01 13 | 34.32 | <0.03 | 0.17 | 0.08 | 0.67 | 0.82 | <0.05 | 1.83 | <0.01 | 0.49 | 4.07 | 0.91 | 3.58 | 0.69 | 5.57 | 0.84 | 27.76 | 99.42 |
| WC01 14 | 34.45 | <0.03 | 0.26 | 0.08 | 0.86 | 1.01 | <0.05 | 2.08 | <0.01 | 0.50 | 3.98 | 0.90 | 3.59 | 0.66 | 5.51 | 0.87 | 27.81 | 100.10 |
| WC01 15 | 34.26 | <0.03 | 0.21 | 0.08 | 0.89 | 1.00 | <0.05 | 2.15 | <0.01 | 0.47 | 4.11 | 0.91 | 3.60 | 0.67 | 5.56 | 0.81 | 27.76 | 100.03 |
| WC01 16 | 33.49 | <0.03 | 0.22 | 0.10 | 0.84 | 0.99 | <0.05 | 2.12 | 0.07 | 0.49 | 4.13 | 0.89 | 3.58 | 0.67 | 5.44 | 0.84 | 27.28 | 98.35 |
| WC01 17 | 34.24 | <0.03 | 0.17 | 0.11 | 0.84 | 0.91 | <0.05 | 2.02 | 0.01 | 0.42 | 3.92 | 0.90 | 3.49 | 0.74 | 5.61 | 0.92 | 27.62 | 99.34 |
| WC01 18 | 34.64 | 0.04 | 0.17 | <0.05 | 0.72 | 0.81 | <0.05 | 1.73 | <0.01 | 0.40 | 3.68 | 0.95 | 3.59 | 0.67 | 5.93 | 0.92 | 27.67 | 99.41 |
| WC01 19 | 34.11 | 0.04 | 0.22 | 0.05 | 0.89 | 0.94 | <0.05 | 1.89 | 0.05 | 0.48 | 3.95 | 0.96 | 3.53 | 0.69 | 5.69 | 0.89 | 27.40 | 99.05 |
| WC01 20 | 33.96 | <0.03 | 0.55 | 0.08 | 0.75 | 0.91 | <0.05 | 1.90 | 0.13 | 0.46 | 3.85 | 0.86 | 3.64 | 0.68 | 5.78 | 0.90 | 27.04 | 98.37 |
| WC01 21 | 34.05 | <0.03 | 0.21 | 0.06 | 0.76 | 0.88 | <0.05 | 1.88 | 0.12 | 0.45 | 3.87 | 0.95 | 3.66 | 0.67 | 5.74 | 0.92 | 26.76 | 97.60 |
| WC01 22 | 34.51 | <0.03 | 0.24 | 0.11 | 0.66 | 0.73 | <0.05 | 1.75 | 0.02 | 0.48 | 4.05 | 0.91 | 3.59 | 0.66 | 5.11 | 0.78 | 27.35 | 98.19 |
| WC01 23 | 33.39 | <0.03 | 0.22 | 0.08 | 0.80 | 0.86 | <0.05 | 2.11 | 0.06 | 0.44 | 3.86 | 0.84 | 3.58 | 0.69 | 5.51 | 0.83 | 27.14 | 97.45 |
| WC01 24 | 33.30 | <0.03 | 0.25 | <0.05 | 0.75 | 0.86 | <0.05 | 1.97 | 0.03 | 0.47 | 3.96 | 0.84 | 3.56 | 0.69 | 5.59 | 0.82 | 27.04 | 97.57 |
| WC01 25 | 32.86 | <0.03 | 0.21 | 0.06 | 0.81 | 0.89 | <0.05 | 1.92 | 0.03 | 0.45 | 3.93 | 0.89 | 3.57 | 0.69 | 5.51 | 0.82 | 26.71 | 96.52 |
| WC01 26 | 34.19 | <0.03 | 0.15 | 0.05 | 0.64 | 0.83 | <0.05 | 1.97 | 0.03 | 0.52 | 4.33 | 0.93 | 3.51 | 0.68 | 5.03 | 0.72 | 27.19 | 98.08 |
| WC01 27 | 33.57 | <0.03 | 0.23 | <0.05 | 0.75 | 0.95 | <0.05 | 2.27 | 0.06 | 0.50 | 4.20 | 0.90 | 3.55 | 0.64 | 4.78 | 0.70 | 26.95 | 97.18 |
| WC01 28 | 33.38 | 0.05 | 0.30 | 0.08 | 0.93 | 1.06 | <0.05 | 2.20 | 0.01 | 0.49 | 4.20 | 0.94 | 3.53 | 0.67 | 5.13 | 0.79 | 26.90 | 97.70 |
| WC01 29 | 32.52 | <0.03 | 0.24 | 0.10 | 0.82 | 1.02 | <0.05 | 2.03 | 0.06 | 0.49 | 4.20 | 0.94 | 3.53 | 0.64 | 5.13 | 0.77 | 26.99 | 97.05 |
| WC01 30 | 33.78 | <0.03 | 0.14 | <0.05 | 0.42 | 0.67 | <0.05 | 1.62 | 0.10 | 0.44 | 4.09 | 1.04 | 3.76 | 0.68 | 5.10 | 0.76 | 27.60 | 97.74 |
| WC01 31 | 33.06 | <0.03 | 0.17 | <0.05 | 0.60 | 0.84 | 0.07 | 1.90 | 0.06 | 0.49 | 4.28 | 1.02 | 3.60 | 0.67 | 5.19 | 0.77 | 27.33 | 97.83 |
| WC01 32 | 34.13 | <0.03 | 0.12 | 0.06 | 0.41 | 0.65 | <0.05 | 1.73 | 0.11 | 0.47 | 4.24 | 0.94 | 3.75 | 0.66 | 4.97 | 0.73 | 27.06 | 97.07 |
| WC01 33 | 31.91 | <0.03 | 0.23 | <0.05 | 0.72 | 0.96 | <0.05 | 2.21 | 0.08 | 0.49 | 4.14 | 0.85 | 3.56 | 0.62 | 5.03 | 0.75 | 27.06 | 96.16 |
| WC01 34 | 31.92 | <0.03 | 0.23 | <0.05 | 0.72 | 0.92 | <0.05 | 2.45 | 0.07 | 0.50 | 4.24 | 0.80 | 3.59 | 0.63 | 5.18 | 0.76 | 26.94 | 96.23 |
| WC01 35 | 33.41 | <0.03 | 0.19 | <0.05 | 0.61 | 0.83 | <0.05 | 2.03 | 0.08 | 0.49 | 4.24 | 0.94 | 3.60 | 0.60 | 4.77 | 0.65 | 27.37 | 97.52 |
| WC01 36 | 33.25 | <0.03 | 0.21 | 0.09 | 0.70 | 0.95 | <0.05 | 2.06 | 0.08 | 0.47 | 4.28 | 0.98 | 3.53 | 0.61 | 4.60 | 0.60 | 27.32 | 97.29 |
| WC01 37 | 31.59 | <0.03 | 0.21 | 0.08 | 0.68 | 0.87 | <0.05 | 1.99 | 0.06 | 0.46 | 4.09 | 0.91 | 3.62 | 0.66 | 5.41 | 0.76 | 26.42 | 94.58 |
| WC01 38 | 30.78 | <0.03 | 0.25 | 0.07 | 0.80 | 0.97 | <0.05 | 2.04 | 0.07 | 0.43 | 3.95 | 0.76 | 3.61 | 0.73 | 5.78 | 0.83 | 26.75 | 95.00 |
| WC01 39 | 30.77 | <0.03 | 0.20 | <0.05 | 0.76 | 0.91 | <0.05 | 1.92 | 0.08 | 0.47 | 3.87 | 0.85 | 3.65 | 0.72 | 5.93 | 0.87 | 26.94 | 95.53 |
| WC01 40 | 31.60 | <0.03 | 0.25 | 0.09 | 0.85 | 0.99 | <0.05 | 2.04 | 0.07 | 0.47 | 4.03 | 0.89 | 3.62 | 0.71 | 5.51 | 0.80 | 27.13 | 96.48 |
| WC01 41 | 30.85 | <0.03 | 0.24 | <0.05 | 0.84 | 0.96 | <0.05 | 2.00 | 0.05 | 0.46 | 3.93 | 0.85 | 3.50 | 0.70 | 5.53 | 0.79 | 26.76 | 94.74 |
| WC01 42 | 30.79 | 0.05 | 0.24 | 0.07 | 0.86 | 0.97 | <0.05 | 2.04 | 0.04 | 0.44 | 4.00 | 0.84 | 3.57 | 0.66 | 5.62 | 0.81 | 26.65 | 94.71 |
| WC01 43 | 31.29 | 0.04 | 0.25 | <0.05 | 0.87 | 1.03 | <0.05 | 2.02 | 0.05 | 0.47 | 4.05 | 0.88 | 3.69 | 0.69 | 5.53 | 0.78 | 26.78 | 95.43 |
| WC01 44 | 30.74 | <0.03 | 0.26 | 0.09 | 0.88 | 1.00 | <0.05 | 1.96 | 0.06 | 0.43 | 4.07 | 0.88 | 3.61 | 0.67 | 5.48 | 0.81 | 26.52 | 95.07 |
| WC01 45 | 30.38 | 0.04 | 0.29 | 0.10 | 0.95 | 0.94 | <0.05 | 2.16 | 0.06 | 0.50 | 4.06 | 0.83 | 3.50 | 0.67 | 5.43 | 0.80 | 26.48 | 94.17 |
| WC01 46 | 30.94 | <0.03 | 0.28 | <0.05 | 0.93 | 1.05 | <0.05 | 2.16 | 0.06 | 0.47 | 4.07 | 0.85 | 3.59 | 0.69 | 5.49 | 0.77 | 26.48 | 94.92 |
| WC01 47 | 33.19 | 0.05 | 0.24 | 0.06 | 0.87 | 1.03 | <0.05 | 2.18 | 0.02 | 0.52 | 4.10 | 0.88 | 3.57 | 0.66 | 5.24 | 0.77 | 26.70 | 96.51 |
| WC01 48 | 32.94 | <0.03 | 0.25 | 0.07 | 0.90 | 1.04 | <0.05 | 2.20 | 0.03 | 0.51 | 4.11 | 0.88 | 3.55 | 0.67 | 5.36 | 0.81 | 26.84 | 96.60 |
| WC01 49 | 32.60 | <0.03 | 0.21 | 0.07 | 0.71 | 0.80 | <0.05 | 1.90 | 0.03 | 0.42 | 3.81 | 0.86 | 3.98 | 0.76 | 6.30 | 0.97 | 27.13 | 97.46 |
| WC01 50 | 32.72 | 0.04 | 0.30 | <0.05 | 0.85 | 1.03 | <0.05 | 2.12 | 0.03 | 0.47 | 4.11 | 0.86 | 3.51 | 0.68 | 5.24 | 0.79 | 26.81 | 96.51 |
| WC01 51 | 32.15 | <0.03 | 0.26 | 0.11 | 0.88 | 0.97 | <0.05 | 2.06 | 0.04 | 0.48 | 4.02 | 0.81 | 3.55 | 0.67 | 5.48 | 0.81 | 27.02 | 95.96 |
| WC01 52 | 32.21 | <0.03 | 0.30 | 0.07 | 0.93 | 1.01 | <0.05 | 2.14 | 0.03 | 0.46 | 4.08 | 0.84 | 3.55 | 0.67 | 5.33 | 0.81 | 26.87 | 95.90 |
| WC01 53 | 32.34 | <0.03 | 0.26 | 0.10 | 0.97 | 1.03 | <0.05 | 2.26 | 0.02 | 0.46 | 4.06 | 0.86 | 3.54 | 0.65 | 5.22 | 0.75 | 26.88 | 96.35 |
| WC01 54 | 33.05 | <0.03 | 0.30 | 0.11 | 0.95 | 1.02 | <0.05 | 2.19 | <0.01 | 0.50 | 4.11 | 0.89 | 3.47 | 0.65 | 5.25 | 0.80 | 27.00 | 97.34 |
| WC01 55 | 32.92 | <0.03 | 0.30 | 0.09 | 0.95 | 1.05 | <0.05 | 2.13 | 0.01 | 0.48 | 4.04 | 0.90 | 3.50 | 0.68 | 5.24 | 0.73 | 26.92 | 96.73 |
| WC01 56 | 33.25 | <0.03 | 0.28 | 0.15 | 0.99 | 1.01 | <0.05 | 2.22 | 0.03 | 0.44 | 4.03 | 0.85 | 3.47 | 0.65 | 5.21 | 0.81 | 27.08 | 97.34 |
| WC01 57 | 32.72 | <0.03 | 0.25 | 0.05 | 0.83 | 0.93 | <0.05 | 2.17 | 0.03 | 0.47 | 3.90 | 0.81 | 3.52 | 0.68 | 5.43 | 0.80 | 26.71 | 96.06 |
| WC01 58 | 32.62 | <0.03 | 0.22 | 0.07 | 0.88 | 0.93 | <0.05 | 2.12 | 0.04 | 0.48 | 3.94 | 0.85 | 3.61 | 0.71 | 5.65 | 0.84 | 26.87 | 96.32 |
| WC01 59 | 32.33 | <0.03 | 0.19 | 0.10 | 0.78 | 1.00 | <0.05 | 2.07 | 0.05 | 0.41 | 3.89 | 0.83 | 3.63 | 0.70 | 5.84 | 0.90 | 26.76 | 95.79 |
| WC01 60 | 32.23 | <0.03 | 0.18 | 0.07 | 0.76 | 0.87 | <0.05 | 1.91 | 0.03 | 0.45 | 3.86 | 0.91 | 3.54 | 0.69 | 5.58 | 0.83 | 26.92 | 95.43 |
| WC01 61 | 30.57 | <0.03 | 0.28 | <0.05 | 0.87 | 0.88 | <0.05 | 1.90 | 0.06 | 0.42 | 3.82 | 0.84 | 3.36 | 0.66 | 5.37 | 0.80 | 27.27 | 94.78 |
| WC01 62 | 31.28 | 0.03 | 0.23 | 0.06 | 0.80 | 0.94 | <0.05 | 1.96 | 0.06 | 0.48 | 3.84 | 0.84 | 3.50 | 0.67 | 5.56 | 0.82 | 27.41 | 96.21 |
| WC01 63 | 30.27 | <0.03 | 0.21 | <0.05 | 0.76 | 0.89 | 0.05 | 1.79 | 0.06 | 0.44 | 3.72 | 0.79 | 3.62 | 0.72 | 6.27 | 0.99 | 27.36 | 95.89 |
| WC01 64 | 30.51 | <0.03 | 0.24 | 0.06 | 0.78 | 0.88 | <0.05 | 1.75 | 0.08 | 0.44 | 3.74 | 0.86 | 3.62 | 0.76 | 6.28 | 0.98 | 27.50 | 96.58 |
| WC01 65 | 30.92 | <0.03 | 0.27 | 0.07 | 0.86 | 1.01 | <0.05 | 2.05 | 0.06 | 0.46 | 3.98 | 0.79 | 3.56 | 0.65 | 5.64 | 0.83 | 27.52 | 96.56 |
| WC01 66 | 31.22 | <0.03 | 0.22 | 0.09 | 0.78 | 0.88 | <0.05 | 1.98 | 0.08 | 0.47 | 3.90 | 0.84 | 3.48 | 0.68 | 5.52 | 0.82 | 27.55 | 96.59 |
| WC01 67 | 31.98 | <0.03 | 0.20 | <0.05 | 0.79 | 0.96 | <0.05 | 1.98 | 0.07 | 0.41 | 3.78 | 0.85 | 3.46 | 0.65 | 5.76 | 0.85 | 27.33 | 96.43 |
| WC01 68 | 32.16 | <0.03 | 0.22 | <0.05 | 0.84 | 0.96 | <0.05 | 1.96 | 0.09 | 0.44 | 3.85 | 0.87 | 3.53 | 0.67 | 5.44 | 0.87 | 27.53 | 96.93 |
| WC01 69 | 32.66 | <0.03 | 0.20 | <0.05 | 0.76 | 0.89 | <0.05 | 1.96 | 0.07 | 0.40 | 3.72 | 0.81 | 3.54 | 0.71 | 5.86 | 0.87 | 27.22 | 96.76 |
| WC01 70 | 32.52 | <0.03 | 0.22 | <0.05 | 0.82 | 0.89 | <0.05 | 1.82 | 0.06 | 0.45 | 3.80 | 0.91 | 3.54 | 0.69 | 5.84 | 0.92 | 27.17 | 96.49 |
| WC01 71 | 33.26 | <0.03 | 0.25 | 0.08 | 0.83 | 0.83 | <0.05 | 2.04 | 0.04 | 0.44 | 3.86 | 0.82 | 3.57 | 0.69 | 5.72 | 0.89 | 26.94 | 96.90 |
| WC01 72 | 32.13 | <0.03 | 0.23 | 0.07 | 0.76 | 0.88 | <0.05 | 1.83 | 0.05 | 0.41 | 3.75 | 0.84 | 3.49 | 0.73 | 5.96 | 0.93 | 27.03 | 95.86 |
| WC01 73 | 32.90 | <0.03 | 0.20 | 0.10 | 0.82 | 0.88 | <0.05 | 1.91 | 0.04 | 0.44 | 3.86 | 0.86 | 3.56 | 0.72 | 5.99 | 0.97 | 27.15 | 97.37 |
| WC01 74 | 30.21 | <0.03 | 0.06 | <0.05 | 0.15 | 0.27 | <0.05 | 0.88 | 0.03 | 0.25 | 3.05 | 0.85 | 4.91 | 1.29 | 12.06 | 2.00 | 26.48 | 99.39 |
| WC01 75 | 35.49 | <0.03 | 0.26 | 0.05 | 0.88 | 0.88 | <0.05 | 1.81 | <0.01 | 0.44 | 3.67 | 0.95 | 3.43 | 0.74 | 5.73 | 0.92 | 28.20 | 101.02 |
| WC01 76 | 35.73 | 0.04 | 0.20 | 0.09 | 0.78 | 0.88 | <0.05 | 1.86 | <0.01 | 0.42 | 3.75 | 0.96 | 3.52 | 0.70 | 5.56 | 0.90 | 28.13 | 100.98 |
| WC01 77 | 35.78 | <0.03 | 0.22 | 0.10 | 0.79 | 0.93 | <0.05 | 1.77 | <0.01 | 0.46 | 3.79 | 0.95 | 3.51 | 0.72 | 5.70 | 0.91 | 28.21 | 101.32 |
| WC01 78 | 37.07 | <0.03 | <0.03 | <0.05 | 0.12 | 0.48 | <0.05 | 1.48 | <0.01 | 0.45 | 3.82 | 0.96 | 3.61 | 0.70 | 5.78 | 0.91 | 28.41 | 101.48 |
| WC02 1 | 30.86 | <0.05 | 0.09 | <0.08 | 0.15 | 0.24 | <0.08 | 0.55 | 0.02 | 0.27 | 3.79 | 1.13 | 5.56 | 1.25 | 10.50 | 1.59 | 28.01 | 101.08 |
| WC02 2 | 33.05 | 0.08 | 0.24 | <0.08 | 0.14 | 0.13 | <0.08 | 0.67 | 0.03 | 0.29 | 4.08 | 1.05 | 5.57 | 1.11 | 7.84 | 1.10 | 28.19 | 100.86 |
| WC02 3 | 30.80 | <0.05 | 0.05 | <0.08 | 0.08 | 0.18 | 0.09 | 0.31 | 0.02 | 0.23 | 3.72 | 1.12 | 5.56 | 1.38 | 11.70 | 1.82 | 27.98 | 102.01 |
| WC02 4 | 32.42 | <0.05 | 0.13 | <0.08 | 0.19 | 0.36 | <0.08 | 0.65 | <0.02 | 0.39 | 4.47 | 1.29 | 5.54 | 1.09 | 8.58 | 1.26 | 28.12 | 101.46 |
| WC02 5 | 31.21 | <0.05 | 0.10 | <0.08 | 0.14 | 0.25 | <0.08 | 0.45 | 0.03 | 0.31 | 3.67 | 1.12 | 5.26 | 1.26 | 10.68 | 1.69 | 27.86 | 100.98 |
| WC02 6 | 20.53 | <0.05 | 0.14 | <0.08 | 0.28 | 0.33 | <0.08 | 0.94 | 0.06 | 0.52 | 6.22 | 1.61 | 7.58 | 1.74 | 16.15 | 2.37 | 25.99 | 100.44 |
| WC02 7 | 29.32 | 0.05 | 0.22 | <0.08 | 0.24 | 0.34 | <0.08 | 0.78 | <0.02 | 0.34 | 4.10 | 1.05 | 5.18 | 1.19 | 11.86 | 1.87 | 27.24 | 100.38 |
| WC02 8 | 32.33 | 0.05 | 0.20 | <0.08 | 0.32 | 0.46 | <0.08 | 1.27 | <0.02 | 0.61 | 6.36 | 1.47 | 4.81 | 0.83 | 6.06 | 0.96 | 28.07 | 100.86 |
| WC02 9 | 28.69 | <0.05 | 0.15 | <0.08 | 0.19 | 0.41 | 0.13 | 1.03 | <0.02 | 0.48 | 5.52 | 1.41 | 6.10 | 1.22 | 9.98 | 1.45 | 27.58 | 101.29 |
| WC02 10 | 26.94 | <0.05 | 0.38 | <0.08 | 0.39 | 0.26 | <0.08 | 0.70 | 0.04 | 0.25 | 4.05 | 1.21 | 6.25 | 1.55 | 13.38 | 2.06 | 27.01 | 100.94 |
| WC02 11 | 33.98 | <0.05 | 0.25 | <0.08 | 0.68 | 1.04 | <0.08 | 2.75 | 0.02 | 0.72 | 4.88 | 0.97 | 3.29 | 0.61 | 4.43 | 0.67 | 27.64 | 99.63 |
| WC02 12 | 35.34 | <0.05 | 0.13 | 0.10 | 0.63 | 1.09 | <0.08 | 2.77 | <0.02 | 0.70 | 4.85 | 1.02 | 3.15 | 0.61 | 4.21 | 0.69 | 28.11 | 101.14 |
| WC02 13 | 34.80 | 0.05 | <0.05 | <0.08 | 0.22 | 0.49 | <0.08 | 1.53 | <0.02 | 0.55 | 4.68 | 1.07 | 4.03 | 0.74 | 5.62 | 0.74 | 27.56 | 99.75 |
| WC02 14 | 32.43 | 0.08 | 0.41 | 0.25 | 1.67 | 1.87 | <0.08 | 3.22 | <0.02 | 0.75 | 5.02 | 0.97 | 3.61 | 0.58 | 4.72 | 0.72 | 27.60 | 101.03 |
| WC02 15 | 33.70 | <0.05 | 0.35 | 0.21 | 1.26 | 1.62 | <0.08 | 2.88 | <0.02 | 0.69 | 4.95 | 1.11 | 3.55 | 0.67 | 4.51 | 0.67 | 28.01 | 101.49 |
| WC02 16 | 32.85 | 0.08 | 0.30 | 0.15 | 1.43 | 1.59 | <0.08 | 2.79 | <0.02 | 0.70 | 5.03 | 1.22 | 3.58 | 0.67 | 4.42 | 0.66 | 27.56 | 100.33 |
| WC02 17 | 32.20 | 0.05 | 0.47 | 0.18 | 1.80 | 2.15 | <0.08 | 3.27 | <0.02 | 0.78 | 5.19 | 1.18 | 3.58 | 0.63 | 4.28 | 0.51 | 27.73 | 101.12 |
| aSample WC01 1, WC01 2 etc… correspond to different locations than the sample marked WC01 01 found in table S6 | | | | | | | | | | | | | | | | | | |

**Table S8**. Elemental wt. %, oxide wt. % and apfu for point WC01 11, taken on the JEOL-8600 microprobe, both for fixed Si=3 and not fixed Si

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Wt. % element** |  | **Wt. % oxide** | **Si != 3** | **Si = 3 (Fixed)** | **apfu** | **Si !=3** | **Si = 3 (Fixed)** |
| **S** | < 0.02 | **SO3** | 0.00 | 0.00 | **S** | 0.00 | 0.00 |
| **P** | < 0.02 | **P2O5** | 0.00 | 0.00 | **P** | 0.00 | 0.00 |
| **Si** | 15.67 | **SiO2** | 33.53 | 31.21 | **Si** | 3.09 | 3(Fixed) |
| **Ti** | < 0.03 | **TiO2** | 0.00 | 0.00 | **Ti** | 0.00 | 0.00 |
| **Th** | < 0.07 | **ThO2** | 0.00 | 0.00 | **Th** | 0.00 | 0.00 |
| **U** | < 0.05 | **UO2** | 0.00 | 0.00 | **U** | 0.00 | 0.00 |
| **Al** | < 0.03 | **Al2O3** | 0.00 | 0.00 | **Al** | 0.00 | 0.00 |
| **Y** | 36.27 | **Y2O3** | 46.07 | 46.07 | **Y** | 2.26 | 2.36 |
| **La** | < 0.07 | **La2O3** | 0.00 | 0.00 | **La** | 0.00 | 0.00 |
| **Ce** | < 0.06 | **Ce2O3** | 0.00 | 0.00 | **Ce** | 0.00 | 0.00 |
| **Pr** | < 0.08 | **Pr2O3** | 0.00 | 0.00 | **Pr** | 0.00 | 0.00 |
| **Nd** | 0.09 | **Nd2O3** | 0.11 | 0.11 | **Nd** | 0.00 | 0.00 |
| **Sm** | 0.30 | **Sm2O3** | 0.34 | 0.34 | **Sm** | 0.01 | 0.01 |
| **Eu** | 0.33 | **Eu2O3** | 0.38 | 0.38 | **Eu** | 0.01 | 0.01 |
| **Gd** | 1.14 | **Gd2O3** | 1.31 | 1.31 | **Gd** | 0.04 | 0.04 |
| **Tb** | 0.52 | **Tb2O3** | 0.59 | 0.59 | **Tb** | 0.02 | 0.02 |
| **Dy** | 4.52 | **Dy2O3** | 5.19 | 5.19 | **Dy** | 0.15 | 0.16 |
| **Ho** | 1.07 | **Ho2O3** | 1.23 | 1.23 | **Ho** | 0.04 | 0.04 |
| **Er** | 3.76 | **Er2O3** | 4.30 | 4.30 | **Er** | 0.12 | 0.13 |
| **Tm** | 0.65 | **Tm2O3** | 0.74 | 0.74 | **Tm** | 0.02 | 0.02 |
| **Yb** | 4.99 | **Yb2O3** | 5.68 | 5.68 | **Yb** | 0.16 | 0.17 |
| **Lu** | 0.74 | **Lu2O3** | 0.85 | 0.85 | **Lu** | 0.02 | 0.02 |
| **Mg** | < 0.01 | **MgO** | 0.00 | 0.00 | **Mg** | 0.00 | 0.00 |
| **Mn** | < 0.02 | **MnO** | 0.00 | 0.00 | **Mn2+** | 0.00 | 0.00 |
| **Fe** | < 0.02 | **Fe2O3** | 0.00 | 0.00 | **Fe3+** | 0.00 | 0.00 |
| **Sr** | < 0.05 | **SrO** | 0.00 | 0.00 | **Sr** | 0.00 | 0.00 |
| **Ca** | 0.15 | **CaO** | 0.21 | 0.21 | **Ca** | 0.02 | 0.02 |
| **Na** | < 0.02 | **Na2O** | 0.00 | 0.00 | **Na** | 0.00 | 0.00 |
| **F** | 3.35 | **F** | 3.35 | 3.29 | **F(Fixed)** | 1 | 1 |
| **O** | 28.94 | **O=F** | -1.64 | -1.39 | **O(Fixed)** | 11 | 11 |
| **TOTAL** | 102.50 | **TOTAL** | 102.24 | 100.12 | **Total** | 6.98 | 7.01 |