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**Petrology of Paleoarchean mafic-ultramafic rock suites of western Iron Ore Group, Singhbhum Craton, eastern India using chemistry of minerals**

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**Supplementary Materials**

**Supplementary Table S1 Representative EPMA data of Pyroxene (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1004 | | | | | | 840 | | 994a | | |
| Rock type | Gabbro | | | | | | Basalt | | Gabbro | | |
| Data point | 12 | 3 | 4 | 41 | 69/9 | 70 | 40 | 48 | 35 | 55 | 56 |
| SiO2 | 49.91 | 48.16 | 47.84 | 48.58 | 49.57 | 48.86 | 52.40 | 51.80 | 49.38 | 51.30 | 50.38 |
| TiO2 | 0.43 | 1.01 | 0.93 | 0.53 | 0.58 | 0.64 | 0.34 | 0.57 | 0.47 | 0.46 | 0.71 |
| Al2O3 | 0.97 | 1.24 | 0.97 | 1.09 | 1.05 | 1.08 | 1.26 | 1.62 | 0.94 | 1.84 | 1.70 |
| FeO | 22.49 | 26.92 | 26.49 | 26.42 | 25.13 | 25.04 | 11.51 | 11.80 | 24.95 | 12.00 | 15.93 |
| Cr2O3 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.06 | 0.03 |
| MnO | 0.48 | 0.44 | 0.40 | 0.54 | 0.58 | 0.50 | 0.23 | 0.22 | 0.47 | 0.29 | 0.38 |
| NiO | 0.02 | 0.02 | 0.05 | 0.00 | 0.02 | 0.04 | 0.05 | 0.03 | 0.00 | 0.00 | 0.06 |
| MgO | 9.92 | 3.42 | 3.41 | 7.09 | 9.81 | 7.45 | 15.83 | 15.11 | 10.34 | 14.47 | 12.31 |
| CaO | 14.56 | 19.17 | 19.01 | 14.65 | 12.62 | 15.37 | 17.02 | 17.23 | 12.79 | 18.74 | 17.54 |
| Na2O | 0.21 | 0.21 | 0.20 | 0.21 | 0.19 | 0.19 | 0.18 | 0.22 | 0.15 | 0.21 | 0.22 |
| K2O | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| P2O5 | 0.03 | 0.00 | 0.03 | 0.01 | 0.01 | 0.04 | 0.02 | 0.06 | 0.00 | 0.01 | 0.00 |
| Total | 99.02 | 100.59 | 99.36 | 99.11 | 99.55 | 99.21 | 98.87 | 98.68 | 99.50 | 99.36 | 99.24 |
| Structural formulas based on 6 oxygen anions and 4 cations | | | |  |  |  |  |  |  |  |  |
| TSi | 1.969 | 1.939 | 1.951 | 1.953 | 1.958 | 1.955 | 1.973 | 1.961 | 1.946 | 1.933 | 1.934 |
| TAl | 0.031 | 0.059 | 0.047 | 0.047 | 0.042 | 0.045 | 0.027 | 0.039 | 0.044 | 0.067 | 0.066 |
| TFe3 | 0 | 0.002 | 0.002 | 0 | 0 | 0 | 0 | 0 | 0.011 | 0 | 0 |
| M1Al | 0.014 | 0 | 0 | 0.005 | 0.007 | 0.006 | 0.029 | 0.034 | 0 | 0.014 | 0.011 |
| M1Ti | 0.013 | 0.03 | 0.029 | 0.016 | 0.017 | 0.019 | 0.01 | 0.016 | 0.014 | 0.013 | 0.02 |
| M1Fe3 | 0.007 | 0.017 | 0.007 | 0.026 | 0.015 | 0.014 | 0 | 0 | 0.038 | 0.041 | 0.03 |
| M1Fe2 | 0.382 | 0.747 | 0.755 | 0.528 | 0.383 | 0.514 | 0.07 | 0.096 | 0.341 | 0.118 | 0.232 |
| M1Cr | 0 | 0 | 0 | 0 | 0 | 0 | 0.001 | 0.001 | 0 | 0.002 | 0.001 |
| M1Mg | 0.583 | 0.205 | 0.207 | 0.425 | 0.577 | 0.445 | 0.889 | 0.853 | 0.607 | 0.813 | 0.704 |
| M1Ni | 0.001 | 0.001 | 0.002 | 0 | 0.001 | 0.001 | 0.002 | 0.001 | 0 | 0 | 0.002 |
| M2Mg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| M2Fe2 | 0.353 | 0.141 | 0.139 | 0.334 | 0.432 | 0.309 | 0.293 | 0.278 | 0.433 | 0.219 | 0.25 |
| M2Mn | 0.016 | 0.015 | 0.014 | 0.018 | 0.019 | 0.017 | 0.007 | 0.007 | 0.016 | 0.009 | 0.012 |
| M2Ca | 0.615 | 0.827 | 0.831 | 0.631 | 0.534 | 0.659 | 0.687 | 0.699 | 0.54 | 0.756 | 0.722 |
| M2Na | 0.016 | 0.017 | 0.016 | 0.016 | 0.014 | 0.015 | 0.013 | 0.016 | 0.011 | 0.015 | 0.016 |
| M2K | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum\_cat | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Q | 1.933 | 1.921 | 1.932 | 1.918 | 1.926 | 1.927 | 1.938 | 1.926 | 1.921 | 1.906 | 1.908 |
| J | 0.032 | 0.033 | 0.031 | 0.032 | 0.029 | 0.029 | 0.026 | 0.032 | 0.023 | 0.031 | 0.033 |
| WO | 31.451 | 42.326 | 42.485 | 32.155 | 27.234 | 33.644 | 35.303 | 36.168 | 27.194 | 38.664 | 37.015 |
| EN | 29.815 | 10.506 | 10.597 | 21.651 | 29.443 | 22.7 | 45.685 | 44.132 | 30.588 | 41.541 | 36.122 |
| FS | 38.735 | 47.168 | 46.918 | 46.195 | 43.323 | 43.656 | 19.012 | 19.699 | 42.218 | 19.795 | 26.863 |
| Mg# | 0.44 | 0.19 | 0.19 | 0.33 | 0.41 | 0.35 | 0.71 | 0.70 | 0.44 | 0.71 | 0.59 |
| **Species** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** | **Augite** |

**Supplementary Table S2 Representative EPMA data of Plagioclase (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1004 | | | | | | 994a | 840 | | 866 | | |
| Rock type | Gabbro | | | | | | Gabbro | Basalt | | Basalt | | |
| Data point | 12 | 13 | 14 | 15 | 16 | 46 | 47 | 41 | 42 | 18 | 19 | 2 |
| SiO2 | 68.05 | 67.89 | 66.93 | 68.03 | 67.66 | 47.80 | 70.40 | 66.41 | 68.01 | 67.49 | 66.91 | 67.06 |
| TiO2 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| Al2O3 | 19.54 | 19.54 | 19.47 | 19.42 | 19.47 | 25.67 | 18.09 | 21.20 | 18.79 | 19.74 | 19.77 | 19.56 |
| FeO | 0.33 | 0.44 | 1.13 | 0.48 | 0.70 | 5.07 | 0.95 | 0.38 | 0.53 | 0.24 | 0.64 | 0.33 |
| MnO | 0.00 | 0.01 | 0.00 | 0.00 | 0.05 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 |
| MgO | 0.05 | 0.14 | 0.41 | 0.14 | 0.18 | 0.06 | 0.02 | 0.07 | 0.30 | 0.00 | 0.18 | 0.05 |
| CaO | 0.30 | 0.23 | 0.18 | 0.17 | 0.30 | 17.60 | 3.25 | 1.70 | 0.93 | 0.50 | 0.65 | 0.63 |
| Na2O | 12.44 | 12.38 | 12.12 | 12.37 | 11.66 | 3.09 | 7.33 | 10.06 | 12.25 | 12.21 | 12.07 | 11.91 |
| K2O | 0.26 | 0.05 | 0.25 | 0.09 | 0.69 | 0.49 | 0.12 | 0.45 | 0.04 | 0.08 | 0.27 | 0.24 |
| P2O5 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.03 | 0.01 | 0.00 |
| Total | 100.99 | 100.68 | 100.48 | 100.74 | 100.69 | 99.85 | 100.18 | 100.33 | 100.86 | 100.28 | 100.50 | 99.81 |
| Formulae based on 32 oxygens | | | |  |  |  |  |  |  |  |  |  |
| Si | 11.861 | 11.859 | 11.771 | 11.875 | 11.851 | 9.128 | 12.223 | 11.632 | 11.89 | 11.83 | 11.753 | 11.825 |
| Ti | 0.001 | 0 | 0 | 0.001 | 0 | 0.007 | 0.004 | 0.001 | 0 | 0 | 0 | 0.002 |
| Al | 4.01 | 4.018 | 4.034 | 3.993 | 4.016 | 5.773 | 3.698 | 4.374 | 3.869 | 4.075 | 4.089 | 4.062 |
| Fe2 | 0.048 | 0.064 | 0.165 | 0.07 | 0.102 | 0.81 | 0.138 | 0.056 | 0.078 | 0.035 | 0.094 | 0.049 |
| Mn | 0 | 0.002 | 0 | 0 | 0.007 | 0.002 | 0 | 0.002 | 0.001 | 0 | 0 | 0.001 |
| Mg | 0.013 | 0.037 | 0.107 | 0.037 | 0.046 | 0.017 | 0.005 | 0.019 | 0.079 | 0 | 0.048 | 0.014 |
| Ca | 0.055 | 0.043 | 0.034 | 0.032 | 0.056 | 3.602 | 0.604 | 0.32 | 0.173 | 0.093 | 0.122 | 0.119 |
| Na | 4.206 | 4.191 | 4.133 | 4.187 | 3.959 | 1.142 | 2.468 | 3.415 | 4.151 | 4.149 | 4.11 | 4.073 |
| K | 0.059 | 0.012 | 0.056 | 0.019 | 0.153 | 0.119 | 0.025 | 0.099 | 0.008 | 0.018 | 0.061 | 0.055 |
| Cations | 20.253 | 20.226 | 20.3 | 20.214 | 20.19 | 20.6 | 19.165 | 19.918 | 20.249 | 20.2 | 20.277 | 20.2 |
| X | 15.872 | 15.877 | 15.805 | 15.869 | 15.867 | 14.908 | 15.925 | 16.007 | 15.759 | 15.905 | 15.842 | 15.889 |
| Z | 4.381 | 4.349 | 4.495 | 4.345 | 4.323 | 5.692 | 3.24 | 3.911 | 4.49 | 4.295 | 4.435 | 4.311 |
| Ab | 97.4 | 98.7 | 97.9 | 98.8 | 95 | 23.5 | 79.7 | 89.1 | 95.8 | 97.4 | 95.7 | 95.9 |
| An | 1.3 | 1 | 0.8 | 0.8 | 1.3 | 74.1 | 19.5 | 8.3 | 4 | 2.2 | 2.8 | 2.8 |
| Or | 1.4 | 0.3 | 1.3 | 0.4 | 3.7 | 2.4 | 0.8 | 2.6 | 0.2 | 0.4 | 1.4 | 1.3 |
| **Species** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** | **Bytownite** | **Oligoclase** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** |

**Supplementary Table S2 (contd…)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 866 | | | | 988a | | | |
| Rock type | Basalt | | | | Basalt | | | |
| Data point | 20 | 37 | 41 | 6 | 42 | 43 | 44 | 45 |
| SiO2 | 66.77 | 65.58 | 67.16 | 66.53 | 67.64 | 66.49 | 67.74 | 67.52 |
| TiO2 | 0.06 | 0.00 | 0.00 | 0.03 | 0.00 | 0.14 | 0.02 | 0.02 |
| Al2O3 | 18.77 | 19.55 | 19.44 | 20.14 | 19.49 | 19.78 | 19.66 | 19.76 |
| FeO | 0.92 | 0.75 | 0.33 | 0.46 | 0.44 | 0.40 | 0.28 | 0.10 |
| MnO | 0.00 | 0.00 | 0.02 | 0.04 | 0.01 | 0.00 | 0.01 | 0.02 |
| MgO | 0.76 | 0.32 | 0.10 | 0.14 | 0.00 | 0.08 | 0.02 | 0.00 |
| CaO | 1.42 | 0.80 | 0.33 | 0.75 | 0.28 | 0.89 | 0.49 | 0.49 |
| Na2O | 11.58 | 11.21 | 11.86 | 11.72 | 12.41 | 11.73 | 11.18 | 12.12 |
| K2O | 0.09 | 0.89 | 0.48 | 0.54 | 0.03 | 0.03 | 0.02 | 0.06 |
| P2O5 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 100.35 | 99.11 | 99.75 | 100.34 | 100.29 | 99.54 | 99.42 | 100.08 |
| Formulae based on 32 oxygens | | | | |  |  |  |  |
| Si | 11.772 | 11.714 | 11.851 | 11.708 | 11.862 | 11.758 | 11.915 | 11.844 |
| Ti | 0.007 | 0 | 0 | 0.005 | 0 | 0.018 | 0.002 | 0.003 |
| Al | 3.896 | 4.113 | 4.039 | 4.173 | 4.026 | 4.119 | 4.073 | 4.082 |
| Fe2 | 0.135 | 0.113 | 0.049 | 0.068 | 0.064 | 0.059 | 0.041 | 0.015 |
| Mn | 0 | 0 | 0.004 | 0.005 | 0.001 | 0 | 0.002 | 0.003 |
| Mg | 0.2 | 0.086 | 0.026 | 0.036 | 0.001 | 0.021 | 0.004 | 0 |
| Ca | 0.267 | 0.153 | 0.063 | 0.141 | 0.053 | 0.168 | 0.092 | 0.092 |
| Na | 3.96 | 3.881 | 4.057 | 3.998 | 4.219 | 4.022 | 3.813 | 4.121 |
| K | 0.02 | 0.202 | 0.108 | 0.121 | 0.006 | 0.007 | 0.005 | 0.013 |
| Cations | 20.257 | 20.262 | 20.197 | 20.255 | 20.232 | 20.172 | 19.947 | 20.173 |
| X | 15.675 | 15.827 | 15.89 | 15.886 | 15.888 | 15.895 | 15.99 | 15.929 |
| Z | 4.582 | 4.435 | 4.307 | 4.369 | 4.344 | 4.277 | 3.957 | 4.244 |
| Ab | 93.2 | 91.6 | 96 | 93.8 | 98.6 | 95.8 | 97.5 | 97.5 |
| An | 6.3 | 3.6 | 1.5 | 3.3 | 1.2 | 4 | 2.4 | 2.2 |
| Or | 0.5 | 4.8 | 2.6 | 2.8 | 0.1 | 0.2 | 0.1 | 0.3 |
| **Species** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** | **Albite** |

**Supplementary Table S3 Representative EPMA data of Amphibole (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Uralite associated with relict clinopyroxene | | | | | | | | |
| Sample No. | 1004 | | | | | | | | |
| Rock type | Gabbro | | | | | | | | |
| Data point | 9 | 11 | 14 | 23 | 36 | 49 | 69/2 | 69/5 | 9/1 |
| SiO2 | 49.72 | 50.09 | 49.65 | 49.76 | 49.81 | 50.05 | 50.07 | 50.16 | 49.72 |
| TiO2 | 0.66 | 0.67 | 0.71 | 0.8 | 0.61 | 0.88 | 0.85 | 0.6 | 0.66 |
| Al2O3 | 1.25 | 1.4 | 1.41 | 1.88 | 1.31 | 1.6 | 1.69 | 1.44 | 1.25 |
| FeO | 20.85 | 19.47 | 18.33 | 14.85 | 20.16 | 16.04 | 16.36 | 19.18 | 20.85 |
| Cr2O3 | 0 | 0.03 | 0 | 0 | 0.03 | 0 | 0 | 0 | 0 |
| MnO | 0.35 | 0.34 | 0.4 | 0.34 | 0.42 | 0.34 | 0.29 | 0.39 | 0.35 |
| MgO | 13.25 | 13.38 | 12.61 | 12.99 | 13.12 | 11.91 | 12.66 | 13.34 | 13.25 |
| CaO | 11.82 | 12.77 | 14.8 | 17.37 | 12.44 | 17.25 | 16.07 | 13.01 | 11.82 |
| Na2O | 0.15 | 0.15 | 0.17 | 0.25 | 0.18 | 0.21 | 0.21 | 0.18 | 0.15 |
| K2O | 0.01 | 0.02 | 0 | 0 | 0 | 0.02 | 0.02 | 0 | 0.01 |
| NiO | 0.02 | 0.02 | 0.01 | 0.03 | 0 | 0.06 | 0 | 0 | 0.02 |
| P2O5 | 0 | 0.01 | 0 | 0.04 | 0.01 | 0.04 | 0 | 0 | 0 |
| Total | 98.08 | 98.35 | 98.09 | 98.31 | 98.09 | 98.4 | 98.22 | 98.3 | 98.08 |
| Formulae based on 23 oxygens | | | |  |  |  |  |  |  |
| TSi | 7.248 | 7.334 | 7.478 | 7.642 | 7.308 | 7.741 | 7.613 | 7.363 | 7.248 |
| TAl | 0.215 | 0.241 | 0.25 | 0.34 | 0.226 | 0.259 | 0.303 | 0.249 | 0.215 |
| TFe3 | 0.537 | 0.424 | 0 | 0 | 0.466 | 0 | 0 | 0.388 | 0.537 |
| TTi | 0 | 0 | 0.08 | 0.092 | 0 | 0 | 0.097 | 0 | 0 |
| Sum\_T | 8 | 8 | 7.809 | 8.074 | 8 | 8 | 8.013 | 8 | 8 |
| CAl | 0 | 0 | 0 | 0 | 0 | 0.032 | 0 | 0 | 0 |
| CCr | 0 | 0.003 | 0 | 0 | 0.003 | 0 | 0 | 0 | 0 |
| CFe3 | 0.87 | 0.462 | 0 | 0 | 0.592 | 0 | 0 | 0.361 | 0.87 |
| CTi | 0.072 | 0.074 | 0 | 0 | 0.067 | 0.102 | 0 | 0.066 | 0.072 |
| CMg | 2.88 | 2.921 | 2.831 | 2.974 | 2.87 | 2.746 | 2.87 | 2.919 | 2.88 |
| CFe2 | 1.135 | 1.498 | 2.169 | 1.907 | 1.415 | 2.075 | 2.08 | 1.605 | 1.135 |
| CMn | 0.043 | 0.042 | 0 | 0.044 | 0.052 | 0.045 | 0.037 | 0.048 | 0.043 |
| CCa | 0 | 0 | 0 | 0.074 | 0 | 0 | 0.013 | 0 | 0 |
| Sum\_C | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| BMg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BFe2 | 0 | 0 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| BMn | 0 | 0 | 0.051 | 0 | 0 | 0 | 0 | 0 | 0 |
| BCa | 1.846 | 2 | 1.809 | 2 | 1.955 | 2 | 2 | 2 | 1.846 |
| BNa | 0.042 | 0 | 0 | 0 | 0.045 | 0 | 0 | 0 | 0.042 |
| Sum\_B | 1.889 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1.889 |
| ACa | 0 | 0.003 | 0.58 | 0.784 | 0 | 0.859 | 0.605 | 0.046 | 0 |
| ANa | 0 | 0.043 | 0.05 | 0.074 | 0.007 | 0.063 | 0.062 | 0.051 | 0 |
| AK | 0.002 | 0.004 | 0 | 0 | 0 | 0.004 | 0.004 | 0 | 0.002 |
| Sum\_A | 0.002 | 0.05 | 0.629 | 0.858 | 0.007 | 0.925 | 0.671 | 0.097 | 0.002 |
| **Species** | **Mg-Hbl** | **Mg-Hbl** | **Mg-Hbl** | **Act** | **Mg-Hbl** | **Act** | **Act** | **Mg-Hbl** | **Mg-Hbl** |

**Supplementary Table S3 (contd…)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Uralite associated with relict clinopyroxene | | | | | |
| Sample No. | 840 | | | | | |
| Rock type | Basalt | | | | | |
| Data point | 12 | 14 | 16 | 17 | 47 | 49 |
| SiO2 | 51.47 | 51.49 | 51.48 | 52.15 | 50.43 | 51.75 |
| TiO2 | 0.55 | 0.48 | 0.5 | 0.25 | 0.61 | 0.47 |
| Al2O3 | 1.36 | 1.55 | 1.32 | 1.65 | 2.32 | 1.32 |
| FeO | 11.31 | 12.36 | 11 | 8.56 | 11.93 | 11.43 |
| Cr2O3 | 0.02 | 0.06 | 0.02 | 0.13 | 0 | 0.02 |
| MnO | 0.22 | 0.31 | 0.24 | 0.14 | 0.23 | 0.28 |
| MgO | 15.23 | 15.8 | 15.42 | 17.58 | 15.26 | 15.5 |
| CaO | 17.5 | 15.67 | 17.84 | 17.46 | 16.49 | 16.99 |
| Na2O | 0.19 | 0.15 | 0.19 | 0.18 | 0.2 | 0.19 |
| K2O | 0 | 0.04 | 0.02 | 0 | 0.01 | 0 |
| NiO | 0.05 | 0 | 0.04 | 0.03 | 0 | 0.03 |
| P2O5 | 0 | 0 | 0 | 0.03 | 0.02 | 0.01 |
| Total | 97.9 | 97.91 | 98.07 | 98.16 | 97.5 | 97.99 |
| Formulae based on 23 oxygens | | | |  |  |  |
| TSi | 7.794 | 7.617 | 7.798 | 7.715 | 7.575 | 7.771 |
| TAl | 0.206 | 0.27 | 0.202 | 0.285 | 0.41 | 0.229 |
| TFe3 | 0 | 0 | 0 | 0 | 0 | 0 |
| TTi | 0 | 0.053 | 0 | 0 | 0.069 | 0 |
| Sum\_T | 8 | 7.941 | 8 | 8 | 8.055 | 8 |
| CAl | 0.036 | 0 | 0.034 | 0.003 | 0 | 0.004 |
| CCr | 0.002 | 0.007 | 0.002 | 0.015 | 0 | 0.002 |
| CFe3 | 0 | 0 | 0 | 0 | 0 | 0 |
| CTi | 0.063 | 0 | 0.057 | 0.028 | 0 | 0.053 |
| CMg | 3.438 | 3.484 | 3.482 | 3.877 | 3.417 | 3.47 |
| CFe2 | 1.432 | 1.509 | 1.394 | 1.059 | 1.499 | 1.435 |
| CMn | 0.028 | 0 | 0.031 | 0.018 | 0.029 | 0.036 |
| CCa | 0 | 0 | 0 | 0 | 0.055 | 0 |
| Sum\_C | 5 | 5 | 5 | 5 | 5 | 5 |
| BMg | 0 | 0 | 0 | 0 | 0 | 0 |
| BFe2 | 0 | 0.021 | 0 | 0 | 0 | 0 |
| BMn | 0 | 0.039 | 0 | 0 | 0 | 0 |
| BCa | 2 | 1.941 | 2 | 2 | 2 | 2 |
| BNa | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum\_B | 2 | 2 | 2 | 2 | 2 | 2 |
| ACa | 0.839 | 0.543 | 0.896 | 0.768 | 0.599 | 0.733 |
| ANa | 0.056 | 0.043 | 0.056 | 0.052 | 0.058 | 0.055 |
| AK | 0 | 0.008 | 0.004 | 0 | 0.002 | 0 |
| Sum\_A | 0.895 | 0.594 | 0.955 | 0.819 | 0.659 | 0.789 |
| **Species** | **Act** | **Act** | **Act** | **Act** | **Act** | **Act** |

**Supplementary Table S3 (contd…)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | C o m p l e t e l y c h a n g e d – o v e r a m p h i b o l e | | | | | | | | |
| Sample No. | 1004 | | | 840 | | | | | |
| Rock type | Gabbro | | | Basalt | | | | | |
| Data point | 6 | 24 | 69/10 | 2 | 3 | 13 | 15 | 19 | 20 |
| SiO2 | 54.83 | 48.08 | 48.04 | 51.17 | 48.2 | 47.93 | 52.12 | 47.13 | 52.16 |
| TiO2 | 0 | 0.69 | 0.51 | 0.64 | 1.18 | 1.19 | 0.35 | 1.46 | 0.29 |
| Al2O3 | 1 | 1 | 1.11 | 1.92 | 1.96 | 1.86 | 1.62 | 1.99 | 1.73 |
| FeO | 16.77 | 26.38 | 25.25 | 10.94 | 19.98 | 21.48 | 8.55 | 24.89 | 8.36 |
| Cr2O3 | 0 | 0.05 | 0 | 0.01 | 0 | 0 | 0.08 | 0 | 0.07 |
| MnO | 0.28 | 0.48 | 0.45 | 0.26 | 0.33 | 0.42 | 0.19 | 0.45 | 0.16 |
| MgO | 12.44 | 7.17 | 5.29 | 15.03 | 10.4 | 10.46 | 16.93 | 9.22 | 16.98 |
| CaO | 12.58 | 14.29 | 17.17 | 17.92 | 15.02 | 13.75 | 18.04 | 12.82 | 18.45 |
| Na2O | 0.17 | 0.14 | 0.2 | 0.21 | 0.21 | 0.18 | 0.2 | 0.24 | 0.18 |
| K2O | 0.06 | 0.01 | 0 | 0 | 0 | 0.02 | 0 | 0.04 | 0 |
| NiO | 0.02 | 0.02 | 0 | 0 | 0.02 | 0.07 | 0.01 | 0 | 0.03 |
| P2O5 | 0 | 0.02 | 0 | 0.03 | 0 | 0 | 0 | 0.05 | 0.01 |
| Total | 98.15 | 98.33 | 98.02 | 98.13 | 97.3 | 97.36 | 98.09 | 98.29 | 98.42 |
| Formulae based on 23 oxygens | | | |  |  |  |  |  |  |
| TSi | 8.026 | 7.533 | 7.894 | 7.762 | 7.469 | 7.337 | 7.797 | 7.165 | 7.802 |
| TAl | 0 | 0.185 | 0.106 | 0.238 | 0.358 | 0.335 | 0.203 | 0.356 | 0.198 |
| TFe3 | 0 | 0 | 0 | 0 | 0 | 0.15 | 0 | 0.479 | 0 |
| TTi | 0 | 0.081 | 0 | 0 | 0.138 | 0.137 | 0 | 0 | 0 |
| Sum\_T | 8.026 | 7.799 | 8 | 8 | 7.965 | 7.959 | 8 | 8 | 8 |
| CAl | 0.172 | 0 | 0.109 | 0.105 | 0 | 0 | 0.082 | 0 | 0.107 |
| CCr | 0 | 0.006 | 0 | 0.001 | 0 | 0 | 0.009 | 0 | 0.008 |
| CFe3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.246 | 0 |
| CTi | 0 | 0 | 0.063 | 0.073 | 0 | 0 | 0.039 | 0.167 | 0.033 |
| CMg | 2.714 | 1.675 | 1.296 | 3.399 | 2.403 | 2.387 | 3.775 | 2.09 | 3.786 |
| CFe2 | 2.053 | 3.319 | 3.47 | 1.388 | 2.589 | 2.6 | 1.07 | 2.439 | 1.046 |
| CMn | 0.035 | 0 | 0.063 | 0.033 | 0.008 | 0.013 | 0.024 | 0.058 | 0.02 |
| CCa | 0.026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum\_C | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| BMg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BFe2 | 0 | 0.137 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BMn | 0 | 0.064 | 0 | 0 | 0.035 | 0.041 | 0 | 0 | 0 |
| BCa | 1.947 | 1.799 | 2 | 2 | 1.965 | 1.959 | 2 | 2 | 2 |
| BNa | 0.048 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum\_B | 1.996 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ACa | 0 | 0.6 | 1.023 | 0.913 | 0.529 | 0.296 | 0.891 | 0.088 | 0.957 |
| ANa | 0 | 0.043 | 0.064 | 0.062 | 0.063 | 0.053 | 0.058 | 0.071 | 0.052 |
| AK | 0.011 | 0.002 | 0 | 0 | 0 | 0.004 | 0 | 0.008 | 0 |
| Sum\_A | 0.011 | 0.644 | 1.087 | 0.974 | 0.592 | 0.353 | 0.949 | 0.167 | 1.009 |
| **Species** | **Act** | **Ferro-Act** | **Ferro-Act** | **Act** | **Ferro-Hbl** | **Ferro-Hbl** | **Act** | **Ferro-Hbl** | **Act** |

**Supplementary Table S3 (contd…)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | C o m p l e t e l y c h a n g e d – o v e r a m p h i b o l e | | | | | | | | | |
| Sample No. | 866 | | | | | | 988a | 994a | | |
| Rock type | Basalt | | | | | | Basalt | Gabbro | | |
| Data point | 1 | 9 | 25 | 28 | 39 | 44 | 9 | 38 | 40 | 58 |
| SiO2 | 51.77 | 50.93 | 51.78 | 50.98 | 51.4 | 50.77 | 53.733 | 52.885 | 44.12 | 53.677 |
| TiO2 | 0.2 | 0.07 | 0.19 | 0.14 | 0.18 | 0.05 | 0 | 0.091 | 1.427 | 0 |
| Al2O3 | 1.38 | 1.52 | 1.07 | 1.47 | 1.38 | 1.57 | 1.544 | 1.77 | 6.159 | 1.327 |
| FeO | 8.97 | 9.98 | 9.18 | 9.35 | 8.93 | 9.5 | 15.564 | 16.498 | 25.23 | 15.786 |
| Cr2O3 | 0.11 | 0.16 | 0.14 | 0.22 | 0.1 | 0.04 | 0.038 | 0 | 0 | 0.022 |
| MnO | 0.27 | 0.36 | 0.26 | 0.24 | 0.32 | 0.28 | 0.286 | 0.288 | 0.314 | 0.274 |
| MgO | 15.47 | 12.73 | 14.7 | 15.22 | 13.54 | 13.54 | 13.297 | 12.68 | 7.456 | 13.263 |
| CaO | 19.4 | 21.18 | 20.28 | 19.5 | 21.39 | 21.26 | 12.394 | 12.388 | 10.15 | 12.414 |
| Na2O | 0.21 | 0.22 | 0.18 | 0.16 | 0.25 | 0.16 | 0.151 | 0.327 | 1.98 | 0.194 |
| K2O | 0 | 0.02 | 0.02 | 0 | 0 | 0 | 0.064 | 0.092 | 0.803 | 0.127 |
| NiO | 0 | 0.08 | 0.02 | 0.02 | 0.04 | 0.05 | 0.025 | 0.005 | 0 | 0.019 |
| P2O5 | 0 | 0.25 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0.001 |
| Total | 97.78 | 97.5 | 97.82 | 97.3 | 97.53 | 97.24 | 97.10 | 97.02 | 97.64 | 97.10 |
| Formulae based on 23 oxygens | | | |  |  |  |  |  |  |  |
| TSi | 7.972 | 8.222 | 8.1 | 7.918 | 8.233 | 8.143 | 7.879 | 7.814 | 6.754 | 7.888 |
| TAl | 0.028 | 0 | 0 | 0.082 | 0 | 0 | 0.121 | 0.186 | 1.11 | 0.112 |
| TFe3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.136 | 0 |
| TTi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum\_T | 8 | 8.222 | 8.1 | 8 | 8.233 | 8.143 | 8 | 8 | 8 | 8 |
| CAl | 0.222 | 0.289 | 0.197 | 0.187 | 0.26 | 0.297 | 0.145 | 0.122 | 0 | 0.118 |
| CCr | 0.013 | 0.02 | 0.017 | 0.027 | 0.013 | 0.005 | 0.004 | 0 | 0 | 0.003 |
| CFe3 | 0 | 0 | 0 | 0 | 0 | 0 | 0.023 | 0.01 | 0.844 | 0.003 |
| CTi | 0.023 | 0.009 | 0.022 | 0.016 | 0.022 | 0.006 | 0 | 0.01 | 0.164 | 0 |
| CMg | 3.551 | 3.064 | 3.428 | 3.524 | 3.233 | 3.237 | 2.906 | 2.793 | 1.701 | 2.906 |
| CFe2 | 1.155 | 1.347 | 1.201 | 1.214 | 1.196 | 1.274 | 1.886 | 2.029 | 2.249 | 1.937 |
| CMn | 0.035 | 0.049 | 0.034 | 0.032 | 0.043 | 0.038 | 0.036 | 0.036 | 0.041 | 0.034 |
| CCa | 0 | 0.222 | 0.1 | 0 | 0.233 | 0.143 | 0 | 0 | 0 | 0 |
| Sum\_C | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| BMg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BFe2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BMn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BCa | 2 | 2 | 2 | 2 | 2 | 2 | 1.947 | 1.961 | 1.665 | 1.955 |
| BNa | 0 | 0 | 0 | 0 | 0 | 0 | 0.043 | 0.039 | 0.335 | 0.045 |
| Sum\_B | 2 | 2 | 2 | 2 | 2 | 2 | 1.99 | 2 | 2 | 2 |
| ACa | 1.201 | 1.442 | 1.299 | 1.245 | 1.438 | 1.511 | 0 | 0 | 0 | 0 |
| ANa | 0.063 | 0.069 | 0.055 | 0.048 | 0.078 | 0.05 | 0 | 0.055 | 0.252 | 0.01 |
| AK | 0 | 0.004 | 0.004 | 0 | 0 | 0 | 0.012 | 0.017 | 0.157 | 0.024 |
| Sum\_A | 1.263 | 1.515 | 1.358 | 1.293 | 1.516 | 1.56 | 0.012 | 0.072 | 0.409 | 0.034 |
| **Species** | **Act** | **Act** | **Act** | **Act** | **Act** | **Act** | **Act** | **Act** | **Ferro-Hbl** | **Act** |

Mg-Hbl: Magnesio-Hornblende, Ferro-Hbl: Ferro-Hornblende, Act: Actinolite, Ferro-Act: Ferro-Actinolite

**Supplementary Table S4 Representative EPMA data of Magnetite (data in wt%)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 992a | | | 992b | | | |
| Rock type | Serpentinized Ultramafic | | | Serpentinized Ultramafic | | | |
| Data point | 11 | 13 | 32 | 2 | 7 | 14 | 15 |
| TiO2 | 0.02 | 0.02 | 0.00 | 0.05 | 0.00 | 0.00 | 0.04 |
| Al2O3 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 |
| Cr2O3 | 1.27 | 0.41 | 1.88 | 0.70 | 0.16 | 0.03 | 0.03 |
| Fe2O3 | 67.98 | 68.59 | 67.34 | 68.04 | 68.43 | 68.48 | 67.89 |
| FeO | 28.98 | 29.43 | 29.12 | 28.56 | 28.99 | 27.46 | 28.41 |
| MnO | 0.30 | 0.18 | 0.25 | 0.26 | 0.29 | 0.28 | 0.17 |
| NiO | 0.94 | 0.54 | 0.73 | 1.43 | 0.92 | 1.73 | 1.43 |
| MgO | 0.58 | 0.54 | 0.62 | 0.48 | 0.39 | 0.80 | 0.38 |
| Total | 100.06 | 99.71 | 99.94 | 99.53 | 99.18 | 98.77 | 98.37 |
| Formulae based on 4 oxygens | | |  |  |  |  |  |
| Ti | 0.001 | 0.001 | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 |
| Al | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 |
| Cr | 0.038 | 0.012 | 0.057 | 0.021 | 0.005 | 0.001 | 0.001 |
| Fe3+ | 1.960 | 1.986 | 1.943 | 1.975 | 1.995 | 1.999 | 1.996 |
| Fe2+ | 0.929 | 0.947 | 0.934 | 0.921 | 0.939 | 0.891 | 0.928 |
| Mn | 0.010 | 0.006 | 0.008 | 0.008 | 0.009 | 0.009 | 0.006 |
| Ni | 0.029 | 0.017 | 0.023 | 0.044 | 0.029 | 0.054 | 0.045 |
| Mg | 0.033 | 0.031 | 0.035 | 0.028 | 0.023 | 0.046 | 0.022 |
| Total | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |
|  |  |  |  |  |  |  |  |
| Mg/(Mg+Fe2) | 0.034 | 0.032 | 0.037 | 0.029 | 0.024 | 0.049 | 0.023 |
| Fe2/(Fe2+Fe3) | 0.321 | 0.323 | 0.325 | 0.318 | 0.320 | 0.308 | 0.317 |
| Al/(Al+Fe3+Cr) | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 |
| Fe2+/Fe3+ | 0.474 | 0.477 | 0.481 | 0.466 | 0.471 | 0.446 | 0.465 |
|  |  |  |  |  |  |  |  |
| Cr# | 1.000 | 0.971 | 1.000 | 0.955 | 1.000 | 1.000 | 0.698 |
| Fe2 | 0.928 | 0.946 | 0.934 | 0.920 | 0.939 | 0.891 | 0.927 |
| Mg | 0.033 | 0.031 | 0.035 | 0.028 | 0.023 | 0.046 | 0.022 |
| Mn+Zn+Ni | 0.039 | 0.023 | 0.031 | 0.053 | 0.038 | 0.063 | 0.051 |
|  |  |  |  |  |  |  |  |
| Al | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 |
| Fe3 | 0.981 | 0.994 | 0.972 | 0.989 | 0.998 | 1.000 | 0.999 |
| Cr | 0.019 | 0.006 | 0.028 | 0.011 | 0.002 | 0.000 | 0.000 |

**Supplementary Table S4 (contd…)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample No. | 992b | | | | |
| Rock type | Serpentinized Ultramafic | | | | |
| Data point | 16 | 17 | 25 | 31 | 34 |
| TiO2 | 0.00 | 0.10 | 0.02 | 0.03 | 0.00 |
| Al2O3 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 |
| Cr2O3 | 0.00 | 0.04 | 0.46 | 0.03 | 0.08 |
| Fe2O3 | 68.13 | 67.96 | 68.16 | 68.69 | 68.57 |
| FeO | 28.69 | 27.56 | 28.61 | 27.86 | 28.02 |
| MnO | 0.15 | 0.28 | 0.22 | 0.22 | 0.28 |
| NiO | 1.34 | 1.81 | 0.95 | 1.99 | 1.08 |
| MgO | 0.30 | 0.67 | 0.67 | 0.55 | 0.87 |
| Total | 98.60 | 98.43 | 99.09 | 99.37 | 98.90 |
| Formulae based on 4 oxygens | |  |  |  |  |
| Ti | 0.000 | 0.003 | 0.001 | 0.001 | 0.000 |
| Al | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 |
| Cr | 0.000 | 0.001 | 0.014 | 0.001 | 0.002 |
| Fe3+ | 2.000 | 1.993 | 1.984 | 1.997 | 1.998 |
| Fe2+ | 0.936 | 0.898 | 0.926 | 0.900 | 0.907 |
| Mn | 0.005 | 0.009 | 0.007 | 0.007 | 0.009 |
| Ni | 0.042 | 0.057 | 0.029 | 0.062 | 0.033 |
| Mg | 0.017 | 0.039 | 0.039 | 0.032 | 0.050 |
| Total | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |
|  |  |  |  |  |  |
| Mg/(Mg+Fe2) | 0.018 | 0.042 | 0.040 | 0.034 | 0.052 |
| Fe2/(Fe2+Fe3) | 0.319 | 0.311 | 0.318 | 0.311 | 0.312 |
| Al/(Al+Fe3+Cr) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Fe2+/Fe3+ | 0.468 | 0.451 | 0.467 | 0.451 | 0.454 |
|  |  |  |  |  |  |
| Cr# | 0.335 | 0.761 | 0.951 | 1.000 | 1.000 |
| Fe2 | 0.936 | 0.895 | 0.925 | 0.899 | 0.907 |
| Mg | 0.017 | 0.039 | 0.039 | 0.032 | 0.050 |
| Mn+Zn+Ni | 0.047 | 0.066 | 0.036 | 0.069 | 0.043 |
|  |  |  |  |  |  |
| Al | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Fe3 | 1.000 | 0.999 | 0.993 | 1.000 | 0.999 |
| Cr | 0.000 | 0.001 | 0.007 | 0.000 | 0.001 |

**Supplementary Table S5 Representative EPMA data of Chromite (data in wt%)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 992a | | | | 992b | | |
| Rock type | Serpentinized Ultramafic | | | | Serpentinized Ultramafic | | |
| Data point | 10 | 12 | 29 | 31 | 1 | 3 | 4 |
| Cr2O3 | 56.33 | 54.31 | 55.93 | 56.33 | 57.02 | 57.44 | 56.79 |
| Al2O3 | 9.59 | 10.28 | 9.36 | 9.26 | 9.00 | 8.93 | 9.19 |
| TiO2 | 0.40 | 0.36 | 0.34 | 0.30 | 0.33 | 0.39 | 0.35 |
| FeO | 19.86 | 19.94 | 19.60 | 19.53 | 19.45 | 20.17 | 19.31 |
| Fe2O3 | 4.33 | 4.37 | 4.30 | 3.93 | 3.03 | 2.70 | 3.21 |
| MnO | 0.34 | 0.32 | 0.24 | 0.28 | 0.34 | 0.34 | 0.30 |
| MgO | 8.88 | 8.56 | 8.78 | 8.73 | 8.67 | 8.29 | 8.82 |
| NiO | 0.02 | 0.01 | 0.08 | 0.09 | 0.00 | 0.07 | 0.07 |
| Total | 99.75 | 98.15 | 98.62 | 98.45 | 97.83 | 98.32 | 98.03 |
| Formulae based on 4 oxygens | | |  |  |  |  |  |
| Cr | 1.492 | 1.458 | 1.499 | 1.513 | 1.542 | 1.551 | 1.531 |
| Al | 0.378 | 0.411 | 0.374 | 0.371 | 0.363 | 0.359 | 0.369 |
| Ti | 0.010 | 0.009 | 0.009 | 0.008 | 0.008 | 0.010 | 0.009 |
| Fe2+ | 0.557 | 0.566 | 0.556 | 0.555 | 0.556 | 0.576 | 0.550 |
| Fe3+ | 0.109 | 0.112 | 0.110 | 0.101 | 0.078 | 0.069 | 0.082 |
| Mn | 0.010 | 0.009 | 0.007 | 0.008 | 0.010 | 0.010 | 0.009 |
| Mg | 0.443 | 0.433 | 0.444 | 0.442 | 0.442 | 0.422 | 0.448 |
| Ni | 0.001 | 0.000 | 0.002 | 0.003 | 0.000 | 0.002 | 0.002 |
| Total | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |
|  |  |  |  |  |  |  |  |
| Mg/(Mg+Fe2) | 0.443 | 0.433 | 0.444 | 0.443 | 0.443 | 0.423 | 0.449 |
| Fe2/(Fe2+Fe3) | 0.836 | 0.835 | 0.835 | 0.847 | 0.877 | 0.893 | 0.870 |
| Al/(Al+Fe3+Cr) | 0.191 | 0.208 | 0.189 | 0.187 | 0.183 | 0.182 | 0.186 |
| Fe2+/Fe3+ | 5.093 | 5.068 | 5.068 | 5.522 | 7.134 | 8.319 | 6.690 |
|  |  |  |  |  |  |  |  |
| Cr# | 0.798 | 0.780 | 0.800 | 0.803 | 0.810 | 0.812 | 0.806 |
| Fe2 | 0.551 | 0.561 | 0.551 | 0.551 | 0.552 | 0.571 | 0.545 |
| Mg | 0.439 | 0.429 | 0.440 | 0.439 | 0.438 | 0.418 | 0.444 |
| Mn+Zn+Ni | 0.010 | 0.010 | 0.009 | 0.010 | 0.010 | 0.011 | 0.010 |
|  |  |  |  |  |  |  |  |
| Al | 0.191 | 0.208 | 0.189 | 0.187 | 0.183 | 0.182 | 0.186 |
| Fe3 | 0.055 | 0.056 | 0.055 | 0.051 | 0.039 | 0.035 | 0.042 |
| Cr | 0.754 | 0.736 | 0.756 | 0.763 | 0.778 | 0.783 | 0.772 |

**Supplementary Table S5 (contd…)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample No. | 992b | | | |
| Rock type | Serpentinized Ultramafic | | | |
| Data point | 6 | 24 | 32 | 35 |
| Cr2O3 | 57.15 | 56.75 | 55.08 | 56.20 |
| Al2O3 | 9.17 | 8.28 | 10.01 | 9.39 |
| TiO2 | 0.32 | 0.22 | 0.32 | 0.39 |
| FeO | 19.42 | 20.56 | 18.95 | 19.68 |
| Fe2O3 | 3.38 | 4.22 | 4.63 | 4.06 |
| MnO | 0.34 | 0.28 | 0.35 | 0.28 |
| MgO | 8.84 | 7.89 | 9.20 | 8.76 |
| NiO | 0.06 | 0.04 | 0.04 | 0.14 |
| Total | 98.67 | 98.24 | 98.58 | 98.90 |
| Formulae based on 4 oxygens | |  |  |  |
| Cr | 1.531 | 1.544 | 1.469 | 1.503 |
| Al | 0.366 | 0.336 | 0.398 | 0.374 |
| Ti | 0.008 | 0.006 | 0.008 | 0.010 |
| Fe2+ | 0.551 | 0.592 | 0.535 | 0.557 |
| Fe3+ | 0.086 | 0.109 | 0.118 | 0.103 |
| Mn | 0.010 | 0.008 | 0.010 | 0.008 |
| Mg | 0.446 | 0.405 | 0.462 | 0.442 |
| Ni | 0.002 | 0.001 | 0.001 | 0.004 |
| Total | 3.000 | 3.000 | 3.000 | 3.000 |
|  |  |  |  |  |
| Mg/(Mg+Fe2) | 0.448 | 0.406 | 0.464 | 0.442 |
| Fe2/(Fe2+Fe3) | 0.864 | 0.844 | 0.820 | 0.843 |
| Al/(Al+Fe3+Cr) | 0.185 | 0.169 | 0.201 | 0.189 |
| Fe2+/Fe3+ | 6.379 | 5.414 | 4.547 | 5.384 |
|  |  |  |  |  |
| Cr# | 0.807 | 0.821 | 0.787 | 0.801 |
| Fe2 | 0.546 | 0.588 | 0.530 | 0.551 |
| Mg | 0.443 | 0.402 | 0.459 | 0.437 |
| Mn+Zn+Ni | 0.011 | 0.009 | 0.011 | 0.012 |
|  |  |  |  |  |
| Al | 0.185 | 0.169 | 0.201 | 0.189 |
| Fe3 | 0.044 | 0.055 | 0.059 | 0.052 |
| Cr | 0.772 | 0.776 | 0.740 | 0.759 |

**Supplementary Table S6 Representative EPMA data of Ilmenite (data in wt%)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 994a | | | 1004 | | | |
| Rock type | Gabbro | | | Gabbro | | | |
| Data point | 13 | 22 | 53 | 6 | 26 | 40 | 54 |
| SiO2 | 0.05 | 0.02 | 0.07 | 0.05 | 0.03 | 0.19 | 0.16 |
| TiO2 | 49.36 | 50.28 | 50.60 | 50.53 | 51.16 | 49.93 | 51.23 |
| Al2O3 | 0.02 | 0.00 | 0.00 | 0.03 | 0.02 | 0.04 | 0.08 |
| FeO | 44.48 | 44.62 | 43.74 | 41.95 | 40.41 | 41.97 | 40.79 |
| MnO | 4.08 | 3.61 | 3.95 | 4.74 | 5.27 | 4.66 | 4.99 |
| MgO | 0.04 | 0.08 | 0.07 | 0.01 | 0.02 | 0.02 | 0.06 |
| CaO | 0.47 | 0.07 | 0.25 | 0.57 | 0.44 | 0.48 | 0.51 |
| Total | 98.49 | 98.68 | 98.68 | 97.89 | 97.35 | 97.29 | 97.81 |
| Formulae based on 6 oxygens | | |  |  |  |  |  |
| Si | 0.002 | 0.001 | 0.004 | 0.003 | 0.001 | 0.010 | 0.008 |
| Ti | 1.894 | 1.930 | 1.941 | 1.954 | 1.992 | 1.941 | 1.982 |
| Al | 0.001 | 0.000 | 0.000 | 0.002 | 0.001 | 0.003 | 0.005 |
| Fe2 | 1.898 | 1.904 | 1.866 | 1.803 | 1.749 | 1.814 | 1.755 |
| Mn | 0.176 | 0.156 | 0.171 | 0.206 | 0.231 | 0.204 | 0.217 |
| Mg | 0.003 | 0.006 | 0.005 | 0.001 | 0.001 | 0.002 | 0.004 |
| Ca | 0.026 | 0.004 | 0.013 | 0.320 | 0.025 | 0.027 | 0.028 |

**Supplementary Table S7 Representative EPMA data of Serpentine (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 992a | | | | | | | | | | | | | |
| Rock type | Serpentinized Ultramafic | | | | | | | | | | | | | |
| Data point | 6 | 7 | 8 | 9 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| SiO2 | 43.12 | 44.84 | 43.46 | 43.98 | 40.31 | 40.48 | 42.43 | 42.30 | 45.35 | 42.52 | 43.64 | 38.24 | 43.68 | 42.44 |
| TiO2 | 0.03 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al2O3 | 0.15 | 0.17 | 0.18 | 0.17 | 1.10 | 0.57 | 0.62 | 0.18 | 0.13 | 0.18 | 0.17 | 3.27 | 0.16 | 0.15 |
| FeO | 2.37 | 1.40 | 2.49 | 2.50 | 4.21 | 3.24 | 4.09 | 2.32 | 1.20 | 2.02 | 2.56 | 3.97 | 2.63 | 2.71 |
| Cr2O3 | 0.62 | 0.68 | 0.44 | 0.53 | 0.13 | 0.29 | 0.39 | 0.86 | 0.45 | 0.96 | 0.26 | 0.69 | 0.41 | 0.37 |
| MnO | 0.04 | 0.05 | 0.04 | 0.09 | 0.00 | 0.03 | 0.02 | 0.06 | 0.06 | 0.05 | 0.01 | 0.04 | 0.04 | 0.00 |
| MgO | 37.81 | 40.39 | 39.38 | 40.60 | 38.13 | 38.28 | 39.44 | 38.40 | 39.84 | 38.14 | 38.93 | 36.70 | 38.77 | 38.71 |
| NiO | 0.20 | 0.15 | 0.14 | 0.07 | 0.20 | 0.23 | 0.20 | 0.26 | 0.17 | 0.20 | 0.34 | 0.15 | 0.18 | 0.20 |
| CaO | 0.05 | 0.05 | 0.02 | 0.04 | 0.01 | 0.08 | 0.02 | 0.06 | 0.02 | 0.12 | 0.05 | 0.01 | 0.07 | 0.01 |
| Na2O | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 |
| K2O | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 |
| P2O5 | 0.02 | 0.00 | 0.00 | 0.00 | 0.04 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| Total | 84.19 | 87.61 | 86.01 | 87.91 | 83.93 | 83.02 | 87.08 | 84.18 | 87.04 | 83.99 | 85.62 | 82.94 | 85.76 | 84.40 |
| Formulae based on 7 oxygens | | | |  |  |  |  |  |  |  |  |  |  |  |
| Si | 2.076 | 2.060 | 2.052 | 2.036 | 1.975 | 1.995 | 2.009 | 2.047 | 2.102 | 2.051 | 2.066 | 1.894 | 2.067 | 2.045 |
| Ti | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Al | 0.008 | 0.009 | 0.010 | 0.009 | 0.063 | 0.033 | 0.035 | 0.010 | 0.007 | 0.010 | 0.010 | 0.191 | 0.009 | 0.008 |
| Fe2 | 0.096 | 0.054 | 0.098 | 0.097 | 0.173 | 0.134 | 0.162 | 0.094 | 0.046 | 0.081 | 0.101 | 0.164 | 0.104 | 0.109 |
| Cr | 0.023 | 0.025 | 0.017 | 0.020 | 0.005 | 0.011 | 0.015 | 0.033 | 0.016 | 0.036 | 0.010 | 0.027 | 0.015 | 0.014 |
| Mn | 0.002 | 0.002 | 0.002 | 0.004 | 0.000 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.000 | 0.002 | 0.002 | 0.000 |
| Mg | 2.714 | 2.765 | 2.773 | 2.802 | 2.785 | 2.812 | 2.784 | 2.771 | 2.753 | 2.742 | 2.747 | 2.710 | 2.735 | 2.780 |
| Ni | 0.008 | 0.005 | 0.005 | 0.003 | 0.008 | 0.009 | 0.008 | 0.010 | 0.006 | 0.008 | 0.013 | 0.006 | 0.007 | 0.008 |
| Ca | 0.002 | 0.002 | 0.001 | 0.002 | 0.000 | 0.004 | 0.001 | 0.003 | 0.001 | 0.006 | 0.002 | 0.000 | 0.003 | 0.001 |
| Na | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.001 | 0.000 | 0.001 | 0.000 | 0.002 |
| K | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 |
| P | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 |
| Cations | 4.904 | 4.919 | 4.936 | 4.953 | 4.985 | 4.974 | 4.973 | 4.931 | 4.893 | 4.921 | 4.919 | 4.990 | 4.919 | 4.943 |
| Fe+Mg | 2.81 | 2.82 | 2.87 | 2.90 | 2.96 | 2.95 | 2.95 | 2.87 | 2.80 | 2.82 | 2.85 | 2.87 | 2.84 | 2.89 |

**Supplementary Table S7 (contd…)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 992a | | | | 992b | | | | | | | | | |
| Rock type | Serpentinized Ultramafic | | | | Serpentinized Ultramafic | | | | | | | | | |
| Data point | 28 | 34 | 35 | 36 | 9 | 10 | 11 | 12 | 13 | 18 | 19 | 20 | 21 | 22 |
| SiO2 | 42.50 | 44.72 | 43.73 | 42.70 | 42.91 | 43.85 | 41.41 | 43.96 | 43.06 | 44.30 | 43.90 | 43.60 | 41.34 | 42.57 |
| TiO2 | 0.01 | 0.01 | 0.00 | 0.03 | 0.04 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.00 |
| Al2O3 | 0.16 | 0.20 | 0.16 | 0.17 | 0.30 | 0.19 | 0.22 | 0.26 | 0.24 | 0.27 | 0.24 | 0.22 | 0.17 | 0.25 |
| FeO | 2.76 | 2.40 | 2.49 | 2.79 | 3.01 | 2.65 | 2.34 | 2.69 | 2.59 | 2.70 | 2.73 | 3.00 | 2.23 | 2.49 |
| Cr2O3 | 0.20 | 0.55 | 0.42 | 0.41 | 0.54 | 0.52 | 0.59 | 0.50 | 0.47 | 0.34 | 0.22 | 0.31 | 0.25 | 0.37 |
| MnO | 0.00 | 0.03 | 0.00 | 0.05 | 0.00 | 0.00 | 0.04 | 0.02 | 0.02 | 0.04 | 0.00 | 0.03 | 0.08 | 0.00 |
| MgO | 38.00 | 40.33 | 39.15 | 39.03 | 37.36 | 38.51 | 34.26 | 37.78 | 38.21 | 40.03 | 38.16 | 38.38 | 35.12 | 37.86 |
| NiO | 0.28 | 0.20 | 0.22 | 0.21 | 0.25 | 0.25 | 0.32 | 0.23 | 0.23 | 0.34 | 0.28 | 0.17 | 0.32 | 0.19 |
| CaO | 0.09 | 0.08 | 0.06 | 0.05 | 0.09 | 0.03 | 0.02 | 0.06 | 0.03 | 0.01 | 0.05 | 0.05 | 0.04 | 0.03 |
| Na2O | 0.02 | 0.03 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.06 | 0.00 | 0.03 | 0.02 |
| K2O | 0.00 | 0.02 | 0.04 | 0.02 | 0.03 | 0.00 | 0.02 | 0.03 | 0.00 | 0.04 | 0.03 | 0.00 | 0.03 | 0.00 |
| P2O5 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 |
| Total | 83.74 | 88.35 | 86.04 | 85.27 | 84.27 | 85.75 | 78.90 | 85.34 | 84.62 | 87.75 | 85.41 | 85.60 | 79.26 | 83.59 |
| Formulae based on 7 oxygens | | | |  |  |  |  |  |  |  |  |  |  |  |
| Si | 2.070 | 2.058 | 2.070 | 2.036 | 2.067 | 2.082 | 2.124 | 2.096 | 2.061 | 2.050 | 2.074 | 2.070 | 2.106 | 2.074 |
| Ti | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 |
| Al | 0.009 | 0.011 | 0.009 | 0.010 | 0.017 | 0.011 | 0.013 | 0.015 | 0.014 | 0.015 | 0.013 | 0.012 | 0.010 | 0.015 |
| Fe2 | 0.112 | 0.092 | 0.099 | 0.111 | 0.121 | 0.105 | 0.100 | 0.107 | 0.104 | 0.104 | 0.108 | 0.119 | 0.095 | 0.102 |
| Cr | 0.008 | 0.020 | 0.016 | 0.015 | 0.021 | 0.020 | 0.024 | 0.019 | 0.018 | 0.012 | 0.008 | 0.011 | 0.010 | 0.014 |
| Mn | 0.000 | 0.001 | 0.000 | 0.002 | 0.000 | 0.000 | 0.002 | 0.001 | 0.001 | 0.001 | 0.000 | 0.001 | 0.003 | 0.000 |
| Mg | 2.759 | 2.768 | 2.762 | 2.774 | 2.683 | 2.726 | 2.620 | 2.685 | 2.727 | 2.761 | 2.688 | 2.716 | 2.667 | 2.749 |
| Ni | 0.011 | 0.007 | 0.008 | 0.008 | 0.010 | 0.010 | 0.013 | 0.009 | 0.009 | 0.013 | 0.011 | 0.007 | 0.013 | 0.008 |
| Ca | 0.005 | 0.004 | 0.003 | 0.002 | 0.004 | 0.001 | 0.001 | 0.003 | 0.001 | 0.000 | 0.003 | 0.003 | 0.002 | 0.001 |
| Na | 0.001 | 0.002 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.002 | 0.005 | 0.000 | 0.003 | 0.002 |
| K | 0.000 | 0.001 | 0.002 | 0.001 | 0.002 | 0.000 | 0.001 | 0.002 | 0.000 | 0.003 | 0.002 | 0.000 | 0.002 | 0.000 |
| P | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 |
| Cations | 4.925 | 4.931 | 4.925 | 4.947 | 4.907 | 4.908 | 4.858 | 4.894 | 4.917 | 4.932 | 4.902 | 4.917 | 4.882 | 4.919 |
| Fe+Mg | 2.87 | 2.86 | 2.86 | 2.89 | 2.80 | 2.83 | 2.72 | 2.79 | 2.83 | 2.87 | 2.80 | 2.84 | 2.76 | 2.85 |

**Supplementary Table S7 (contd…)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 992b | | | | | | | | | |
| Rock type | Serpentinized Ultramafic | | | | | | | | | |
| Data point | 23 | 26 | 27 | 28 | 29 | 30 | 33 | 36 | 37 | 38 |
| SiO2 | 43.74 | 43.74 | 43.25 | 42.99 | 42.55 | 44.05 | 44.68 | 45.17 | 43.77 | 43.50 |
| TiO2 | 0.04 | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 |
| Al2O3 | 0.37 | 0.27 | 0.19 | 0.20 | 0.26 | 0.23 | 0.24 | 0.25 | 0.20 | 0.28 |
| FeO | 2.85 | 2.99 | 2.58 | 3.36 | 2.83 | 2.87 | 3.31 | 2.31 | 2.55 | 2.39 |
| Cr2O3 | 0.30 | 0.43 | 0.48 | 0.28 | 0.23 | 0.27 | 0.90 | 0.48 | 0.50 | 0.69 |
| MnO | 0.07 | 0.02 | 0.00 | 0.01 | 0.08 | 0.02 | 0.04 | 0.02 | 0.03 | 0.05 |
| MgO | 34.95 | 38.56 | 38.73 | 38.76 | 37.80 | 37.83 | 38.10 | 38.78 | 39.72 | 37.40 |
| NiO | 0.35 | 0.28 | 0.24 | 0.16 | 0.24 | 0.22 | 0.20 | 0.31 | 0.20 | 0.31 |
| CaO | 0.03 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 | 0.11 | 0.05 | 0.04 | 0.07 |
| Na2O | 0.08 | 0.03 | 0.02 | 0.00 | 0.03 | 0.03 | 0.00 | 0.02 | 0.00 | 0.03 |
| K2O | 0.04 | 0.02 | 0.00 | 0.00 | 0.02 | 0.05 | 0.00 | 0.04 | 0.02 | 0.01 |
| P2O5 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 82.46 | 86.12 | 85.31 | 85.63 | 83.80 | 85.36 | 87.41 | 87.11 | 86.82 | 84.44 |
| Formulae based on 7 oxygens | | | |  |  |  |  |  |  |  |
| Si | 2.146 | 2.072 | 2.054 | 2.048 | 2.056 | 2.092 | 2.081 | 2.103 | 2.053 | 2.094 |
| Ti | 0.002 | 0.002 | 0.002 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 |
| Al | 0.021 | 0.015 | 0.011 | 0.011 | 0.015 | 0.013 | 0.013 | 0.013 | 0.011 | 0.016 |
| Fe2 | 0.117 | 0.118 | 0.102 | 0.134 | 0.115 | 0.114 | 0.129 | 0.090 | 0.100 | 0.096 |
| Cr | 0.011 | 0.016 | 0.018 | 0.011 | 0.009 | 0.010 | 0.033 | 0.018 | 0.018 | 0.026 |
| Mn | 0.003 | 0.001 | 0.000 | 0.000 | 0.003 | 0.001 | 0.002 | 0.001 | 0.001 | 0.002 |
| Mg | 2.556 | 2.724 | 2.743 | 2.753 | 2.723 | 2.678 | 2.645 | 2.691 | 2.777 | 2.684 |
| Ni | 0.014 | 0.011 | 0.009 | 0.006 | 0.009 | 0.008 | 0.008 | 0.012 | 0.008 | 0.012 |
| Ca | 0.002 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.006 | 0.002 | 0.002 | 0.004 |
| Na | 0.007 | 0.003 | 0.002 | 0.000 | 0.003 | 0.002 | 0.000 | 0.002 | 0.000 | 0.003 |
| K | 0.003 | 0.001 | 0.000 | 0.000 | 0.001 | 0.003 | 0.000 | 0.002 | 0.001 | 0.001 |
| P | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Cations | 4.841 | 4.918 | 4.924 | 4.940 | 4.925 | 4.897 | 4.895 | 4.886 | 4.937 | 4.891 |
| Fe+Mg | 2.67 | 2.84 | 2.85 | 2.89 | 2.84 | 2.79 | 2.77 | 2.78 | 2.88 | 2.78 |

**Supplementary Table S8 Representative EPMA data of Chlorite (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1004 | | | | 840 | | 866 | | | | | |
| Rock type | Gabbro | | | | Basalt | | Basalt | | | | | |
| Data point | 33 | 42 | 51 | 52 | 38 | 9 | 12 | 13 | 42 | 43 | 56 | 57 |
| SiO2 | 27.31 | 25.66 | 26.19 | 26.68 | 32.30 | 26.57 | 26.65 | 35.76 | 25.95 | 26.54 | 27.74 | 26.35 |
| TiO2 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Al2O3 | 18.87 | 18.12 | 17.81 | 18.45 | 17.66 | 19.30 | 19.24 | 12.25 | 19.61 | 20.14 | 18.07 | 19.05 |
| FeO | 27.94 | 28.53 | 27.54 | 27.77 | 28.91 | 30.71 | 23.61 | 20.64 | 24.22 | 23.79 | 24.99 | 25.07 |
| MnO | 0.39 | 0.34 | 0.33 | 0.34 | 0.39 | 0.35 | 0.28 | 0.30 | 0.27 | 0.30 | 0.33 | 0.26 |
| MgO | 12.83 | 12.38 | 13.12 | 13.34 | 10.38 | 11.40 | 15.30 | 15.11 | 14.92 | 15.64 | 16.07 | 15.17 |
| CaO | 0.51 | 0.11 | 0.08 | 0.11 | 0.13 | 0.08 | 0.18 | 5.01 | 0.09 | 0.15 | 0.12 | 0.10 |
| Na2O | 0.23 | 0.16 | 0.11 | 0.04 | 0.10 | 0.02 | 0.03 | 0.04 | 0.02 | 0.02 | 0.03 | 0.02 |
| K2O | 0.06 | 0.05 | 0.03 | 0.00 | 0.05 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.00 |
| H2O | 11.28 | 10.82 | 10.87 | 11.10 | 11.66 | 11.17 | 11.17 | 11.88 | 11.09 | 11.34 | 11.37 | 11.16 |
| Total | 99.44 | 96.17 | 96.07 | 97.84 | 101.57 | 99.60 | 96.48 | 100.99 | 96.17 | 97.94 | 98.73 | 97.17 |
| Formulae based on 28 oxygens | | | |  |  |  |  |  |  |  |  |  |
| Si | 5.809 | 5.690 | 5.777 | 5.766 | 6.647 | 5.707 | 5.725 | 7.223 | 5.614 | 5.614 | 5.852 | 5.663 |
| AlIV | 2.191 | 2.310 | 2.223 | 2.234 | 1.353 | 2.293 | 2.275 | 0.777 | 2.386 | 2.386 | 2.148 | 2.337 |
| AlVI | 2.535 | 2.422 | 2.403 | 2.461 | 2.926 | 2.589 | 2.592 | 2.137 | 2.609 | 2.633 | 2.340 | 2.483 |
| Ti | 0.002 | 0.000 | 0.000 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 |
| Fe2 | 4.969 | 5.290 | 5.081 | 5.018 | 4.975 | 5.517 | 4.242 | 3.486 | 4.382 | 4.209 | 4.408 | 4.505 |
| Mn | 0.070 | 0.064 | 0.061 | 0.063 | 0.068 | 0.064 | 0.052 | 0.050 | 0.049 | 0.053 | 0.058 | 0.047 |
| Mg | 4.069 | 4.092 | 4.314 | 4.299 | 3.185 | 3.651 | 4.899 | 4.549 | 4.813 | 4.933 | 5.054 | 4.859 |
| Ca | 0.116 | 0.025 | 0.019 | 0.026 | 0.029 | 0.019 | 0.042 | 1.084 | 0.022 | 0.034 | 0.028 | 0.023 |
| Na | 0.095 | 0.070 | 0.045 | 0.016 | 0.039 | 0.007 | 0.010 | 0.015 | 0.007 | 0.009 | 0.013 | 0.006 |
| K | 0.017 | 0.013 | 0.007 | 0.000 | 0.012 | 0.002 | 0.004 | 0.005 | 0.001 | 0.006 | 0.003 | 0.000 |
| Cations | 19.873 | 19.976 | 19.930 | 19.886 | 19.234 | 19.849 | 19.841 | 19.326 | 19.884 | 19.877 | 19.904 | 19.924 |
| OH | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fe/(Fe+Mg) | 0.55 | 0.56 | 0.54 | 0.54 | 0.61 | 0.60 | 0.46 | 0.43 | 0.48 | 0.46 | 0.47 | 0.48 |
| Mg/(Fe+Mg) | 0.45 | 0.44 | 0.46 | 0.46 | 0.39 | 0.40 | 0.54 | 0.57 | 0.52 | 0.54 | 0.53 | 0.52 |

**Supplementary Table S8 (contd…)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 988a | | 994a | | | | |
| Rock type | Basalt | | Gabbro | | | | |
| Data point | 31 | 32 | 1 | 3 | 5 | 50 | 52 |
| SiO2 | 24.61 | 25.86 | 25.66 | 25.92 | 26.66 | 26.50 | 26.59 |
| TiO2 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Al2O3 | 18.03 | 19.96 | 18.15 | 18.14 | 18.33 | 18.89 | 18.93 |
| FeO | 28.41 | 28.21 | 28.86 | 28.20 | 28.19 | 29.21 | 28.61 |
| MnO | 0.51 | 0.40 | 0.35 | 0.39 | 0.35 | 0.33 | 0.40 |
| MgO | 11.91 | 12.79 | 12.49 | 13.02 | 13.16 | 12.84 | 13.24 |
| CaO | 0.18 | 0.14 | 0.11 | 0.18 | 0.28 | 0.11 | 0.10 |
| Na2O | 0.08 | 0.09 | 0.11 | 0.12 | 0.18 | 0.16 | 0.04 |
| K2O | 0.03 | 0.00 | 0.10 | 0.02 | 0.05 | 0.14 | 0.00 |
| H2O | 10.57 | 11.16 | 10.86 | 10.93 | 11.11 | 11.19 | 11.21 |
| Total | 94.33 | 98.60 | 96.68 | 96.91 | 98.32 | 99.37 | 99.17 |
| Formulae based on 28 oxygens | | |  |  |  |  |  |
| Si | 5.587 | 5.560 | 5.670 | 5.689 | 5.755 | 5.682 | 5.688 |
| AlIV | 2.413 | 2.440 | 2.330 | 2.311 | 2.245 | 2.318 | 2.312 |
| AlVI | 2.407 | 2.614 | 2.391 | 2.379 | 2.414 | 2.451 | 2.459 |
| Ti | 0.000 | 0.001 | 0.000 | 0.001 | 0.000 | 0.000 | 0.006 |
| Fe2 | 5.394 | 5.071 | 5.331 | 5.177 | 5.088 | 5.236 | 5.120 |
| Mn | 0.098 | 0.072 | 0.065 | 0.073 | 0.064 | 0.060 | 0.073 |
| Mg | 4.031 | 4.097 | 4.112 | 4.259 | 4.233 | 4.103 | 4.224 |
| Ca | 0.045 | 0.032 | 0.026 | 0.043 | 0.064 | 0.026 | 0.024 |
| Na | 0.034 | 0.036 | 0.048 | 0.049 | 0.075 | 0.066 | 0.017 |
| K | 0.008 | 0.000 | 0.027 | 0.004 | 0.014 | 0.039 | 0.000 |
| Cations | 20.017 | 19.923 | 20.000 | 19.985 | 19.952 | 19.981 | 19.923 |
| OH | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fe/(Fe+Mg) | 0.57 | 0.55 | 0.56 | 0.55 | 0.55 | 0.56 | 0.55 |
| Mg/(Fe+Mg) | 0.43 | 0.45 | 0.44 | 0.45 | 0.45 | 0.44 | 0.45 |

**Supplementary Table S9 Representative EPMA data of Epidote (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1004 | | | 840 | | | | | | |
| Rock type | Gabbro | | | Basalt | | | | | | |
| Data point | 21 | 22 | 43 | 1 | 24 | 25 | 30 | 31 | 32 | 6 |
| SiO2 | 37.56 | 46.10 | 37.36 | 39.23 | 36.82 | 39.46 | 40.68 | 38.25 | 39.17 | 39.13 |
| TiO2 | 0.00 | 0.00 | 0.05 | 0.04 | 0.08 | 0.09 | 0.02 | 0.03 | 0.05 | 0.04 |
| Al2O3 | 22.46 | 19.28 | 23.63 | 25.27 | 18.89 | 25.84 | 26.14 | 22.75 | 25.75 | 26.31 |
| FeO | 12.46 | 11.38 | 11.29 | 8.50 | 15.56 | 8.54 | 7.99 | 12.13 | 8.89 | 8.76 |
| MnO | 0.07 | 0.13 | 0.21 | 0.10 | 0.06 | 0.09 | 0.00 | 0.08 | 0.04 | 0.00 |
| MgO | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| CaO | 23.25 | 20.34 | 23.12 | 22.98 | 22.98 | 22.69 | 22.24 | 22.91 | 23.15 | 23.33 |
| Na2O | 0.02 | 0.02 | 0.02 | 0.20 | 0.04 | 0.07 | 0.26 | 0.05 | 0.21 | 0.13 |
| K2O | 0.00 | 0.00 | 0.01 | 0.31 | 0.01 | 0.34 | 1.47 | 0.04 | 0.03 | 0.13 |
| Total | 95.84 | 97.25 | 95.69 | 96.63 | 94.45 | 97.12 | 98.81 | 96.22 | 97.29 | 97.83 |
| Formulae based on 13 oxygens | | | |  |  |  |  |  |  |  |
| Si | 3.020 | 3.547 | 2.999 | 3.085 | 3.040 | 3.080 | 3.126 | 3.052 | 3.057 | 3.037 |
| Al | 2.127 | 1.746 | 2.234 | 2.340 | 1.837 | 2.376 | 2.366 | 2.138 | 2.366 | 2.405 |
| Fe3 | 0.837 | 0.731 | 0.757 | 0.558 | 1.073 | 0.556 | 0.513 | 0.808 | 0.580 | 0.568 |
| Mg | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 |
| Ca | 2.002 | 1.676 | 1.989 | 1.936 | 2.033 | 1.898 | 1.831 | 1.958 | 1.936 | 1.940 |
| Sum\_Cats | 7.986 | 7.700 | 7.979 | 7.919 | 7.984 | 7.910 | 7.837 | 7.957 | 7.939 | 7.950 |

**Supplementary Table S9 (contd…)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 866 | | | | | | | 988a | | | | | | |
| Rock type | Basalt | | | | | | | Basalt | | | | | | |
| Data point | 23 | 32 | 4 | 50 | 51 | 53 | 7 | 16 | 17 | 18 | 19 | 2 | 23 | 4 |
| SiO2 | 38.91 | 37.77 | 40.45 | 37.42 | 37.64 | 37.93 | 37.37 | 37.98 | 39.25 | 38.82 | 37.83 | 38.26 | 37.79 | 38.62 |
| TiO2 | 0.02 | 0.06 | 0.18 | 0.08 | 0.05 | 0.01 | 0.00 | 0.11 | 0.05 | 0.04 | 0.10 | 0.03 | 0.08 | 0.05 |
| Al2O3 | 21.44 | 27.25 | 21.33 | 26.91 | 26.34 | 23.53 | 24.56 | 23.56 | 29.44 | 27.83 | 23.21 | 28.57 | 23.86 | 28.27 |
| FeO | 5.93 | 6.72 | 9.35 | 7.18 | 7.97 | 10.90 | 9.60 | 11.45 | 4.99 | 7.04 | 12.08 | 5.75 | 11.32 | 6.26 |
| MnO | 0.15 | 0.00 | 0.15 | 0.05 | 0.06 | 0.05 | 0.03 | 0.06 | 0.02 | 0.00 | 0.00 | 0.05 | 0.11 | 0.01 |
| MgO | 4.03 | 0.08 | 2.35 | 0.00 | 0.41 | 0.07 | 0.06 | 0.11 | 0.02 | 0.00 | 0.04 | 0.03 | 0.09 | 0.02 |
| CaO | 21.79 | 23.96 | 22.56 | 23.85 | 23.42 | 23.11 | 23.04 | 23.02 | 23.90 | 24.17 | 23.16 | 23.98 | 23.04 | 24.41 |
| Na2O | 0.07 | 0.00 | 0.09 | 0.01 | 0.00 | 0.09 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.02 |
| K2O | 0.04 | 0.04 | 0.04 | 0.00 | 0.00 | 0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 |
| Total | 92.39 | 95.88 | 96.50 | 95.50 | 95.90 | 95.70 | 94.66 | 96.33 | 97.68 | 97.90 | 96.45 | 96.68 | 96.30 | 97.66 |
| Formulae based on 13 oxygens | | | |  |  |  |  |  |  |  |  |  |  |  |
| Si | 3.183 | 2.987 | 3.189 | 2.976 | 2.984 | 3.037 | 3.014 | 3.023 | 3.018 | 3.002 | 3.014 | 2.987 | 3.009 | 2.991 |
| Al | 2.066 | 2.538 | 1.981 | 2.521 | 2.459 | 2.218 | 2.332 | 2.208 | 2.666 | 2.534 | 2.177 | 2.627 | 2.237 | 2.579 |
| Fe3 | 0.405 | 0.444 | 0.616 | 0.477 | 0.527 | 0.729 | 0.647 | 0.761 | 0.320 | 0.455 | 0.804 | 0.375 | 0.753 | 0.405 |
| Mg | 0.492 | 0.010 | 0.276 | 0.000 | 0.048 | 0.008 | 0.007 | 0.012 | 0.002 | 0.000 | 0.005 | 0.004 | 0.011 | 0.002 |
| Ca | 1.910 | 2.030 | 1.906 | 2.033 | 1.989 | 1.982 | 1.990 | 1.963 | 1.970 | 2.003 | 1.977 | 2.006 | 1.965 | 2.026 |
| Sum\_Cats | 8.056 | 8.009 | 7.968 | 8.007 | 8.007 | 7.974 | 7.990 | 7.967 | 7.976 | 7.994 | 7.977 | 7.999 | 7.975 | 8.003 |

**Supplementary Table S9 (contd…)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample No. | 988a | | | | 994a |
| Rock type | Basalt | | | | Gabbro |
| Data point | 47 | 48 | 5 | 8 | 41 |
| SiO2 | 37.89 | 37.06 | 37.46 | 38.97 | 37.10 |
| TiO2 | 0.04 | 0.04 | 0.02 | 0.07 | 0.00 |
| Al2O3 | 23.80 | 23.31 | 23.12 | 28.97 | 21.78 |
| FeO | 10.93 | 11.59 | 12.21 | 5.26 | 13.53 |
| MnO | 0.13 | 0.06 | 0.10 | 0.16 | 0.15 |
| MgO | 0.38 | 0.03 | 0.04 | 0.04 | 0.01 |
| CaO | 22.96 | 23.18 | 23.13 | 24.22 | 23.19 |
| Na2O | 0.01 | 0.02 | 0.00 | 0.04 | 0.01 |
| K2O | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| Total | 96.14 | 95.28 | 96.07 | 97.73 | 95.79 |
| Formulae based on 13 oxygens | | |  |  |  |
| Si | 3.018 | 2.991 | 3.000 | 3.006 | 2.998 |
| Al | 2.233 | 2.216 | 2.181 | 2.632 | 2.072 |
| Fe3 | 0.727 | 0.781 | 0.817 | 0.339 | 0.913 |
| Mg | 0.045 | 0.004 | 0.005 | 0.004 | 0.001 |
| Ca | 1.960 | 2.004 | 1.985 | 2.002 | 2.008 |
| Sum\_Cats | 7.983 | 7.996 | 7.988 | 7.983 | 7.992 |

**Supplementary Table S10 Representative EPMA data of K-feldspar (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No | 994a | | | 866 | | | | | |
| Rock type | Gabbro | | | Basalt | | | | | |
| Data point | 33 | 34 | 44 | 14 | 17 | 55 | 60 | 61 | 8 |
| SiO2 | 63.91 | 64.30 | 64.18 | 63.79 | 62.47 | 64.69 | 65.21 | 64.65 | 63.07 |
| TiO2 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Al2O3 | 18.07 | 18.37 | 18.02 | 18.20 | 18.11 | 18.88 | 18.38 | 18.28 | 18.21 |
| FeO | 0.21 | 0.17 | 0.16 | 0.34 | 0.84 | 0.29 | 0.34 | 0.32 | 0.42 |
| MnO | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.06 | 0.02 |
| MgO | 0.00 | 0.01 | 0.01 | 0.00 | 0.37 | 0.10 | 0.01 | 0.08 | 0.15 |
| CaO | 0.03 | 0.22 | 0.00 | 0.13 | 0.09 | 1.09 | 0.01 | 0.44 | 0.01 |
| Na2O | 0.21 | 0.66 | 0.29 | 0.52 | 0.31 | 0.20 | 0.20 | 0.18 | 0.20 |
| K2O | 16.07 | 14.91 | 16.00 | 15.96 | 15.82 | 15.18 | 16.04 | 15.99 | 16.09 |
| P2O5 | 0.05 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.29 | 0.00 |
| Total | 98.53 | 98.72 | 98.66 | 98.96 | 98.01 | 100.43 | 100.23 | 100.29 | 98.18 |
| Formulae based on 32 oxygens | | | |  |  |  |  |  |  |
| Si | 11.993 | 11.982 | 12.02 | 11.943 | 11.849 | 11.883 | 12.014 | 11.923 | 11.913 |
| Ti | 0 | 0.007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Al | 3.993 | 4.032 | 3.974 | 4.012 | 4.045 | 4.085 | 3.988 | 3.97 | 4.052 |
| Fe2 | 0.032 | 0.027 | 0.025 | 0.053 | 0.133 | 0.044 | 0.052 | 0.05 | 0.067 |
| Mn | 0 | 0.004 | 0.001 | 0 | 0 | 0 | 0.007 | 0.009 | 0.003 |
| Mg | 0 | 0.003 | 0.002 | 0 | 0.104 | 0.028 | 0.002 | 0.023 | 0.043 |
| Ca | 0.006 | 0.043 | 0 | 0.026 | 0.018 | 0.214 | 0.002 | 0.086 | 0.001 |
| Na | 0.075 | 0.237 | 0.105 | 0.188 | 0.115 | 0.07 | 0.072 | 0.063 | 0.074 |
| K | 3.846 | 3.544 | 3.824 | 3.813 | 3.827 | 3.558 | 3.77 | 3.763 | 3.877 |
| Cations | 19.945 | 19.879 | 19.951 | 20.035 | 20.091 | 19.882 | 19.907 | 19.887 | 20.03 |
| X | 15.986 | 16.021 | 15.994 | 15.955 | 15.894 | 15.968 | 16.002 | 15.893 | 15.965 |
| Z | 3.959 | 3.858 | 3.957 | 4.08 | 4.197 | 3.914 | 3.905 | 3.994 | 4.065 |
| Ab | 1.9 | 6.2 | 2.7 | 4.7 | 2.9 | 1.8 | 1.9 | 1.6 | 1.9 |
| An | 0.2 | 1.1 | 0 | 0.6 | 0.5 | 5.6 | 0.1 | 2.2 | 0 |
| Or | 97.9 | 92.7 | 97.3 | 94.7 | 96.6 | 92.6 | 98.1 | 96.2 | 98.1 |
| **Species** | **Or** | **Or** | **Or** | **Or** | **Or** | **Or** | **Or** | **Or** | **Or** |

**Supplementary Table S11 Representative EPMA data of Titanite (data in wt%)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1004 | | | | | | | | 840 |
| Rock type | Gabbro | | | | | | | | Basalt |
| Data point | 17 | 18 | 2 | 29 | 30 | 39 | 4 | 48 | 11 |
| SiO2 | 29.72 | 29.25 | 29.61 | 30.29 | 30.37 | 29.51 | 28.81 | 29.70 | 31.04 |
| TiO2 | 37.37 | 36.10 | 36.12 | 35.26 | 36.84 | 37.80 | 37.91 | 35.67 | 30.44 |
| Al2O3 | 1.62 | 1.95 | 1.74 | 1.88 | 1.69 | 1.21 | 2.03 | 2.08 | 2.45 |
| FeO | 1.45 | 3.28 | 2.00 | 1.80 | 1.22 | 1.45 | 2.08 | 2.14 | 3.29 |
| MnO | 0.00 | 0.16 | 0.09 | 0.00 | 0.00 | 0.08 | 0.04 | 0.01 | 0.06 |
| MgO | 0.31 | 0.69 | 0.62 | 0.24 | 0.20 | 0.19 | 0.63 | 0.72 | 0.66 |
| CaO | 27.41 | 26.33 | 26.93 | 27.59 | 27.88 | 27.52 | 25.82 | 26.96 | 28.80 |
| Na2O | 0.00 | 0.03 | 0.05 | 0.04 | 0.02 | 0.03 | 0.03 | 0.05 | 0.07 |
| K2O | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.02 | 0.07 |
| P2O5 | 0.00 | 0.01 | 0.04 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 4.07 |
| Total | 97.87 | 97.83 | 97.20 | 97.09 | 98.23 | 97.81 | 97.36 | 97.34 | 100.95 |
| Formulae based on 20 oxygens | | | |  |  |  |  |  |  |
| Si | 3.974 | 3.940 | 3.994 | 4.082 | 4.040 | 3.958 | 3.875 | 3.999 | 3.990 |
| Ti | 3.759 | 3.658 | 3.664 | 3.574 | 3.685 | 3.813 | 3.835 | 3.613 | 2.944 |
| Al | 0.254 | 0.310 | 0.277 | 0.298 | 0.265 | 0.191 | 0.322 | 0.329 | 0.371 |
| Fe2 | 0.162 | 0.369 | 0.225 | 0.203 | 0.136 | 0.163 | 0.234 | 0.241 | 0.353 |
| Mn | 0.000 | 0.018 | 0.010 | 0.000 | 0.000 | 0.009 | 0.005 | 0.001 | 0.007 |
| Mg | 0.061 | 0.139 | 0.125 | 0.048 | 0.040 | 0.038 | 0.126 | 0.144 | 0.127 |
| Ca | 3.927 | 3.801 | 3.891 | 3.985 | 3.974 | 3.955 | 3.721 | 3.888 | 3.967 |
| Na | 0.000 | 0.008 | 0.012 | 0.009 | 0.004 | 0.007 | 0.007 | 0.014 | 0.018 |
| K | 0.003 | 0.004 | 0.000 | 0.000 | 0.000 | 0.004 | 0.000 | 0.004 | 0.011 |
| Sum\_cats | 12.140 | 12.247 | 12.198 | 12.199 | 12.144 | 12.138 | 12.125 | 12.233 | 11.788 |

**Supplementary Table S11 (contd…)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 866 | | | | 988a | | | | | | 994a | |
| Rock type | Basalt | | | | Basalt | | | | | | Gabbro | |
| Data point | 21 | 29 | 49 | 5 | 13 | 27 | 36 | 37 | 38 | 49 | 24 | 25 |
| SiO2 | 33.27 | 30.69 | 29.74 | 30.74 | 29.71 | 31.05 | 30.53 | 31.98 | 29.83 | 29.81 | 29.96 | 30.32 |
| TiO2 | 29.74 | 35.24 | 32.92 | 32.75 | 27.84 | 33.23 | 36.92 | 32.63 | 35.96 | 32.67 | 38.60 | 36.56 |
| Al2O3 | 5.28 | 2.27 | 3.81 | 3.77 | 5.13 | 3.46 | 1.87 | 4.82 | 2.20 | 3.52 | 0.84 | 1.75 |
| FeO | 1.54 | 1.51 | 2.00 | 1.34 | 4.63 | 1.61 | 0.61 | 1.41 | 1.78 | 1.95 | 1.27 | 1.11 |
| MnO | 0.05 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.04 | 0.04 | 0.01 | 0.00 |
| MgO | 0.25 | 0.71 | 0.28 | 0.12 | 1.07 | 0.32 | 0.00 | 0.11 | 0.71 | 0.44 | 0.08 | 0.20 |
| CaO | 25.31 | 26.60 | 28.06 | 27.88 | 26.24 | 26.89 | 28.12 | 27.59 | 27.30 | 27.78 | 28.09 | 28.01 |
| Na2O | 0.03 | 0.28 | 0.04 | 0.13 | 0.04 | 0.17 | 0.22 | 0.03 | 0.08 | 0.00 | 0.05 | 0.06 |
| K2O | 1.53 | 0.03 | 0.06 | 0.16 | 0.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.06 | 0.04 | 0.19 |
| P2O5 | 0.03 | 0.17 | 0.20 | 0.13 | 1.12 | 0.25 | 0.00 | 0.01 | 0.00 | 0.74 | 0.02 | 0.00 |
| Total | 97.02 | 97.51 | 97.12 | 97.02 | 95.79 | 97.00 | 98.27 | 98.59 | 97.91 | 97.01 | 98.95 | 98.19 |
| Formulae based on 20 oxygens | | | |  |  |  |  |  |  |  |  |  |
| Si | 4.422 | 4.095 | 4.008 | 4.123 | 4.060 | 4.153 | 4.050 | 4.193 | 3.989 | 4.010 | 3.971 | 4.038 |
| Ti | 2.973 | 3.536 | 3.337 | 3.304 | 2.861 | 3.342 | 3.684 | 3.219 | 3.617 | 3.306 | 3.849 | 3.664 |
| Al | 0.827 | 0.356 | 0.605 | 0.596 | 0.826 | 0.545 | 0.293 | 0.745 | 0.346 | 0.558 | 0.131 | 0.275 |
| Fe2 | 0.171 | 0.168 | 0.226 | 0.150 | 0.529 | 0.180 | 0.068 | 0.155 | 0.199 | 0.219 | 0.141 | 0.123 |
| Mn | 0.005 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.004 | 0.005 | 0.002 | 0.000 |
| Mg | 0.050 | 0.142 | 0.055 | 0.025 | 0.219 | 0.064 | 0.000 | 0.021 | 0.142 | 0.088 | 0.015 | 0.040 |
| Ca | 3.604 | 3.803 | 4.051 | 4.007 | 3.842 | 3.853 | 3.996 | 3.876 | 3.911 | 4.003 | 3.990 | 3.997 |
| Na | 0.007 | 0.073 | 0.010 | 0.034 | 0.010 | 0.044 | 0.056 | 0.008 | 0.020 | 0.001 | 0.012 | 0.015 |
| K | 0.260 | 0.005 | 0.010 | 0.027 | 0.000 | 0.001 | 0.000 | 0.000 | 0.003 | 0.011 | 0.006 | 0.032 |
| Sum\_cats | 12.319 | 12.179 | 12.303 | 12.266 | 12.347 | 12.182 | 12.148 | 12.217 | 12.231 | 12.201 | 12.117 | 12.184 |