**Supplementary Data 3: quality control (QC) data of geochemical analysis**

QC Table 1. XRF major oxide contents in wt.% (g/100g) of the rock standards measured along with the whole rock samples (JB-2, JB-3, JA-2, JR-1 at GEOMAR; BIR-1; BHVO-2, AGV-2, SO-18 at ACME®).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide (g/100g)** | **JB-2 #1** | **JB-2 #2** | **JB-2 #3** | **Mean** | **Ref. value1** |  | **JB-3 #1** | **JB-3 #2** | **JB-3 #3** | **Mean** | **Ref. value1** |
| SiO2 | 53.12 | 53.05 | 53.03 | 53.07 | 53.2 |  | 50.82 | 50.75 | 51.08 | 50.88 | 51.04 |
| TiO2 | 1.17 | 1.17 | 1.16 | 1.17 | 1.19 |  | 1.41 | 1.4 | 1.4 | 1.40 | 1.45 |
| Al2O3 | 14.8 | 14.89 | 14.8 | 14.83 | 14.67 |  | 17.31 | 17.3 | 17.45 | 17.35 | 16.89 |
| Fe2O3 | 14.44 | 14.47 | 14.41 | 14.44 | 14.34 |  | 11.95 | 11.97 | 11.98 | 11.97 | 11.88 |
| MnO | 0.21 | 0.21 | 0.21 | 0.21 | 0.2 |  | 0.18 | 0.18 | 0.17 | 0.18 | 0.16 |
| MgO | 4.76 | 4.8 | 4.79 | 4.78 | 4.66 |  | 5.26 | 5.24 | 5.28 | 5.26 | 5.2 |
| CaO | 9.91 | 9.9 | 9.84 | 9.88 | 9.89 |  | 9.78 | 9.77 | 9.74 | 9.76 | 9.86 |
| Na2O | 2.15 | 2.19 | 2.34 | 2.23 | 2.03 |  | 2.88 | 2.84 | 3.05 | 2.92 | 2.82 |
| K2O | 0.42 | 0.42 | 0.43 | 0.42 | 0.42 |  | 0.78 | 0.77 | 0.78 | 0.78 | 0.78 |
| P2O5 | 0.1 | 0.1 | 0.1 | 0.10 | 0.1 |  | 0.30 | 0.30 | 0.29 | 0.30 | 0.29 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Oxide (g/100g)** | **JA-2 #1** | **JA-2 #2** | **JA-2 #3** | **Mean** | **Ref. value1** |  | **JR-1 #1** | **JR-1 #2** | **JR-1 #3** | **Mean** | **Ref. value1** |
| SiO2 | 56.24 | 56.28 | 56.22 | 56.25 | 62.26 |  | 75.02 | 75.03 | 74.72 | 74.92 | 75.41 |
| TiO2 | 0.67 | 0.67 | 0.67 | 0.67 | 0.68 |  | 0.11 | 0.11 | 0.11 | 0.11 | 12.89 |
| Al2O3 | 15.46 | 15.41 | 15.51 | 15.46 | 15.57 |  | 12.74 | 12.79 | 12.72 | 12.75 | 0.1 |
| Fe2O3 | 6.38 | 6.37 | 6.38 | 6.38 | 6.59 |  | 0.85 | 0.86 | 0.85 | 0.85 | 0.96 |
| MnO | 0.11 | 0.11 | 0.11 | 0.11 | 0.106 |  | 0.11 | 0.11 | 0.11 | 0.11 | 0.1 |
| MgO | 8.06 | 8.04 | 8.04 | 8.05 | 3.65 |  | 0.14 | 0.13 | 0.13 | 0.13 | 0.09 |
| CaO | 6.26 | 6.27 | 6.23 | 6.25 | 6.28 |  | 0.7 | 0.7 | 0.69 | 0.70 | 0.63 |
| Na2O | 3.05 | 3.05 | 3.24 | 3.11 | 3.17 |  | 4.19 | 4.1 | 4.26 | 4.18 | 4.1 |
| K2O | 1.75 | 1.75 | 1.77 | 1.76 | 1.41 |  | 4.46 | 4.46 | 4.45 | 4.46 | 4.41 |
| P2O5 | 0.15 | 0.16 | 0.16 | 0.16 | 0.11 |  | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 |
| 1Working values from Govindaraju (1994). | | | | | | | | | | |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide (g/100g)** | **BIR-1 #1** | **BIR-1 #2** | **Mean** | **Ref. value2** |  | **BHVO-2** | **Ref. value2** |  | **BCR-2** | **Ref. value2** |
| SiO2 | 46.81 | 46.96 | 46.89 | 47.79 |  | 49.52 | 49.60 |  | 53.53 | 54.00 |
| TiO2 | 0.94 | 0.94 | 0.94 | 0.96 |  | 2.75 | 2.73 |  | 2.26 | 2.27 |
| Al2O3 | 15.56 | 15.49 | 15.53 | 15.51 |  | 13.56 | 13.44 |  | 13.70 | 13.48 |
| Fe2O3 | 11.15 | 11.13 | 11.14 | 11.40 |  | 12.26 | 12.39 |  | 13.75 | 13.77 |
| MnO | 0.17 | 0.17 | 0.17 | 0.17 |  | 0.17 | 0.17 |  | 0.20 | 0.20 |
| MgO | 9.78 | 9.71 | 9.75 | 9.69 |  | 7.38 | 7.26 |  | 3.65 | 3.60 |
| CaO | 13.12 | 13.14 | 13.13 | 13.29 |  | 11.29 | 11.40 |  | 7.12 | 7.11 |
| Na2O | 1.77 | 1.77 | 1.77 | 1.83 |  | 2.20 | 2.22 |  | 3.09 | 3.12 |
| K2O | 0.02 | 0.02 | 0.02 | 0.03 |  | 0.52 | 0.51 |  | 1.79 | 1.77 |
| P2O5 | 0.02 | 0.02 | 0.02 | 0.03 |  | 0.27 | 0.27 |  | 0.34 | 0.36 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oxide (g/100g)** | **AGV-2** | **Ref. value2** |  | **SO-18 #1** | **SO-18 #2** | **SO-18 #3** | **SO-18 #4** | **Mean** | **Ref. value3** |
| SiO2 | 58.96 | 59.14 |  | 58.07 | 58.24 | 58.16 | 58.17 | 58.16 | 58.13 |
| TiO2 | 1.02 | 1.05 |  | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |
| Al2O3 | 17.05 | 17.03 |  | 14.07 | 14.05 | 14.15 | 14.16 | 14.11 | 14.11 |
| Fe2O3 | 6.61 | 6.78 |  | 7.64 | 7.59 | 7.54 | 7.53 | 7.58 | 7.61 |
| MnO | 0.10 | 0.10 |  | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | 0.40 |
| MgO | 1.78 | 1.80 |  | 3.35 | 3.35 | 3.35 | 3.35 | 3.35 | 3.37 |
| CaO | 5.20 | 5.15 |  | 6.36 | 6.33 | 6.32 | 6.32 | 6.33 | 6.35 |
| Na2O | 4.10 | 4.20 |  | 3.70 | 3.66 | 3.68 | 3.69 | 3.68 | 3.69 |
| K2O | 2.90 | 2.90 |  | 2.15 | 2.14 | 2.15 | 2.16 | 2.15 | 2.16 |
| P2O5 | 0.46 | 0.48 |  | 0.82 | 0.82 | 0.81 | 0.81 | 0.82 | 0.81 |
| 2GeoReM reference values (Jochum et al., 2016); 3GeoReM reference values (Jochum et al., 2005). | | | | | | | | | |

QC Table 2. EMP major oxide contents in wt.% (g/100g) of reference materials measured along with the glass samples at GEOMAR.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **SiO2** | **TiO2** | **Al2O3** | **FeO** | **MnO** | **MgO** | **CaO** | **Na2O** | **K2O** | **P2O5** | **S** | **Cl** | **Total** |
| Scapolite R6600 | 48.55 | 0.02 | 25.00 | 0.02 | 0.02 | 0.02 | 14.02 | 5.31 | 0.87 | 0.00 | 0.53 | 1.44 | 95.81 |
| Scapolite R6600 | 49.26 | 0.04 | 24.60 | 0.10 | 0.00 | 0.00 | 13.93 | 5.59 | 0.87 | 0.03 | 0.55 | 1.42 | 96.39 |
| Scapolite R6600 | 49.02 | 0.00 | 24.82 | 0.07 | 0.02 | 0.01 | 13.94 | 5.33 | 0.86 | 0.05 | 0.52 | 1.42 | 96.05 |
| Scapolite R6600 | 49.10 | 0.03 | 25.06 | 0.15 | 0.06 | 0.00 | 13.88 | 5.43 | 0.83 | 0.00 | 0.56 | 1.44 | 96.55 |
| Scapolite R6600 | 50.28 | 0.01 | 25.12 | 0.14 | 0.01 | 0.00 | 13.66 | 5.33 | 0.85 | 0.05 | 0.52 | 1.45 | 97.42 |
| Scapolite R6600 | 50.34 | 0.00 | 25.07 | 0.05 | 0.06 | 0.02 | 13.73 | 5.50 | 0.86 | 0.03 | 0.56 | 1.41 | 97.62 |
| Scapolite R6600 | 49.17 | 0.00 | 24.82 | 0.13 | 0.00 | 0.01 | 13.83 | 5.24 | 0.85 | 0.00 | 0.54 | 1.43 | 96.02 |
| Scapolite R6600 | 49.18 | 0.03 | 25.05 | 0.13 | 0.05 | 0.01 | 13.78 | 5.20 | 0.86 | 0.02 | 0.54 | 1.43 | 96.28 |
| Scapolite R6600 | 48.59 | 0.00 | 24.71 | 0.10 | 0.00 | 0.02 | 13.92 | 5.31 | 0.83 | 0.02 | 0.54 | 1.42 | 95.46 |
| Scapolite R6600 | 48.71 | 0.00 | 24.89 | 0.08 | 0.06 | 0.01 | 13.82 | 5.65 | 0.87 | 0.01 | 0.54 | 1.44 | 96.08 |
| **average** | **49.22** | **0.01** | **24.91** | **0.10** | **0.03** | **0.01** | **13.85** | **5.39** | **0.85** | **0.02** | **0.54** | **1.43** | **96.37** |
| **2SD** | **1.25** | **0.03** | **0.35** | **0.08** | **0.05** | **0.02** | **0.22** | **0.30** | **0.03** | **0.04** | **0.03** | **0.03** | **1.36** |
| **Jarosewich et al. (1980)** | **49.78** |  | **25.05** |  |  |  | **13.58** | **5.20** | **0.78** |  |  | **1.43** | **97.17** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| VG-568 | 76.94 | 0.08 | 12.08 | 1.00 | 0.00 | 0.03 | 0.44 | 3.78 | 4.86 | 0.00 | 0.00 | 0.09 | 99.32 |
| VG-568 | 76.47 | 0.08 | 12.03 | 1.25 | 0.07 | 0.00 | 0.44 | 3.72 | 4.92 | 0.01 | 0.00 | 0.08 | 99.09 |
| VG-568 | 76.72 | 0.10 | 12.08 | 1.10 | 0.03 | 0.00 | 0.45 | 3.83 | 4.87 | 0.02 | 0.00 | 0.12 | 99.32 |
| VG-568 | 76.70 | 0.10 | 12.04 | 1.11 | 0.08 | 0.02 | 0.45 | 3.68 | 4.91 | 0.06 | 0.00 | 0.12 | 99.27 |
| VG-568 | 76.80 | 0.08 | 12.14 | 0.99 | 0.07 | 0.00 | 0.44 | 3.68 | 4.89 | 0.00 | 0.00 | 0.12 | 99.20 |
| VG-568 | 76.62 | 0.08 | 11.98 | 1.22 | 0.02 | 0.02 | 0.46 | 3.75 | 4.89 | 0.01 | 0.00 | 0.12 | 99.16 |
| VG-568 | 76.63 | 0.08 | 12.14 | 1.12 | 0.03 | 0.01 | 0.45 | 3.72 | 4.89 | 0.03 | 0.01 | 0.10 | 99.23 |
| VG-568 | 76.79 | 0.08 | 11.97 | 0.99 | 0.00 | 0.04 | 0.45 | 3.79 | 4.89 | 0.00 | 0.00 | 0.12 | 99.11 |
| VG-568 | 76.75 | 0.07 | 12.12 | 1.14 | 0.03 | 0.05 | 0.45 | 3.65 | 4.89 | 0.00 | 0.00 | 0.11 | 99.25 |
| VG-568 | 76.67 | 0.11 | 12.00 | 1.09 | 0.05 | 0.05 | 0.46 | 3.57 | 4.89 | 0.03 | 0.00 | 0.10 | 99.03 |
| **average** | **76.71** | **0.08** | **12.06** | **1.10** | **0.04** | **0.02** | **0.45** | **3.72** | **4.89** | **0.02** | **0.00** | **0.11** | **99.20** |
| **2SD** | **0.25** | **0.03** | **0.13** | **0.18** | **0.06** | **0.04** | **0.02** | **0.15** | **0.03** | **0.04** | **0.01** | **0.03** | **0.19** |
| **Jarosewich et al. (1980)** | **76.71** | **0.12** | **12.06** | **0.80** | **0.03** |  | **0.50** | **3.75** | **4.89** |  |  |  | **99.02** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| VG-A99 | 50.14 | 4.04 | 12.12 | 13.47 | 0.20 | 5.08 | 9.30 | 2.65 | 0.83 | 0.41 | 0.01 | 0.03 | 98.29 |
| VG-A99 | 50.04 | 4.08 | 12.47 | 13.13 | 0.20 | 5.08 | 9.30 | 2.94 | 0.84 | 0.42 | 0.02 | 0.01 | 98.53 |
| VG-A99 | 50.24 | 4.06 | 12.11 | 13.23 | 0.28 | 5.04 | 9.33 | 2.80 | 0.83 | 0.41 | 0.01 | 0.02 | 98.34 |
| VG-A99 | 50.62 | 4.06 | 12.12 | 13.37 | 0.18 | 5.13 | 9.27 | 2.81 | 0.80 | 0.42 | 0.02 | 0.03 | 98.84 |
| VG-A99 | 51.31 | 4.06 | 12.39 | 13.22 | 0.19 | 5.05 | 9.31 | 2.82 | 0.82 | 0.47 | 0.02 | 0.02 | 99.68 |
| VG-A99 | 51.13 | 4.06 | 12.43 | 13.38 | 0.17 | 5.12 | 9.28 | 2.77 | 0.83 | 0.38 | 0.02 | 0.02 | 99.59 |
| VG-A99 | 51.16 | 4.07 | 12.43 | 13.30 | 0.22 | 5.11 | 9.37 | 2.74 | 0.87 | 0.42 | 0.01 | 0.02 | 99.72 |
| VG-A99 | 51.69 | 4.04 | 12.33 | 13.30 | 0.18 | 5.05 | 9.23 | 2.61 | 0.88 | 0.42 | 0.02 | 0.03 | 99.77 |
| VG-A99 | 50.36 | 4.09 | 12.18 | 13.18 | 0.20 | 5.13 | 9.32 | 2.58 | 0.81 | 0.39 | 0.02 | 0.02 | 98.28 |
| VG-A99 | 50.56 | 4.03 | 12.32 | 13.42 | 0.21 | 5.03 | 9.29 | 2.58 | 0.83 | 0.45 | 0.02 | 0.01 | 98.75 |
| **average** | **50.73** | **4.06** | **12.29** | **13.30** | **0.20** | **5.08** | **9.30** | **2.73** | **0.83** | **0.42** | **0.02** | **0.02** | **98.98** |
| **2SD** | **1.12** | **0.04** | **0.29** | **0.22** | **0.06** | **0.08** | **0.07** | **0.24** | **0.05** | **0.05** | **0.01** | **0.01** | **1.28** |
| **Jarosewich et al. (1980)** | **50.94** | **4.06** | **12.49** | **13.30** | **0.15** | **5.08** | **9.30** | **2.66** | **0.82** | **0.38** |  |  | **99.18** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| VG-2 | 49.50 | 1.83 | 13.54 | 11.72 | 0.20 | 7.08 | 11.30 | 2.68 | 0.21 | 0.23 | 0.15 | 0.02 | 98.44 |
| VG-2 | 49.61 | 1.86 | 13.82 | 11.45 | 0.19 | 7.14 | 11.39 | 2.92 | 0.19 | 0.20 | 0.15 | 0.03 | 98.94 |
| VG-2 | 51.57 | 1.84 | 13.66 | 11.51 | 0.20 | 6.95 | 11.25 | 2.49 | 0.20 | 0.20 | 0.17 | 0.04 | 100.07 |
| VG-2 | 51.02 | 1.88 | 14.02 | 11.88 | 0.18 | 7.03 | 11.20 | 2.59 | 0.19 | 0.22 | 0.17 | 0.02 | 100.39 |
| VG-2 | 50.77 | 1.88 | 13.67 | 11.48 | 0.19 | 7.03 | 11.26 | 2.81 | 0.19 | 0.18 | 0.17 | 0.03 | 99.66 |
| VG-2 | 51.08 | 1.87 | 13.84 | 11.72 | 0.15 | 7.14 | 11.18 | 2.88 | 0.18 | 0.24 | 0.16 | 0.03 | 100.47 |
| **average** | **50.59** | **1.86** | **13.76** | **11.63** | **0.18** | **7.06** | **11.26** | **2.73** | **0.19** | **0.21** | **0.16** | **0.03** | **99.66** |
| **2SD** | **1.69** | **0.04** | **0.34** | **0.34** | **0.03** | **0.15** | **0.15** | **0.34** | **0.02** | **0.04** | **0.02** | **0.01** | **1.64** |
| **Jarosewich et al. (1980)** | **50.81** | **1.85** | **14.06** | **11.84** | **0.22** | **6.71** | **11.12** | **2.62** | **0.19** | **0.20** |  |  | **99.62** |

QC Table 3. Solution ICP-MS trace element data in ppm (µg/g) of reference material BIR-1 prepared along with SO199 whole rock samples at Kiel University. CL = confidence level.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **# Analysis/ Element (µg/g)** | **#1** | **#2** | **#3** | **Mean** | **Uncertainty (95% CL)** | **Ref. value1** | **Uncertainty (95% CL)** |
| Li | 3.44 | 3.21 | 3.29 | 3.31 | 0.23 | 3.20 | 0.07 |
| Sc | 43.4 | 44.2 | 44.0 | 43.9 | 0.8 | 43.2 | 0.6 |
| V | 313 | 306 | 334 | 318 | 30 | 321 | 3 |
| Cr | 383 | 369 | 398 | 383 | 29 | 393 | 4 |
| Co | 51.4 | 49.0 | 51.5 | 50.6 | 2.9 | 52.2 | 0.6 |
| Ni | 166 | 154 | 159 | 160 | 12 | 169 | 2 |
| Cu | 124 | 128 | 131 | 127 | 7 | 121 | 2 |
| Zn | 72.2 | 70.7 | 71.9 | 71.6 | 1.6 | 70.4 | 1.1 |
| Ga | 15.9 | 15.3 | 16.1 | 15.8 | 0.8 | 15.5 | 0.2 |
| Rb | 0.210 | 0.196 | 0.190 | 0.199 | 0.020 | 0.210 | 0.008 |
| Sr | 104 | 108 | 112 | 108 | 7 | 109 | 1 |
| Y | 15.5 | 15.5 | 15.5 | 15.5 | 0.1 | 15.6 | 0.2 |
| Zr | 13.9 | 14.4 | 15.1 | 14.5 | 1.2 | 14.8 | 0.2 |
| Nb | 0.505 | 0.525 | 0.542 | 0.524 | 0.037 | 0.553 | 0.014 |
| Cs | 0.006 | 0.005 | 0.004 | 0.005 | 0.002 | 0.006 | 0.001 |
| Ba | 6.53 | 6.48 | 6.47 | 6.50 | 0.06 | 6.75 | 0.13 |
| La | 0.600 | 0.596 | 0.614 | 0.603 | 0.019 | 0.627 | 0.012 |
| Ce | 1.870 | 1.89 | 1.90 | 1.89 | 0.03 | 1.92 | 0.02 |
| Pr | 0.373 | 0.364 | 0.379 | 0.372 | 0.015 | 0.372 | 0.005 |
| Nd | 2.39 | 2.42 | 2.44 | 2.42 | 0.04 | 2.40 | 0.04 |
| Sm | 1.110 | 1.10 | 1.12 | 1.11 | 0.02 | 1.11 | 0.02 |
| Eu | 0.527 | 0.516 | 0.532 | 0.525 | 0.016 | 0.520 | 0.005 |
| Gd | 1.78 | 1.75 | 1.80 | 1.77 | 0.04 | 1.81 | 0.02 |
| Tb | 0.363 | 0.357 | 0.362 | 0.360 | 0.006 | 0.362 | 0.005 |
| Dy | 2.60 | 2.56 | 2.60 | 2.59 | 0.04 | 2.54 | 0.03 |
| Ho | 0.574 | 0.563 | 0.573 | 0.570 | 0.012 | 0.572 | 0.005 |
| Er | 1.63 | 1.60 | 1.62 | 1.62 | 0.03 | 1.68 | 0.02 |
| Tm | 0.249 | 0.245 | 0.246 | 0.247 | 0.005 | 0.256 | 0.004 |
| Yb | 1.65 | 1.63 | 1.64 | 1.64 | 0.02 | 1.63 | 0.02 |
| Lu | 0.251 | 0.243 | 0.243 | 0.245 | 0.009 | 0.248 | 0.003 |
| Hf | 0.578 | 0.573 | 0.588 | 0.580 | 0.015 | 0.582 | 0.009 |
| Ta | 0.053 | 0.046 | 0.044 | 0.048 | 0.009 | 0.041 | 0.002 |
| Pb | 2.80 | 2.89 | 3.17 | 2.95 | 0.38 | 3.04 | 0.05 |
| Th | 0.030 | 0.032 | 0.030 | 0.031 | 0.002 | 0.033 | 0.002 |
| U | 0.012 | 0.012 | 0.012 | 0.012 | 0.001 | 0.011 | 0.0004 |
| 1GeoReM reference values (Jochum et al., 2016). | | | |  |  |  |  |

QC Table 4. Solution ICP-MS trace element data in ppm (µg/g) of reference material BHVO-2 prepared along with SO199 whole rock samples at Kiel University. CL = confidence level.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **# Analysis/ Element (µg/g)** | **#1** | **#2** | **#3** | **Mean** | **Uncertainty (95% CL)** | **Ref. value1** | **Uncertainty (95% CL)** |
| Li | 4.80 | 4.52 | 4.56 | 4.63 | 0.31 | 4.5 | 0.09 |
| Sc | 32.1 | 35.0 | 34.9 | 34.0 | 3.3 | 31.8 | 0.3 |
| V | 319 | 323 | 325 | 322 | 6 | 318 | 2 |
| Cr | 296 | 298 | 298 | 297 | 3 | 287 | 3 |
| Co | 44.7 | 45.0 | 44.6 | 44.8 | 0.4 | 44.9 | 0.3 |
| Ni | 118 | 119 | 118 | 118 | 1 | 120 | 1 |
| Cu | 134 | 142 | 142 | 139 | 10 | 129 | 1 |
| Zn | 109 | 109 | 117 | 112 | 9 | 104 | 1 |
| Ga | 22.2 | 22.1 | 21.9 | 22.1 | 0.3 | 21.4 | 0.2 |
| Rb | 9.45 | 9.26 | 9.23 | 9.31 | 0.24 | 9.26 | 0.10 |
| Sr | 380 | 399 | 391 | 390 | 19 | 394 | 2 |
| Y | 25.9 | 25.8 | 25.7 | 25.8 | 0.2 | 25.9 | 0.3 |
| Zr | 165 | 173 | 173 | 170 | 10 | 171 | 1 |
| Nb | 17.2 | 18.0 | 17.9 | 17.7 | 0.9 | 18.1 | 0.2 |
| Cs | 0.099 | 0.110 | 0.101 | 0.10 | 0.012 | 0.100 | 0.002 |
| Ba | 132 | 130 | 131 | 131 | 2 | 131 | 1 |
| La | 15.3 | 15.4 | 15.3 | 15.3 | 0.1 | 15.2 | 0.1 |
| Ce | 37.6 | 37.9 | 38.1 | 37.8 | 0.5 | 37.5 | 0.2 |
| Pr | 5.38 | 5.34 | 5.31 | 5.35 | 0.07 | 5.34 | 0.03 |
| Nd | 24.9 | 25.0 | 24.8 | 24.9 | 0.2 | 24.3 | 0.3 |
| Sm | 6.17 | 6.13 | 6.08 | 6.12 | 0.09 | 6.02 | 0.06 |
| Eu | 2.08 | 2.07 | 2.07 | 2.07 | 0.02 | 2.04 | 0.01 |
| Gd | 6.31 | 6.26 | 6.24 | 6.27 | 0.07 | 6.21 | 0.04 |
| Tb | 0.964 | 0.962 | 0.957 | 0.961 | 0.007 | 0.939 | 0.006 |
| Dy | 5.41 | 5.34 | 5.33 | 5.36 | 0.09 | 5.28 | 0.03 |
| Ho | 0.987 | 0.981 | 0.974 | 0.981 | 0.013 | 0.989 | 0.005 |
| Er | 2.47 | 2.44 | 2.43 | 2.45 | 0.04 | 2.51 | 0.01 |
| Tm | 0.330 | 0.326 | 0.326 | 0.327 | 0.004 | 0.335 | 0.003 |
| Yb | 2.03 | 2.00 | 2.01 | 2.01 | 0.03 | 1.99 | 0.03 |
| Lu | 0.281 | 0.274 | 0.278 | 0.278 | 0.007 | 0.275 | 0.002 |
| Hf | 4.35 | 4.34 | 4.36 | 4.35 | 0.01 | 4.47 | 0.03 |
| Ta | 1.18 | 1.12 | 1.12 | 1.14 | 0.06 | 1.15 | 0.02 |
| Pb | 1.72 | 1.58 | 2.68 | 1.99 | 1.19 | 1.65 | 0.04 |
| Th | 1.20 | 1.22 | 1.21 | 1.21 | 0.02 | 1.22 | 0.02 |
| U | 0.414 | 0.419 | 0.417 | 0.417 | 0.006 | 0.412 | 0.035 |
| 1GeoReM reference values (Jochum et al., 2016). | | | |  |  |  |  |

QC Table 5. Solution ICP-MS trace element data in ppm (µg/g) of reference material BCR-2 prepared along with SO199 whole rock samples at Kiel University. CL = confidence level.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **# Analysis/ Element (µg/g)** | **#1** | **#2** | **Mean** | **Uncertainty (95% CL)** | **Ref. value1** | **Uncertainty (95% CL)** |
| Li | 8.90 | 8.88 | 8.89 | 0.03 | 9.13 | 0.22 |
| Sc | 36.6 | 36.4 | 36.5 | 0.3 | 33.53 | 0.4 |
| V | 420 | 416 | 418 | 6 | 418 | 4.5 |
| Cr | 19.9 | 20.1 | 20.0 | 0.2 | 15.85 | 0.38 |
| Co | 37.3 | 36.9 | 37.1 | 0.6 | 37.33 | 0.37 |
| Ni | 12.1 | 12.0 | 12.1 | 0.2 | 12.57 | 0.3 |
| Cu | 21.4 | 21.1 | 21.3 | 0.5 | 19.66 | 0.72 |
| Zn | 137 | 135 | 136 | 2 | 130 | 1.8 |
| Ga | 22.8 | 22.5 | 22.6 | 0.5 | 22.07 | 0.19 |
| Rb | 47.5 | 46.8 | 47.2 | 0.9 | 46.02 | 0.56 |
| Sr | 343 | 340 | 341 | 4 | 337 | 6.7 |
| Y | 35.6 | 34.7 | 35.2 | 1.3 | 36.07 | 0.37 |
| Zr | 188 | 184 | 186 | 5 | 187 | 1.5 |
| Nb | 12.2 | 11.9 | 12.1 | 0.4 | 12.44 | 0.2 |
| Cs | 1.20 | 1.17 | 1.19 | 0.04 | 1.16 | 0.023 |
| Ba | 684 | 668 | 676 | 23 | 684 | 4.7 |
| La | 25.6 | 25.0 | 25.3 | 0.9 | 25.08 | 0.16 |
| Ce | 54.2 | 53.3 | 53.8 | 1.2 | 53.12 | 0.33 |
| Pr | 6.92 | 6.77 | 6.84 | 0.21 | 6.827 | 0.044 |
| Nd | 29.5 | 28.8 | 29.2 | 1.1 | 28.26 | 0.37 |
| Sm | 6.70 | 6.57 | 6.64 | 0.17 | 6.547 | 0.047 |
| Eu | 1.99 | 1.96 | 1.97 | 0.05 | 1.989 | 0.024 |
| Gd | 6.92 | 6.80 | 6.86 | 0.16 | 6.811 | 0.078 |
| Tb | 1.10 | 1.07 | 1.09 | 0.03 | 1.077 | 0.026 |
| Dy | 6.47 | 6.39 | 6.43 | 0.11 | 6.424 | 0.055 |
| Ho | 1.30 | 1.28 | 1.29 | 0.02 | 1.313 | 0.011 |
| Er | 3.52 | 3.47 | 3.49 | 0.08 | 3.67 | 0.038 |
| Tm | 0.514 | 0.511 | 0.512 | 0.003 | 0.5341 | 0.006 |
| Yb | 3.41 | 3.33 | 3.37 | 0.12 | 3.392 | 0.036 |
| Lu | 0.502 | 0.495 | 0.498 | 0.011 | 0.5049 | 0.0078 |
| Hf | 4.89 | 4.79 | 4.84 | 0.13 | 4.972 | 0.034 |
| Ta | 0.762 | 0.745 | 0.753 | 0.023 | 0.785 | 0.018 |
| Pb | 10.3 | 10.2 | 10.2 | 0.1 | 10.59 | 0.17 |
| Th | 5.98 | 5.90 | 5.94 | 0.11 | 5.828 | 0.05 |
| U | 1.70 | 1.67 | 1.68 | 0.04 | 1.683 | 0.017 |
| 1GeoReM reference values (Jochum et al., 2016). | | | |  |  |  |

QC Table 6. Solution ICP-MS trace element data in µg/g (ppm) of reference material SO-18 prepared along with SO199 whole rock samples at ACME®. CL = confidence level.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **# Analysis/ Element (µg/g)** | **#1** | **#2** | **#3** | **#4** | **#5** | **#6** | **Mean** | **Uncertainty (95% CL)** | **Ref. value1** | **Uncertainty (95% CL)** |
| Sc | 25 | 25 |  |  | 25 | 25 | 25 | 0.0 | 24.9 | 0.38 |
| V | 205 | 205 | 215 | 210 | 223 | 217 | 213 | 14.3 | 204 | 2.60 |
| Co | 31.3 | 26.7 | 26.8 | 27.0 | 28.4 | 28.0 | 28.0 | 3.5 | 26.7 | 0.39 |
| Ni | 42 | 40 |  |  | 41 | 37 | 40 | 4.3 | 46.2 | 2.89 |
| Ga | 18.9 | 16.8 | 17.1 | 16.7 | 18.0 | 17.7 | 17.5 | 1.7 | 17.2 | 0.31 |
| Rb | 28.0 | 27.5 | 27.5 | 27.3 | 29.0 | 28.5 | 28.0 | 1.3 | 28.2 | 0.38 |
| Sr | 402 | 399 | 405 | 396 | 422 | 411 | 406 | 18.5 | 410 | 5.86 |
| Y | 31.1 | 30.7 | 31.2 | 30.9 | 32.6 | 31.7 | 31.4 | 1.4 | 30.8 | 0.39 |
| Zr | 283 | 281 | 287 | 283 | 300 | 292 | 288 | 14.4 | 293 | 5.53 |
| Nb | 20.7 | 20.7 | 21.1 | 20.4 | 21.5 | 21.4 | 21.0 | 0.9 | 20.2 | 0.35 |
| Cs | 6.8 | 7.0 | 7.0 | 6.7 | 7.4 | 7.0 | 7.0 | 0.5 | 6.95 | 0.14 |
| Ba | 503 | 509 | 512 | 495 | 534 | 521 | 512 | 27.5 | 517 | 7.39 |
| La | 12.0 | 11.8 | 12.7 | 12.1 | 12.7 | 12.2 | 12.3 | 0.7 | 12.5 | 0.30 |
| Ce | 27.1 | 27.1 | 28.5 | 27.2 | 29.7 | 28.2 | 28.0 | 2.1 | 27.2 | 0.37 |
| Pr | 3.34 | 3.27 | 3.45 | 3.39 | 3.49 | 3.37 | 3.4 | 0.2 | 3.33 | 0.05 |
| Nd | 13.8 | 13.1 | 14.2 | 13.3 | 14.2 | 13.8 | 13.7 | 0.9 | 13.4 | 0.29 |
| Sm | 2.87 | 2.79 | 2.77 | 2.75 | 2.95 | 2.87 | 2.8 | 0.2 | 2.88 | 0.05 |
| Eu | 0.87 | 0.85 | 0.87 | 0.85 | 0.89 | 0.87 | 0.9 | 0.0 | 0.866 | 0.01 |
| Gd | 2.91 | 2.81 | 2.84 | 2.78 | 3.04 | 2.90 | 2.9 | 0.2 | 2.98 | 0.06 |
| Tb | 0.50 | 0.49 | 0.51 | 0.50 | 0.52 | 0.51 | 0.5 | 0.0 | 0.488 | 0.01 |
| Dy | 2.93 | 2.89 | 2.87 | 2.79 | 3.01 | 2.91 | 2.9 | 0.1 | 2.94 | 0.06 |
| Ho | 0.62 | 0.60 | 0.62 | 0.62 | 0.63 | 0.62 | 0.6 | 0.0 | 0.616 | 0.01 |
| Er | 1.82 | 1.80 | 1.85 | 1.76 | 1.88 | 1.83 | 1.8 | 0.1 | 1.82 | 0.03 |
| Tm | 0.27 | 0.27 | 0.27 | 0.27 | 0.28 | 0.28 | 0.3 | 0.0 | 0.277 | 0.01 |
| Yb | 1.77 | 1.72 | 1.74 | 1.73 | 1.80 | 1.78 | 1.8 | 0.1 | 1.76 | 0.04 |
| Lu | 0.27 | 0.26 | 0.28 | 0.27 | 0.28 | 0.27 | 0.3 | 0.0 | 0.275 | 0.01 |
| Hf | 9.6 | 9.3 | 9.2 | 9.5 | 10.1 | 9.7 | 9.6 | 0.6 | 9.50 | 0.17 |
| Ta | 6.9 | 7.0 | 7.0 | 7.0 | 7.3 | 7.3 | 7.1 | 0.3 | 6.75 | 0.18 |
| Th | 10.2 | 10.1 | 10.3 | 10.5 | 10.7 | 10.7 | 10.4 | 0.5 | 9.91 | 0.23 |
| U | 16.4 | 16.2 | 16.8 | 16.3 | 17.3 | 16.9 | 16.7 | 0.8 | 16.1 | 0.23 |
| 1GeoReM reference values (Jochum et al., 2005). | | | | | | | | | | |

QC Table 7. Precision of whole rock trace element data in µg/g (ppm) for separate sample digests (Duplicate (Dup) 1 and Dup2) by solution ICP-MS analysis at Kiel University.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Element (µg/g)** | **SO199-DR2-4 Dup1** | **SO199-DR2-4 Dup2** | **Diff. (%)** |  | **SO199-DR6-8 Dup1** | **SO199-DR6-8 Dup2** | **Diff. (%)** |  | **SO199-DR23-19 Dup1** | **SO199-DR23-19 Dup2** | **Diff. (%)** |
| Li | 35.7 | 35.0 | *1.9* |  | 48.4 | 47.0 | *2.9* |  | 81.0 | 81.4 | *0.3* |
| Sc | 42.4 | 41.6 | *1.9* |  | 17.3 | 17.0 | *1.3* |  | 29.7 | 29.9 | *0.1* |
| V | 254 | 250 | *1.7* |  | 141 | 141 | *0.3* |  | 108 | 107 | *0.1* |
| Cr | 408 | 408 | *-0.2* |  | 543 | 537 | *1.1* |  | 529 | 534 | *0.5* |
| Co | 29.9 | 29.2 | *2.2* |  | 21.6 | 21.6 | *0.1* |  | 21.7 | 21.9 | *0.7* |
| Ni | 97.1 | 96.0 | *1.2* |  | 162 | 161 | *0.4* |  | 254 | 261 | *0.6* |
| Cu | 88.8 | 87.8 | *1.1* |  | 8.44 | 8.29 | *1.8* |  | 20.6 | 21.0 | *0.2* |
| Zn | 108 | 108 | *0.5* |  | 35.5 | 36.0 | *-1.5* |  | 73.3 | 74.7 | *0.5* |
| Ga | 16.9 | 16.9 | *0.0* |  | 4.59 | 4.54 | *1.1* |  | 10.2 | 10.3 | *0.2* |
| Rb | 5.98 | 5.94 | *0.8* |  | 1.54 | 1.32 | *13.9* |  | 5.56 | 5.57 | *0.1* |
| Sr | 99.5 | 99.4 | *0.0* |  | 358 | 341 | *4.7* |  | 21.5 | 21.2 | *0.2* |
| Y | 22.6 | 22.4 | *0.9* |  | 6.85 | 6.38 | *6.9* |  | 6.39 | 6.43 | *0.1* |
| Zr | 52.4 | 52.4 | *0.0* |  | 6.61 | 6.98 | *-5.7* |  | 6.14 | 6.89 | *0.1* |
| Nb | 0.697 | 0.678 | *2.8* |  | 0.489 | 0.481 | *1.8* |  | 0.653 | 0.528 | *0.5* |
| Cs | 0.432 | 0.427 | *1.0* |  | 0.010 | 0.007 | *26.0* |  | 0.084 | 0.083 | *0.7* |
| Ba | 5.64 | 5.53 | *2.0* |  | 33.0 | 31.4 | *4.7* |  | 11.3 | 11.0 | *0.1* |
| La | 1.647 | 1.628 | *1.2* |  | 0.849 | 1.021 | *-20.2* |  | 1.02 | 1.01 | *0.5* |
| Ce | 5.16 | 5.11 | *1.0* |  | 2.43 | 2.79 | *-15.2* |  | 3.09 | 3.04 | *0.4* |
| Pr | 0.973 | 0.963 | *1.0* |  | 0.404 | 0.440 | *-9.0* |  | 0.501 | 0.505 | *0.3* |
| Nd | 5.70 | 5.63 | *1.1* |  | 2.20 | 2.33 | *-6.0* |  | 2.50 | 2.52 | *0.0* |
| Sm | 2.14 | 2.12 | *1.1* |  | 0.782 | 0.796 | *-1.8* |  | 0.772 | 0.763 | *0.3* |
| Eu | 0.858 | 0.856 | *0.2* |  | 0.444 | 0.429 | *3.3* |  | 0.208 | 0.216 | *0.5* |
| Gd | 3.00 | 2.97 | *1.0* |  | 1.07 | 1.06 | *0.7* |  | 0.949 | 0.965 | *0.4* |
| Tb | 0.572 | 0.566 | *1.1* |  | 0.196 | 0.191 | *2.4* |  | 0.174 | 0.178 | *0.0* |
| Dy | 3.91 | 3.88 | *0.9* |  | 1.30 | 1.26 | *3.4* |  | 1.16 | 1.16 | *0.2* |
| Ho | 0.835 | 0.824 | *1.3* |  | 0.271 | 0.263 | *2.8* |  | 0.244 | 0.247 | *0.1* |
| Er | 2.35 | 2.33 | *0.9* |  | 0.739 | 0.705 | *4.6* |  | 0.683 | 0.669 | *0.6* |
| Tm | 0.354 | 0.349 | *1.4* |  | 0.106 | 0.101 | *4.6* |  | 0.100 | 0.101 | *0.2* |
| Yb | 2.33 | 2.29 | *1.6* |  | 0.680 | 0.641 | *5.7* |  | 0.642 | 0.649 | *0.6* |
| Lu | 0.341 | 0.339 | *0.6* |  | 0.097 | 0.092 | *5.4* |  | 0.093 | 0.095 | *0.3* |
| Hf | 1.51 | 1.49 | *1.3* |  | 0.233 | 0.237 | *-1.9* |  | 0.201 | 0.218 | *0.3* |
| Ta | 0.061 | 0.056 | *8.5* |  | 0.044 | 0.042 | *4.3* |  | 0.077 | 0.060 | *0.4* |
| Pb | 0.650 | 0.650 | *0.0* |  | 0.382 | 0.383 | *-0.3* |  | 0.294 | 0.296 | *0.3* |
| Th | 0.095 | 0.097 | *-2.4* |  | 0.093 | 0.049 | *47.6* |  | 0.084 | 0.096 | *0.9* |
| U | 0.075 | 0.072 | *4.0* |  | 0.026 | 0.027 | *-2.5* |  | 0.050 | 0.056 | *0.0* |

QC Table 8. Evaluation of instrument stability for ICP-MS trace element data in µg/g (ppm) based on multiple analyses of the same dissolved whole rock samples (Measurements (Meas.)1-6) by solution ICP-MS analysis at Kiel University.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Element (µg/g)** | **SO199-DR23-19 Meas.1** | **SO199-DR23-19 Meas.2** | **SO199-DR23-19 Meas.3** | **SO199-DR23-19 Meas.4** | **SO199-DR23-19 Meas.5** | **SO199-DR23-19 Meas.6** | **Std. dev. (±1σ %)** |
| Li | 81.0 | 80.7 | 81.0 | 80.8 | 81.2 | 81.2 | *0.2* |
| Sc | 29.7 | 29.8 | 29.8 | 32.0 | 32.7 | 32.1 | *4.1* |
| V | 108 | 109 | 109 | 114 | 116 | 113 | *2.7* |
| Cr | 529 | 545 | 541 | 570 | 576 | 573 | *3.3* |
| Co | 21.7 | 21.9 | 21.8 | 22.7 | 23.3 | 22.9 | *2.7* |
| Ni | 254 | 256 | 256 | 270 | 275 | 271 | *3.2* |
| Cu | 20.6 | 20.6 | 20.7 | 21.4 | 21.9 | 21.5 | *2.4* |
| Zn | 73.3 | 72.7 | 73.9 | 74.7 | 75.6 | 75.2 | *1.4* |
| Ga | 10.2 | 10.2 | 10.3 | 10.4 | 10.5 | 10.4 | *1.3* |
| Rb | 5.56 | 5.62 | 5.66 | 5.67 | 5.76 | 5.67 | *1.0* |
| Sr | 21.5 | 22.1 | 22.1 | 21.7 | 21.8 | 21.5 | *1.1* |
| Y | 6.39 | 6.39 | 6.46 | 6.43 | 6.49 | 6.39 | *0.6* |
| Zr | 6.14 | 6.13 | 6.23 | 6.26 | 6.21 | 6.07 | *1.0* |
| Nb | 0.653 | 0.578 | 0.623 | 0.541 | 0.548 | 0.534 | *7.6* |
| Cs | 0.084 | 0.085 | 0.085 | 0.086 | 0.086 | 0.087 | *1.2* |
| Ba | 11.3 | 11.9 | 11.8 | 11.6 | 11.6 | 11.5 | *1.7* |
| La | 1.02 | 1.02 | 1.05 | 1.02 | 1.03 | 1.02 | *1.3* |
| Ce | 3.09 | 3.08 | 3.14 | 3.07 | 3.11 | 3.08 | *0.8* |
| Pr | 0.501 | 0.509 | 0.511 | 0.506 | 0.513 | 0.508 | *0.8* |
| Nd | 2.50 | 2.51 | 2.56 | 2.54 | 2.55 | 2.52 | *0.9* |
| Sm | 0.772 | 0.763 | 0.773 | 0.771 | 0.788 | 0.772 | *1.0* |
| Eu | 0.208 | 0.208 | 0.211 | 0.211 | 0.212 | 0.212 | *0.8* |
| Gd | 0.949 | 0.958 | 0.966 | 0.965 | 0.980 | 0.951 | *1.1* |
| Tb | 0.174 | 0.175 | 0.175 | 0.176 | 0.177 | 0.176 | *0.5* |
| Dy | 1.16 | 1.16 | 1.17 | 1.17 | 1.18 | 1.15 | *0.7* |
| Ho | 0.244 | 0.242 | 0.245 | 0.243 | 0.247 | 0.242 | *0.7* |
| Er | 0.683 | 0.669 | 0.675 | 0.669 | 0.675 | 0.669 | *0.7* |
| Tm | 0.100 | 0.099 | 0.099 | 0.098 | 0.102 | 0.099 | *1.2* |
| Yb | 0.642 | 0.636 | 0.645 | 0.650 | 0.643 | 0.627 | *1.1* |
| Lu | 0.093 | 0.092 | 0.094 | 0.093 | 0.092 | 0.093 | *0.7* |
| Hf | 0.201 | 0.195 | 0.202 | 0.208 | 0.212 | 0.207 | *2.8* |
| Ta | 0.077 | 0.077 | 0.087 | 0.068 | 0.070 | 0.069 | *8.9* |
| Pb | 0.294 | 0.272 | 0.282 | 0.274 | 0.282 | 0.278 | *2.6* |
| Th | 0.084 | 0.084 | 0.085 | 0.082 | 0.084 | 0.081 | *1.5* |
| U | 0.050 | 0.050 | 0.051 | 0.051 | 0.052 | 0.052 | *1.3* |

QC Table 9. LA-ICP-MS trace element data in µg/g (ppm) of the rock standards measured along with the glass samples at Kiel University. Primary reference: KL2-G. 2RSD% = % relative 2SD analytical uncertainties.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Li** | | **Be** | **B** | **Na** | **Mg** | **Al** | **Si** | **P** | **K** | **Ca** | **Sc** | **Ti** | **V** |
| KL2-G | | 5.15 | 0.875 | 2.85 | 17868 | 45266 | 71967 | 239092 | 1032 | 4050 | 78049 | 32.3 | 15518 | 315 |
| KL2-G | | 5.22 | 0.916 | 2.71 | 17593 | 44769 | 71243 | 239127 | 1026 | 4053 | 80484 | 32.4 | 15728 | 314 |
| KL2-G | | 5.20 | 0.907 | 2.78 | 17807 | 44941 | 71504 | 239731 | 1025 | 4043 | 78677 | 32.5 | 15584 | 311 |
| KL2-G | | 5.18 | 0.883 | 2.78 | 17671 | 45103 | 71721 | 238567 | 1033 | 4060 | 79688 | 32.2 | 15651 | 317 |
| KL2-G | | 5.11 | 0.884 | 2.75 | 17550 | 44938 | 71407 | 239394 | 1040 | 4010 | 79191 | 32.1 | 15690 | 315 |
| KL2-G | | 5.26 | 0.906 | 2.80 | 17915 | 45090 | 71790 | 238913 | 1019 | 4092 | 79234 | 32.6 | 15554 | 313 |
| KL2-G | | 5.19 | 0.894 | 2.89 | 17755 | 44770 | 71093 | 239833 | 1055 | 4130 | 79393 | 31.9 | 15636 | 315 |
| KL2-G | | 5.18 | 0.895 | 2.68 | 17703 | 45254 | 72091 | 238470 | 1006 | 3977 | 79062 | 32.8 | 15609 | 314 |
| **average** | | **5.19** | **0.895** | **2.78** | **17733** | **45016** | **71602** | **239141** | **1030** | **4052** | **79222** | **32.3** | **15621** | **314** |
| **2SD** | | **0.04** | **0.014** | **0.07** | **128** | **195** | **350** | **496** | **14** | **46** | **711** | **0.3** | **70** | **2** |
| **2RSD%** | | **0.9** | **1.6** | **2.5** | **0.7** | **0.4** | **0.5** | **0.2** | **1.4** | **1.1** | **0.9** | **0.9** | **0.4** | **0.6** |
| ***GEOREM*** | | ***5.10*** | ***0.880*** | ***2.73*** | ***17437*** | ***44266*** | ***70410*** | ***235135*** | ***1012*** | ***3984*** | ***77902*** | ***31.8*** | ***15360*** | ***309*** |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BCR-2G | | 8.27 | 2.27 | 4.81 | 24248 | 21595 | 72608 | 259240 | 1514 | 14946 | 50765 | 34.7 | 13653 | 417 |
| BCR-2G | | 8.01 | 2.29 | 4.65 | 23824 | 21851 | 73377 | 256665 | 1429 | 14596 | 51893 | 34.7 | 13980 | 424 |
| BCR-2G | | 7.99 | 2.23 | 5.60 | 23914 | 21561 | 74901 | 256283 | 1381 | 14584 | 51466 | 35.2 | 13751 | 418 |
| BCR-2G | | 8.17 | 2.11 | 5.36 | 24122 | 21999 | 74522 | 255986 | 1419 | 14753 | 52195 | 35.4 | 13850 | 420 |
| **average** | | **8.11** | **2.22** | **5.11** | **24027** | **21752** | **73852** | **257043** | **1436** | **14720** | **51580** | **35.0** | **13809** | **420** |
| **2SD** | | **0.13** | **0.08** | **0.45** | **193** | **210** | **1052** | **1491** | **56** | **170** | **620** | **0.3** | **140** | **3** |
| **2RSD%** | | **1.6** | **3.6** | **8.8** | **0.8** | **1.0** | **1.4** | **0.6** | **3.9** | **1.2** | **1.2** | **0.9** | **1.0** | **0.8** |
| ***GEOREM*** | | ***9.00*** | ***2.30*** | ***6.00*** | ***23967*** | ***21470*** | ***70940*** | ***254301*** | ***1615*** | ***14442*** | ***50458*** | ***33.0*** | ***13620*** | ***425*** |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GOR132-G | | 8.61 | 0.045 | 18.44 | 6619 | 136694 | 58551 | 215812 | 122 | 224 | 59856 | 37.5 | 1727 | 214 |
| GOR132-G | | 8.48 | 0.031 | 18.12 | 6444 | 138413 | 58019 | 214554 | 117 | 235 | 60793 | 37.4 | 1735 | 217 |
| **average** | | **8.54** | **0.038** | **18.3** | **6532** | **137554** | **58285** | **215183** | **120** | **230** | **60324** | **37.4** | **1731** | **215** |
| **2SD** | | **0.09** | **0.010** | **0.2** | **124** | **1216** | **376** | **890** | **4** | **8** | **662** | **0.1** | **6** | **2** |
| **2RSD%** | | **1.0** | **25.9** | **1.2** | **1.9** | **0.9** | **0.6** | **0.4** | **3.2** | **3.6** | **1.1** | **0.2** | **0.3** | **1.0** |
| ***GEOREM*** | | ***8.90*** | ***0.080*** | ***17.2*** | ***6159*** | ***135089*** | ***58234*** | ***212697*** | ***157*** | ***256*** | ***60392*** | ***36.5*** | ***1836*** | ***214*** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Cr** | | **Mn** | **Fe** | **Co** | **Ni** | **Cu** | **Zn** | **Ga** | **As** | **Rb** | **Sr** | **Y** | **Zr** |
| KL2-G | | 298 | 1308 | 85067 | 42.1 | 113 | 89.8 | 114 | 20.4 | 0.185 | 8.78 | 361 | 25.7 | 153 |
| KL2-G | | 300 | 1292 | 84105 | 41.7 | 115 | 89.0 | 110 | 20.2 | 0.162 | 8.92 | 364 | 26.0 | 157 |
| KL2-G | | 297 | 1293 | 84433 | 42.0 | 114 | 89.2 | 107 | 20.1 | 0.174 | 8.86 | 362 | 26.4 | 157 |
| KL2-G | | 301 | 1307 | 84754 | 41.8 | 114 | 89.6 | 117 | 20.6 | 0.172 | 8.83 | 362 | 25.4 | 152 |
| KL2-G | | 300 | 1316 | 84694 | 42.0 | 114 | 89.2 | 113 | 20.4 | 0.169 | 8.76 | 363 | 25.4 | 152 |
| KL2-G | | 298 | 1284 | 84476 | 41.8 | 114 | 89.6 | 110 | 20.3 | 0.177 | 8.93 | 361 | 26.3 | 157 |
| KL2-G | | 299 | 1301 | 84154 | 42.1 | 114 | 90.2 | 112 | 20.6 | 0.175 | 8.87 | 361 | 25.4 | 153 |
| KL2-G | | 299 | 1300 | 85010 | 41.7 | 114 | 88.6 | 112 | 20.1 | 0.171 | 8.83 | 363 | 26.2 | 156 |
| **average** | | **299** | **1300** | **84587** | **41.9** | **114** | **89.4** | **112** | **20.3** | **0.173** | **8.85** | **362** | **25.8** | **155** |
| **2SD** | | **1** | **10** | **360** | **0.2** | **0.4** | **0.5** | **3** | **0.2** | **0.006** | **0.06** | **1** | **0.4** | **2** |
| **2RSD%** | | **0.5** | **0.8** | **0.4** | **0.4** | **0.4** | **0.5** | **2.7** | **0.9** | **3.7** | **0.7** | **0.3** | **1.6** | **1.4** |
| ***GEOREM*** | | ***294*** | ***1278*** | ***83173*** | ***41.2*** | ***112*** | ***87.9*** | ***110*** | ***20.0*** | ***0.170*** | ***8.70*** | ***356.0*** | ***25.4*** | ***152*** |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BCR-2G | | 16.8 | 1495 | 95290 | 35.5 | 12.1 | 17.2 | 147 | 21.4 | 0.898 | 49.4 | 334 | 35.3 | 184 |
| BCR-2G | | 16.7 | 1515 | 97366 | 35.2 | 12.3 | 17.2 | 154 | 21.4 | 0.869 | 48.6 | 342 | 35.4 | 188 |
| BCR-2G | | 16.8 | 1530 | 96885 | 35.7 | 12.1 | 17.6 | 143 | 21.8 | 1.038 | 47.4 | 343 | 36.2 | 189 |
| BCR-2G | | 16.9 | 1509 | 96027 | 35.8 | 12.2 | 17.3 | 144 | 20.8 | 1.067 | 48.0 | 347 | 36.5 | 193 |
| **average** | | **16.8** | **1512** | **96392** | **35.6** | **12.2** | **17.3** | **147** | **21.4** | **0.968** | **48.4** | **341** | **35.9** | **188** |
| **2SD** | | **0.1** | **14** | **920** | **0.3** | **0.1** | **0.2** | **5** | **0.4** | **0.099** | **0.8** | **6** | **0.6** | **4** |
| **2RSD%** | | **0.6** | **0.9** | **1.0** | **0.8** | **0.8** | **1.2** | **3.2** | **1.9** | **10.2** | **1.7** | **1.6** | **1.6** | **2.0** |
| ***GEOREM*** | | ***17.0*** | ***1471*** | ***96387*** | ***38.0*** | ***13.0*** | ***21.0*** | ***125*** | ***23.0*** |  | ***47.0*** | ***342*** | ***35.0*** | ***184*** |
|  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GOR132-G | | 2599 | 1174 | 80421 | 94.8 | 1268 | 212 | 73.0 | 11.0 | 0.115 | 2.17 | 15.3 | 14.1 | 10.5 |
| GOR132-G | | 2596 | 1179 | 80227 | 92.4 | 1250 | 205 | 70.5 | 10.9 | 0.125 | 2.14 | 15.3 | 14.0 | 10.2 |
| **average** | | **2598** | **1176** | **80324** | **93.6** | **1259** | **209** | **71.7** | **11.0** | **0.120** | **2.15** | **15.3** | **14.0** | **10.4** |
| **2SD** | | **2** | **4** | **137** | **1.7** | **12** | **5** | **1.8** | **0.1** | **0.007** | **0.02** | **0.0** | **0.1** | **0.2** |
| **2RSD%** | | **0.1** | **0.3** | **0.2** | **1.8** | **1.0** | **2.2** | **2.5** | **1.0** | **5.7** | **0.8** | **0.1** | **0.5** | **1.9** |
| ***GEOREM*** | | ***2528*** | ***1193*** | ***78509*** | ***92.7*** | ***1187*** | ***205*** | ***76.8*** | ***10.4*** | ***0.160*** | ***2.10*** | ***15.3*** | ***12.9*** | ***9.9*** |

**QC Table 9. continued**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Nb** | **Mo** | **In** | **Sn** | **Sb** | **Cs** | **Ba** | **La** | **Ce** | **Pr** | **Nd** | **Sm** | **Eu** |
| KL2-G | 15.2 | 3.68 | 0.268 | 1.60 | 0.132 | 0.120 | 126 | 13.4 | 33.4 | 4.70 | 22.1 | 5.58 | 1.95 |
| KL2-G | 15.3 | 3.64 | 0.224 | 1.54 | 0.155 | 0.114 | 124 | 13.2 | 32.5 | 4.65 | 21.8 | 5.69 | 1.96 |
| KL2-G | 15.2 | 3.74 | 0.241 | 1.51 | 0.141 | 0.119 | 125 | 13.4 | 32.8 | 4.69 | 22.0 | 5.62 | 1.91 |
| KL2-G | 15.3 | 3.59 | 0.248 | 1.62 | 0.143 | 0.115 | 125 | 13.2 | 33.1 | 4.67 | 22.0 | 5.65 | 1.99 |
| KL2-G | 15.3 | 3.59 | 0.241 | 1.63 | 0.146 | 0.119 | 125 | 13.2 | 33.0 | 4.69 | 21.9 | 5.70 | 1.94 |
| KL2-G | 15.2 | 3.74 | 0.247 | 1.51 | 0.139 | 0.115 | 126 | 13.4 | 32.9 | 4.67 | 22.1 | 5.57 | 1.97 |
| KL2-G | 15.3 | 3.66 | 0.244 | 1.59 | 0.140 | 0.113 | 123 | 13.2 | 32.8 | 4.66 | 21.7 | 5.64 | 1.91 |
| KL2-G | 15.2 | 3.66 | 0.244 | 1.55 | 0.145 | 0.121 | 127 | 13.5 | 33.1 | 4.70 | 22.2 | 5.64 | 1.99 |
| **average** | **15.3** | **3.66** | **0.245** | **1.57** | **0.143** | **0.117** | **125** | **13.3** | **33.0** | **4.68** | **22.0** | **5.63** | **1.95** |
| **2SD** | **0.1** | **0.06** | **0.012** | **0.05** | **0.007** | **0.003** | **1** | **0.1** | **0.3** | **0.02** | **0.2** | **0.05** | **0.03** |
| **2RSD%** | **0.5** | **1.5** | **4.9** | **3.0** | **4.6** | **2.4** | **0.9** | **1.0** | **0.8** | **0.4** | **0.7** | **0.8** | **1.6** |
| ***GEOREM*** | ***15.0*** | ***3.60*** | ***0.240*** | ***1.54*** | ***0.140*** | ***0.115*** | ***123*** | ***13.1*** | ***32.4*** | ***4.60*** | ***21.6*** | ***5.54*** | ***1.92*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BCR-2G | 12.4 | 247 | 0.118 | 2.31 | 0.319 | 1.09 | 661 | 24.2 | 50.7 | 6.57 | 28.0 | 6.38 | 1.87 |
| BCR-2G | 12.6 | 249 | 0.122 | 2.37 | 0.336 | 1.06 | 671 | 24.4 | 51.3 | 6.63 | 28.5 | 6.33 | 1.92 |
| BCR-2G | 12.2 | 232 | 0.140 | 2.46 | 0.328 | 1.10 | 671 | 24.9 | 52.4 | 6.75 | 29.4 | 6.54 | 1.97 |
| BCR-2G | 12.6 | 237 | 0.144 | 2.48 | 0.322 | 1.11 | 683 | 25.8 | 53.7 | 6.86 | 29.7 | 6.69 | 1.99 |
| **average** | **12.5** | **241** | **0.131** | **2.40** | **0.326** | **1.09** | **671** | **24.8** | **52.0** | **6.70** | **28.9** | **6.48** | **1.94** |
| **2SD** | **0.2** | **8** | **0.013** | **0.08** | **0.007** | **0.02** | **9** | **0.7** | **1.3** | **0.13** | **0.8** | **0.17** | **0.05** |
| **2RSD%** | **1.5** | **3.2** | **9.9** | **3.3** | **2.2** | **1.8** | **1.3** | **3.0** | **2.6** | **1.9** | **2.7** | **2.6** | **2.8** |
| ***GEOREM*** | ***12.5*** | ***270*** | ***0.110*** | ***2.60*** | ***0.350*** | ***1.16*** | ***683*** | ***24.7*** | ***53.3*** | ***6.70*** | ***28.9*** | ***6.59*** | ***1.97*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GOR132-G | 0.052 | 27.1 | 0.079 | 0.362 | 0.070 | 7.47 | 0.753 | 0.093 | 0.340 | 0.087 | 0.717 | 0.484 | 0.245 |
| GOR132-G | 0.049 | 27.7 | 0.086 | 0.339 | 0.068 | 7.28 | 0.768 | 0.095 | 0.339 | 0.088 | 0.673 | 0.536 | 0.258 |
| **average** | **0.050** | **27.4** | **0.083** | **0.350** | **0.069** | **7.38** | **0.761** | **0.094** | **0.340** | **0.087** | **0.695** | **0.510** | **0.252** |
| **2SD** | **0.002** | **0.4** | **0.005** | **0.017** | **0.002** | **0.13** | **0.010** | **0.001** | **0.001** | **0.000** | **0.032** | **0.037** | **0.009** |
| **2RSD%** | **4.8** | **1.4** | **6.1** | **4.7** | **2.6** | **1.8** | **1.4** | **0.8** | **0.3** | **0.5** | **4.5** | **7.2** | **3.5** |
| ***GEOREM*** | ***0.073*** | ***30.5*** | ***0.090*** | ***0.340*** | ***0.060*** | ***7.45*** | ***0.815*** | ***0.084*** | ***0.393*** | ***0.089*** | ***0.689*** | ***0.508*** | ***0.255*** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Gd** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** | **Hf** | **Ta** | **W** | **Pb** | **Th** | **U** |
| KL2-G | 6.03 | 0.912 | 5.29 | 0.984 | 2.61 | 0.338 | 2.17 | 0.285 | 4.05 | 1.01 | 0.375 | 2.14 | 1.05 | 0.549 |
| KL2-G | 6.01 | 0.897 | 5.32 | 0.971 | 2.55 | 0.335 | 2.10 | 0.295 | 3.95 | 0.943 | 0.379 | 2.07 | 1.03 | 0.566 |
| KL2-G | 6.09 | 0.921 | 5.37 | 0.986 | 2.60 | 0.341 | 2.15 | 0.293 | 4.02 | 0.982 | 0.359 | 2.09 | 1.05 | 0.561 |
| KL2-G | 5.96 | 0.891 | 5.25 | 0.969 | 2.57 | 0.333 | 2.12 | 0.287 | 3.98 | 0.975 | 0.394 | 2.12 | 1.03 | 0.553 |
| KL2-G | 6.02 | 0.887 | 5.24 | 0.974 | 2.53 | 0.336 | 2.13 | 0.286 | 3.96 | 0.982 | 0.368 | 2.07 | 1.04 | 0.552 |
| KL2-G | 6.02 | 0.924 | 5.37 | 0.981 | 2.64 | 0.337 | 2.14 | 0.294 | 4.03 | 0.973 | 0.384 | 2.14 | 1.03 | 0.562 |
| KL2-G | 6.03 | 0.910 | 5.16 | 0.966 | 2.53 | 0.330 | 2.08 | 0.283 | 3.91 | 0.968 | 0.379 | 2.12 | 1.03 | 0.556 |
| KL2-G | 6.02 | 0.900 | 5.45 | 0.988 | 2.63 | 0.343 | 2.19 | 0.297 | 4.09 | 0.986 | 0.374 | 2.09 | 1.04 | 0.558 |
| **average** | **6.02** | **0.905** | **5.31** | **0.977** | **2.58** | **0.337** | **2.14** | **0.290** | **4.00** | **0.978** | **0.376** | **2.11** | **1.04** | **0.557** |
| **2SD** | **0.03** | **0.014** | **0.09** | **0.008** | **0.04** | **0.004** | **0.04** | **0.005** | **0.06** | **0.019** | **0.010** | **0.03** | **0.01** | **0.006** |
| **2RSD%** | **0.6** | **1.5** | **1.7** | **0.9** | **1.6** | **1.3** | **1.7** | **1.8** | **1.5** | **2.0** | **2.7** | **1.3** | **0.7** | **1.0** |
| ***GEOREM*** | ***5.92*** | ***0.890*** | ***5.22*** | ***0.961*** | ***2.54*** | ***0.331*** | ***2.10*** | ***0.285*** | ***3.93*** | ***0.961*** | ***0.370*** | ***2.07*** | ***1.02*** | ***0.548*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BCR-2G | 6.58 | 1.02 | 6.25 | 1.22 | 3.65 | 0.510 | 3.46 | 0.511 | 4.92 | 0.771 | 0.379 | 11.3 | 5.95 | 1.50 |
| BCR-2G | 6.65 | 1.02 | 6.43 | 1.28 | 3.69 | 0.519 | 3.48 | 0.512 | 4.88 | 0.790 | 0.390 | 11.5 | 6.21 | 1.54 |
| BCR-2G | 6.79 | 1.07 | 6.57 | 1.30 | 3.76 | 0.535 | 3.60 | 0.507 | 4.99 | 0.822 | 0.405 | 11.3 | 6.15 | 1.54 |
| BCR-2G | 6.91 | 1.08 | 6.66 | 1.32 | 3.74 | 0.529 | 3.69 | 0.514 | 4.99 | 0.847 | 0.395 | 11.4 | 6.26 | 1.56 |
| **average** | **6.73** | **1.04** | **6.48** | **1.28** | **3.71** | **0.523** | **3.56** | **0.511** | **4.94** | **0.808** | **0.392** | **11.4** | **6.15** | **1.54** |
| **2SD** | **0.15** | **0.03** | **0.18** | **0.04** | **0.05** | **0.011** | **0.11** | **0.003** | **0.05** | **0.034** | **0.011** | **0.1** | **0.13** | **0.03** |
| **2RSD%** | **2.2** | **3.2** | **2.7** | **3.3** | **1.2** | **2.1** | **3.0** | **0.6** | **1.1** | **4.2** | **2.8** | **1.0** | **2.2** | **1.7** |
| ***GEOREM*** | ***6.71*** | ***1.02*** | ***6.44*** | ***1.27*** | ***3.70*** | ***0.510*** | ***3.39*** | ***0.503*** | ***4.84*** | ***0.780*** | ***0.500*** | ***11.0*** | ***5.90*** | ***1.69*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GOR132-G | 1.27 | 0.283 | 2.20 | 0.504 | 1.64 | 0.248 | 1.64 | 0.245 | 0.354 | 0.027 | 22.3 | 22.8 | <0.02 | 0.029 |
| GOR132-G | 1.24 | 0.281 | 2.18 | 0.506 | 1.63 | 0.249 | 1.61 | 0.239 | 0.366 | 0.025 | 22.3 | 22.9 | <0.02 | 0.039 |
| **average** | **1.26** | **0.282** | **2.19** | **0.505** | **1.63** | **0.248** | **1.62** | **0.242** | **0.360** | **0.026** | **22.3** | **22.8** | **<0.02** | **0.034** |
| **2SD** | **0.02** | **0.001** | **0.013** | **0.001** | **0.009** | **0.000** | **0.02** | **0.005** | **0.009** | **0.001** | **0.0** | **0.1** | **na** | **0.007** |
| **2RSD%** | **1.7** | **0.5** | **0.6** | **0.2** | **0.5** | **0.1** | **1.5** | **2.0** | **2.4** | **4.3** | **0.0** | **0.3** | **na** | **21.4** |
| ***GEOREM*** | ***1.190*** | ***0.269*** | ***2.15*** | ***0.507*** | ***1.56*** | ***0.234*** | ***1.61*** | ***0.237*** | ***0.357*** | ***0.031*** | ***25.4*** | ***19.5*** | ***0.009*** | ***0.048*** |

**QC Table 10.** TIMS Sr-Nd-Pb and MC-ICP-MS Hf isotope ratios of reference materials measured along with the glass samples at GEOMAR.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **87Sr/86Sr** | **143Nd/144Nd** | **206Pb/204Pb** | **207Pb/204Pb** | **208Pb/204Pb** | **176Hf/177Hf** |
| Standard | NBS987 | La Jolla | NBS981 | NBS981 | NBS981 | Spex |
| average | 0.710250 | 0.511850 | 16.9408 | 15.4974 | 36.7206 | 0.282170 |
| 2SD (abs) | 0.000009 | 0.000006 | 0.0019 | 0.0019 | 0.005 | 0.000005 |
| N | 8 | 7 | 228 | 228 | 228 | 36 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **87Sr/86Sr** | **2SE** | **143Nd/144Nd** | **2SE** | **176Hf/177Hf** | **2SE** |
| BCR-2 | 0.705001 | 0.000005 | 0.512634 | 0.000005 | 0.282870 | 0.000003 |
| *Fourny et al. (2016)* | |  |  |  |  |  |
| *average* | *0.705006* |  | *0.512643* |  | *0.282869* |  |
| *2SD (abs)* | *0.000007* |  | *0.000014* |  | *0.000014* |  |
| *N* | *7* |  | *10* |  | *11* |  |
|  |  |  |  |  |  |  |
| **Sample** | **206Pb/204Pb** | **2SE** | **207Pb/204Pb** | **2SE** | **208Pb/204Pb** | **2SE** |
| BCR-2 | 18.8019 | 0.0017 | 15.6225 | 0.0018 | 38.8220 | 0.0051 |
| *Fourny et al. (2016)* | |  |  |  |  |  |
| *average* | *18.7988* |  | *15.6235* |  | *38.8281* |  |
| *2SD (abs)* | *0.0027* |  | *0.0028* |  | *0.0099* |  |
| *N* | *3* |  | *3* |  | *3* |  |
| *Todd et al. (2015)* | |  |  |  |  |  |
| *average* | *18.8004* |  | *15.6238* |  | *38.8287* |  |
| *2SD (abs)* | *0.0038* |  | *0.0016* |  | *0.0049* |  |
| *N* | *4* |  | *4* |  | *4* |  |
| 2SE = two standard error uncertainties on the individual analyses. | | | | |  |  |
| 2SD = two standard deviation uncertainties on the average of a number (N) of analyses. | | | | | |  |

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