**Supplementary table 1** Representative compositions of Clinopyroxenes from the Qorveh-Bijar basaltic rocks.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ghezelche-Kand** | | | | | | | | | | | | | |
|  | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** | **C11** | **C12** | **C13** | **C14** |
| **SiO2** | 51.76 | 51.48 | 52.71 | 51.76 | 51.82 | 51.41 | 51.78 | 47.84 | 48.98 | 48.86 | 49.89 | 51.99 | 48.86 | 51.19 |
| **TiO2** | 0.88 | 0.90 | 0.60 | 0.88 | 0.82 | 0.89 | 0.97 | 2.03 | 1.79 | 1.83 | 1.66 | 0.99 | 1.83 | 0.81 |
| **Al2O3** | 2.89 | 2.97 | 2.84 | 2.89 | 2.69 | 2.96 | 2.96 | 6.49 | 5.71 | 5.11 | 4.81 | 3.40 | 5.11 | 2.76 |
| **FeO** | 4.20 | 4.21 | 7.12 | 4.20 | 4.16 | 4.24 | 4.43 | 6.25 | 6.03 | 6.39 | 6.21 | 4.36 | 6.39 | 4.74 |
| **MnO** | 0.09 | 0.06 | 0.19 | 0.09 | 0.08 | 0.07 | 0.10 | 0.10 | 0.09 | 0.11 | 0.12 | 0.09 | 0.11 | 0.09 |
| **MgO** | 14.95 | 14.63 | 13.96 | 14.95 | 15.43 | 15.38 | 15.40 | 12.46 | 12.86 | 13.08 | 12.96 | 16.40 | 13.08 | 16.69 |
| **CaO** | 23.00 | 22.76 | 21.02 | 23.00 | 23.24 | 23.22 | 23.16 | 22.66 | 22.86 | 22.65 | 22.36 | 22.62 | 22.65 | 21.43 |
| **Na2O** | 0.40 | 0.42 | 0.70 | 0.40 | 0.38 | 0.43 | 0.41 | 0.51 | 0.57 | 0.49 | 0.46 | 0.64 | 0.49 | 0.57 |
| **K2O** | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.05 | 0.05 | 0.05 | 0.00 | 0.05 | 0.03 |
| **P2O5** | 0.00 | 0.02 | 0.02 | 0.00 | 0.01 | 0.02 | 0.04 | 0.02 | 0.02 | 0.05 | 0.07 | 0.09 | 0.05 | 0.04 |
| **Total** | 98.21 | 97.50 | 99.18 | 98.21 | 98.66 | 98.63 | 99.28 | 98.38 | 98.96 | 98.62 | 98.59 | 100.57 | 98.62 | 98.34 |
| **Mg#** | 87.62 | 87.32 | 79.62 | 87.51 | 87.90 | 87.90 | 87.40 | 79.72 | 80.99 | 1.84 | 1.87 | 80.22 | 80.60 | 88.09 |
| **Si** | 1.93 | 1.93 | 1.96 | 1.93 | 1.93 | 1.91 | 1.92 | 1.81 | 1.84 | 0.16 | 0.13 | 1.90 | 1.84 | 1.91 |
| **AlIV** | 0.07 | 0.07 | 0.04 | 0.07 | 0.07 | 0.09 | 0.08 | 0.19 | 0.16 | 0.07 | 0.09 | 0.10 | 0.16 | 0.09 |
| **AlVI** | 0.06 | 0.06 | 0.08 | 0.06 | 0.04 | 0.04 | 0.04 | 0.10 | 0.09 | 0.05 | 0.00 | 0.04 | 0.07 | 0.03 |
| **Fe3+** | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.00 | 0.00 | 0.08 | 0.05 | 0.09 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 |
| **Ti** | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.06 | 0.05 | 0.15 | 0.19 | 0.03 | 0.05 | 0.02 |
| **Fe2+** | 0.12 | 0.13 | 0.21 | 0.12 | 0.10 | 0.09 | 0.10 | 0.16 | 0.16 | 0.00 | 0.00 | 0.05 | 0.15 | 0.06 |
| **Mn** | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.73 | 0.72 | 0.00 | 0.00 | 0.00 |
| **Mg** | 0.83 | 0.82 | 0.77 | 0.83 | 0.85 | 0.85 | 0.85 | 0.70 | 0.72 | 0.91 | 0.90 | 0.89 | 0.73 | 0.93 |
| **Ca** | 0.92 | 0.92 | 0.84 | 0.92 | 0.93 | 0.93 | 0.92 | 0.92 | 0.92 | 0.04 | 0.03 | 0.88 | 0.91 | 0.86 |
| **Na** | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.00 | 0.00 | 0.05 | 0.04 | 0.04 |
| **K** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Wo** | 48.79 | 49.00 | 45.53 | 48.79 | 48.40 | 48.41 | 48.14 | 50.44 | 50.22 | 49.37 | 49.34 | 46.27 | 49.37 | 44.31 |
| **En** | 44.09 | 43.79 | 42.07 | 44.09 | 44.70 | 44.60 | 44.49 | 38.56 | 39.30 | 39.61 | 39.70 | 46.68 | 39.61 | 47.96 |
| **Fs** | 7.13 | 7.21 | 12.39 | 7.13 | 6.90 | 6.99 | 7.36 | 11.00 | 10.48 | 11.02 | 10.96 | 7.05 | 11.02 | 7.74 |
| **2Na** | 0.06 | 0.06 | 0.10 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.07 | 0.07 | 0.09 | 0.07 | 0.08 |
| **Ca+Mg+Fe2+** | 1.87 | 1.86 | 1.82 | 1.87 | 1.88 | 1.87 | 1.87 | 1.78 | 1.79 | 1.80 | 1.82 | 1.83 | 1.80 | 1.84 |
| **Cpx-meltKdFe-Mg** | 0  .34 | 0.35 | 0.61 | 0.34 | 0.33 | 0.33 | 0.34 | 0.49 | 0.45 | 0.47 | 0.46 | 0.28 | 0.37 | 0.29 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 1**: continued

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ahmad-Abad** | | | | | | | | | | | | | | |
|  | **C15** | **C16** | **C17** | **C18** | **C19** | **C20** | **C21** | **C22** | **C23** | **C24** | **C25** | **C26** | **C27** | **C28** | **C29** |
| **SiO2** | 50.66 | 51.35 | 49.42 | 48.58 | 51.99 | 53.05 | 52.35 | 52.36 | 51.32 | 51.61 | 51.91 | 51.41 | 51.19 | 53.45 | 51.04 |
| **TiO2** | 1.11 | 0.94 | 1.63 | 1.60 | 0.99 | 0.63 | 0.72 | 0.80 | 0.86 | 1.21 | 1.00 | 1.18 | 0.81 | 0.71 | 0.82 |
| **Al2O3** | 3.61 | 3.63 | 4.33 | 4.92 | 3.40 | 1.75 | 2.78 | 2.71 | 3.84 | 3.60 | 3.00 | 2.85 | 2.76 | 1.97 | 3.34 |
| **FeO** | 5.15 | 4.73 | 5.42 | 5.76 | 4.36 | 4.64 | 4.06 | 4.40 | 7.25 | 5.73 | 5.25 | 5.87 | 4.74 | 4.21 | 4.59 |
| **MnO** | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.14 | 0.08 | 0.09 | 0.19 | 0.11 | 0.11 | 0.12 | 0.09 | 0.11 | 0.09 |
| **MgO** | 15.63 | 16.00 | 14.30 | 13.84 | 16.40 | 16.33 | 15.99 | 16.40 | 13.93 | 15.22 | 15.94 | 15.72 | 16.69 | 16.85 | 16.61 |
| **CaO** | 21.64 | 21.41 | 22.76 | 22.50 | 22.62 | 22.36 | 22.58 | 22.29 | 21.86 | 21.67 | 22.59 | 22.16 | 21.43 | 22.46 | 20.47 |
| **Na2O** | 0.72 | 0.67 | 0.42 | 0.58 | 0.64 | 0.46 | 0.57 | 0.56 | 1.01 | 0.76 | 0.60 | 0.54 | 0.57 | 0.45 | 0.66 |
| **K2O** | 0.08 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.03 | 0.03 | 0.02 | 0.01 |
| **P2O5** | 0.02 | 0.02 | 0.01 | 0.04 | 0.09 | 0.05 | 0.03 | 0.03 | 0.02 | 0.03 | 0.04 | 0.06 | 0.04 | 0.01 | 0.02 |
| **Total** | 98.72 | 98.85 | 98.40 | 98.83 | 100.57 | 99.40 | 99.16 | 99.67 | 100.30 | 99.94 | 100.43 | 99.94 | 98.34 | 100.22 | 97.65 |
| **Mg#** | 84.87 | 87.56 | 85.60 | 86.85 | 83.99 | 82.50 | 88.07 | 87.53 | 88.55 | 88.07 | 79.05 | 84.08 | 85.83 | 84.06 | 87.56 |
| **Si** | 1.89 | 1.90 | 1.84 | 1.75 | 1.896 | 1.95 | 1.930 | 1.92 | 1.90 | 1.90 | 1.90 | 1.90 | 1.91 | 1.95 | 1.94 |
| **AlIV** | 0.11 | 0.10 | 0.13 | 0.25 | 0.104 | 0.05 | 0.070 | 0.08 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 | 0.05 | 0.08 |
| **AlVI** | 0.05 | 0.06 | 0.04 | 0.06 | 0.042 | 0.03 | 0.051 | 0.04 | 0.07 | 0.06 | 0.03 | 0.02 | 0.03 | 0.03 | 0.04 |
| **Fe3+** | 0.09 | 0.06 | 0.09 | 0.09 | 0.079 | 0.02 | 0.037 | 0.05 | 0.09 | 0.05 | 0.08 | 0.08 | 0.09 | 0.02 | 0.09 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| **Ti** | 0.03 | 0.03 | 0.05 | 0.08 | 0.027 | 0.02 | 0.020 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 |
| **Fe2+** | 0.07 | 0.08 | 0.11 | 0.11 | 0.054 | 0.12 | 0.088 | 0.09 | 0.13 | 0.13 | 0.08 | 0.10 | 0.06 | 0.11 | 0.87 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.00 | 0.003 | 0.00 | 0.002 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 |
| **Mg** | 0.87 | 0.88 | 0.80 | 0.73 | 0.892 | 0.90 | 0.878 | 0.90 | 0.77 | 0.84 | 0.87 | 0.87 | 0.93 | 0.92 | 0.86 |
| **Ca** | 0.86 | 0.85 | 0.91 | 0.91 | 0.884 | 0.88 | 0.892 | 0.88 | 0.87 | 0.85 | 0.89 | 0.88 | 0.86 | 0.88 | 0.81 |
| **Na** | 0.05 | 0.05 | 0.03 | 0.04 | 0.046 | 0.03 | 0.041 | 0.04 | 0.07 | 0.05 | 0.04 | 0.04 | 0.04 | 0.03 | 0.098 |
| **K** | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 | 0.00 | 0.001 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Wo** | 45.60 | 45.18 | 47.81 | 47.49 | 46.267 | 45.81 | 47.012 | 45.87 | 46.53 | 45.73 | 46.17 | 45.53 | 44.31 | 45.59 | 42.32 |
| **En** | 45.82 | 46.93 | 41.71 | 40.49 | 46.680 | 46.56 | 46.280 | 46.93 | 41.05 | 44.68 | 45.31 | 44.92 | 47.96 | 47.58 | 47.64 |
| **Fs** | 8.58 | 7.89 | 9.29 | 9.73 | 7.053 | 7.63 | 6.707 | 7.19 | 12.42 | 9.59 | 8.52 | 9.55 | 7.74 | 6.83 | 7.48 |
| **2Na** | 0.10 | 0.10 | 0.06 | 0.07 | 0.091 | 0.07 | 0.081 | 0.08 | 0.15 | 0.11 | 0.09 | 0.08 | 0.08 | 0.06 | 0.70 |
| **Ca+Mg+Fe2+** | 1.80 | 1.82 | 1.82 | 1.76 | 1.829 | 1.90 | 1.858 | 1.86 | 1.77 | 1.82 | 1.84 | 1.85 | 1.84 | 1.90 | 1.80 |
| **Cpx-meltKdFe-Mg** | 0.35 | 0.32 | 0.31 | 0.81 | 0.30 | 0.27 | 0.28 | 0.34 | 0.58 | 0.34 | 0.40 | 0.30 | 0.27 | 0.30 | 0.30 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 1**: continued

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ahmad-Abad** | | **Ghale-Parian Mountain** | | | | | | | | | |
|  | **C30** | **C31** | **C32** | **C33** | **C34** | **C35** | **C36** | **C37** | **C38** | **C39** | **C40** | **C41** |
| **SiO2** | 51.19 | 51.65 | 46.85 | 45.44 | 45.99 | 46.38 | 46.85 | 48.86 | 49.54 | 48.22 | 45.12 | 48.86 |
| **TiO2** | 0.81 | 0.66 | 1.98 | 2.56 | 2.52 | 2.80 | 1.98 | 1.83 | 1.12 | 1.78 | 1.86 | 1.83 |
| **Al2O3** | 2.76 | 2.11 | 6.78 | 7.93 | 6.76 | 6.92 | 6.78 | 5.11 | 4.30 | 5.54 | 7.32 | 5.11 |
| **FeO** | 4.74 | 4.48 | 6.11 | 6.62 | 6.43 | 6.63 | 6.11 | 6.39 | 4.62 | 6.09 | 5.48 | 6.39 |
| **MnO** | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 | 0.10 | 0.11 | 0.07 | 0.08 | 0.09 | 0.11 |
| **MgO** | 16.69 | 16.65 | 12.85 | 12.78 | 13.08 | 12.98 | 12.85 | 13.08 | 15.39 | 13.88 | 13.38 | 13.08 |
| **CaO** | 21.43 | 21.22 | 22.19 | 22.11 | 22.42 | 22.50 | 22.19 | 22.65 | 21.89 | 22.49 | 20.02 | 22.65 |
| **Na2O** | 0.57 | 0.46 | 0.52 | 0.52 | 0.47 | 0.48 | 0.52 | 0.49 | 0.72 | 0.54 | 0.78 | 0.49 |
| **K2O** | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.01 | 0.03 | 0.05 | 0.04 | 0.05 | 0.09 | 0.05 |
| **P2O5** | 0.04 | 0.03 | 0.06 | 0.02 | 0.06 | 0.04 | 0.06 | 0.05 | 0.03 | 0.06 | 0.02 | 0.05 |
| **Total** | 98.34 | 97.37 | 97.46 | 98.12 | 97.86 | 98.83 | 97.46 | 98.62 | 97.72 | 98.73 | 94.16 | 98.62 |
| **Mg#** | 88.80 | 87.73 | 87.79 | 88.67 | 80.61 | 79.35 | 79.73 | 79.60 | 83.54 | 83.35 | 82.80 | 81.87 |
| **Si** | 1.91 | 1.94 | 1.79 | 1.73 | 1.76 | 1.75 | 1.79 | 1.84 | 1.86 | 1.82 | 1.84 | 1.84 |
| **AlIV** | 0.09 | 0.07 | 0.21 | 0.27 | 0.24 | 0.25 | 0.21 | 0.16 | 0.14 | 0.18 | 0.19 | 0.16 |
| **AlVI** | 0.03 | 0.03 | 0.09 | 0.09 | 0.06 | 0.06 | 0.09 | 0.07 | 0.06 | 0.08 | 0.06 | 0.07 |
| **Fe3+** | 0.09 | 0.06 | 0.09 | 0.12 | 0.11 | 0.09 | 0.09 | 0.05 | 0.11 | 0.10 | 0.08 | 0.05 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ti** | 0.02 | 0.02 | 0.06 | 0.07 | 0.07 | 0.08 | 0.06 | 0.05 | 0.03 | 0.03 | 0.02 | 0.05 |
| **Fe2+** | 0.06 | 0.08 | 0.10 | 0.09 | 0.09 | 0.11 | 0.10 | 0.15 | 0.04 | 0.05 | 0.04 | 0.15 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mg** | 0.93 | 0.93 | 0.73 | 0.72 | 0.74 | 0.73 | 0.73 | 0.73 | 0.86 | 0.84 | 0.82 | 0.73 |
| **Ca** | 0.86 | 0.85 | 0.91 | 0.90 | 0.92 | 0.91 | 0.91 | 0.91 | 0.88 | 0.89 | 0.86 | 0.91 |
| **Na** | 0.04 | 0.03 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.04 |
| **K** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Wo** | 44.31 | 44.26 | 49.52 | 49.11 | 49.13 | 49.19 | 49.52 | 49.37 | 46.64 | 47.32 | 45.32 | 49.37 |
| **En** | 47.96 | 48.31 | 39.75 | 39.31 | 39.79 | 39.39 | 39.75 | 39.61 | 45.62 | 40.72 | 42.25 | 39.61 |
| **Fs** | 7.74 | 7.43 | 10.73 | 11.59 | 11.09 | 11.42 | 10.73 | 11.02 | 7.73 | 10.11 | 9.68 | 11.02 |
| **2Na** | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 0.07 | 0.08 | 0.07 | 0.11 | 0.12 | 0.11 | 0.07 |
| **Ca+Mg+Fe2+** | 1.84 | 1.86 | 1.74 | 1.72 | 1.75 | 1.76 | 1.74 | 1.80 | 1.78 | 1.79 | 1.73 | 1.80 |
| **Cpx-meltKdFe-Mg** | 0.27 | 0.32 | 1.01 | 1.91 | 1.25 | 1.08 | 0.98 | 0.90 | 0.90 | 0.90 | 0.40 | 0.40 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 1**: continued

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Tahmoures** | | | | | | | **Ghareh-Toreh** | | | |
|  | **C42** | **C43** | **C44** | **C45** | **C46** | **C47** | **C48** | **C49** | **C50** | **C51** | **C52** |
| **SiO2** | 49.54 | 49.29 | 46.92 | 46.73 | 49.89 | 49.08 | 45.61 | 46.62 | 45.21 | 46.28 | 43.82 |
| **TiO2** | 1.12 | 1.67 | 1.87 | 2.40 | 1.66 | 1.72 | 2.68 | 2.33 | 2.68 | 2.42 | 2.89 |
| **Al2O3** | 4.30 | 10.01 | 6.52 | 7.08 | 4.81 | 4.63 | 5.57 | 5.09 | 6.10 | 4..38 | 6.42 |
| **FeO** | 4.62 | 5.40 | 6.38 | 7.50 | 6.21 | 6.21 | 6.72 | 6.38 | 7.32 | 6.57 | 7.01 |
| **MnO** | 0.07 | 0.06 | 0.08 | 0.12 | 0.12 | 0.11 | 0.12 | 0.11 | 0.10 | 0.08 | 0.08 |
| **MgO** | 15.39 | 10.53 | 12.92 | 12.24 | 12.96 | 14.33 | 14.23 | 14.18 | 13.22 | 14.32 | 12.87 |
| **CaO** | 21.89 | 19.46 | 22.18 | 22.66 | 22.36 | 22.79 | 22.58 | 22.68 | 22.59 | 22.41 | 22.48 |
| **Na2O** | 0.72 | 0.92 | 0.53 | 0.57 | 0.46 | 0.45 | 0.62 | 0.58 | 0.68 | 0.48 | 0.68 |
| **K2O** | 0.04 | 0.30 | 0.02 | 0.03 | 0.05 | 0.04 | 0.03 | 0.02 | 0.03 | 0.02 | 0.01 |
| **P2O5** | 0.03 | 0.10 | 0.04 | 0.09 | 0.07 | 0.08 | 0.10 | 0.04 | 0.08 | 0.07 | 0.28 |
| **Total** | 97.72 | 97.73 | 97.46 | 99.41 | 98.59 | 99.44 | 98.26 | 98.03 | 98.01 | 92.65 | 96.54 |
| **Mg#** | 82.84 | 83.35 | 80.00 | 79.39 | 79.97 | 82.00 | 80.50 | 81.50 | 78.20 | 81.10 | 78.50 |
| **Si** | 1.86 | 1.83 | 1.82 | 1.76 | 1.87 | 1.78 | 1.73 | 1.80 | 1.68 | 1.78 | 1.68 |
| **AlIV** | 0.14 | 0.17 | 0.18 | 0.24 | 0.13 | 0.18 | 0.32 | 0.18 | 0.29 | 0.21 | 0.32 |
| **AlVI** | 0.06 | 0.26 | 0.09 | 0.08 | 0.09 | 0.03 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 |
| **Fe3+** | 0.11 | 0.06 | 0..06 | 0.10 | 0.00 | 0.08 | 0.18 | 0.21 | 0.24 | 0.22 | 0.18 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ti** | 0.03 | 0.05 | 0.08 | 0.07 | 0.05 | 0.06 | 0.07 | 0.08 | 0.07 | 0.08 | 0.09 |
| **Fe2+** | 0.04 | 0.11 | 0.11 | 0.14 | 0.19 | 0.11 | 0.03 | 0.02 | 0.01 | 0.01 | 0.03 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mg** | 0.86 | 0.60 | 0.70 | 0.69 | 0.72 | 0.82 | 0.83 | 0.82 | 0.84 | 0.79 | 0.81 |
| **Ca** | 0.88 | 0.79 | 0.89 | 0.92 | 0.90 | 0.89 | 0.91 | 0.92 | 0.89 | 0.92 | 0.89 |
| **Na** | 0.05 | 0.06 | 0.03 | 0.04 | 0.03 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 |
| **K** | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Wo** | 46.64 | 55.34 | 47.86 | 49.71 | 49.34 | 47.46 | 46.73 | 46.81 | 47.24 | 46.32 | 47.72 |
| **En** | 45.62 | 32.78 | 39.42 | 37.34 | 39.70 | 41.35 | 40.34 | 40.68 | 38.29 | 41.24 | 38.14 |
| **Fs** | 7.73 | 11.88 | 10.98 | 12.95 | 10.96 | 10.14 | 10.79 | 10.29 | 11.82 | 10.68 | 11.49 |
| **2Na** | 0.11 | 0.13 | 0.06 | 0.08 | 0.07 | 0.08 | 0.06 | 2.00 | 0.02 | 0.02 | 0.04 |
| **Ca+Mg+Fe2+** | 1.78 | 1.50 | 1.70 | 1.74 | 1.82 | 1.00 | 0.02 | 1.76 | 1.74 | 1.72 | 1.73 |
| **Cpx-meltKdFe-Mg** | 0.56 | 0.54 | 0.50 | 0.47 | 0.48 | 0.50 | 0.40 | 0.40 | 0.50 | 0.50 | 0.60 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 2** Representative compositions of olivine crystals from the Qorveh-Bijar basaltic rocks.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Tahmoures** | | | | | | | | | | | **Illanlu** | | | | |
|  | **O1** | **O2** | **O3** | **O4** | **O5** | **O6** | **O7** | **O8** | **O9** | **O10** | **O11** | **O12** | **O13** | **O14** | **O15** | **O16** |
| **SiO2** | 39.32 | 39.46 | 39.75 | 40.12 | 40.25 | 39.65 | 40.05 | 40.18 | 39.87 | 39.66 | 39.76 | 39.85 | 39.68 | 39.59 | 39.97 | 40.68 |
| **TiO2** | 0.02 | 0.02 | 0.02 | 0.20 | 0.02 | 0.08 | 0.02 | 0.04 | 0.04 | 0.06 | 0.06 | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 |
| **Al2O3** | 0.12 | 0.10 | 0.04 | 2.04 | 0.04 | 0.08 | 0.39 | 0.05 | 0.09 | 0.07 | 0.05 | 0.03 | 0.04 | 0.04 | 0.12 | 0.04 |
| **FeO** | 12.24 | 12.23 | 12.32 | 12.80 | 12.67 | 12.26 | 12.28 | 12.93 | 12.72 | 12.25 | 12.75 | 12.00 | 11.22 | 11.41 | 12.16 | 11.80 |
| **MnO** | 0.18 | 0.18 | 0.19 | 0.23 | 0.19 | 0.18 | 0.17 | 0.14 | 0.18 | 0.17 | 0.21 | 0.17 | 0.15 | 0.14 | 0.19 | 0.19 |
| **MgO** | 43.03 | 43.39 | 44.72 | 38.27 | 43.70 | 42.58 | 44.45 | 45.40 | 44.57 | 44.97 | 43.04 | 44.91 | 46.24 | 43.02 | 44.38 | 44.88 |
| **CaO** | 0.22 | 0.22 | 0.21 | 0.90 | 0.29 | 0.35 | 0.25 | 0.18 | 0.19 | 0.23 | 0.31 | 0.26 | 0.22 | 0.23 | 0.44 | 0.30 |
| **Na2O** | 0.03 | 0.03 | 0.02 | 0.62 | 0.07 | 0.22 | 0.03 | 0.03 | 0.03 | 0.04 | 0.08 | 0.04 | 0.07 | 0.04 | 0.06 | 0.03 |
| **K2O** | 0.01 | 0.01 | 0.02 | 0.50 | 0.03 | 0.07 | 0.01 | 0.02 | 0.01 | 0.03 | 0.09 | 0.02 | 0.03 | 0.05 | 0.03 | 0.02 |
| **P2O5** | 0.05 | 0.06 | 0.06 | 0.58 | 0.06 | 0.08 | 0.07 | 0.06 | 0.06 | 0.08 | 0.08 | 0.05 | 0.05 | 0.05 | 0.06 | 0.04 |
| **Total** | 95.21 | 95.69 | 97.34 | 96.26 | 97.34 | 95.54 | 97.72 | 99.03 | 97.76 | 97.56 | 96.42 | 97.36 | 97.73 | 94.60 | 97.43 | 97.99 |
| **Mg#** | 87.45 | 87.54 | 87.79 | 85.56 | 87.23 | 87.31 | 87.76 | 87.43 | 87.41 | 87.92 | 87.00 | 88.12 | 89.09 | 88.20 | 87.85 | 88.28 |
| **Si** | 1.03 | 1.02 | 1.01 | 1.06 | 1.03 | 1.03 | 1.02 | 1.01 | 1.01 | 1.01 | 1.03 | 1.02 | 1.00 | 1.03 | 1.02 | 1.03 |
| **Ti** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Al** | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fe(ii)** | 0.27 | 0.27 | 0.26 | 0.28 | 0.27 | 0.27 | 0.26 | 0.27 | 0.27 | 0.26 | 0.28 | 0.26 | 0.24 | 0.25 | 0.26 | 0.25 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mg** | 1.67 | 1.68 | 1.70 | 1.50 | 1.67 | 1.66 | 1.68 | 1.70 | 1.69 | 1.71 | 1.66 | 1.71 | 1.75 | 1.68 | 1.69 | 1.69 |
| **Ni** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ca** | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | 2.98 | 2.98 | 2.99 | 2.93 | 2.98 | 2.97 | 2.98 | 2.99 | 2.99 | 2.99 | 2.98 | 2.99 | 3.00 | 2.97 | 2.99 | 2.98 |
| **Fo** | 86.07 | 86.17 | 86.44 | 83.97 | 85.83 | 85.92 | 86.41 | 86.10 | 86.03 | 86.59 | 85.55 | 86.80 | 87.88 | 86.92 | 86.50 | 86.97 |
| **Fa** | 13.73 | 13.63 | 13.36 | 15.75 | 13.96 | 13.87 | 13.40 | 13.75 | 13.77 | 13.22 | 14.21 | 13.01 | 11.96 | 12.92 | 13.29 | 12.83 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 2:** continued

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Illanlu** | | **Ahmad-Abad** | **Ghale-Parian Mountain** | | | | | | | | | | | | |
|  | **O17** | **O18** | **O19** | **O20** | **O21** | **O22** | **O23** | **O24** | **O25** | **O26** | **O27** | **O28** | **O29** | **O30** | **O31** | **O32** |
| **SiO2** | 39.70 | 37.06 | 39.36 | 38.74 | 41.30 | 40.26 | 34.60 | 39.04 | 38.48 | 39.70 | 38.01 | 35.73 | 38.83 | 39.88 | 39.35 | 38.83 |
| **TiO2** | 0.02 | 0.02 | 0.03 | 0.03 | 0.08 | 0.16 | 0.03 | 0.04 | 0.03 | 0.09 | 0.04 | 0.42 | 0.04 | 0.02 | 0.07 | 0.04 |
| **Al2O3** | 0.03 | 0.11 | 0.05 | 0.20 | 0.29 | 1.80 | 1.39 | 0.26 | 0.28 | 0.95 | 0.28 | 1.36 | 0.28 | 0.04 | 0.06 | 0.28 |
| **FeO** | 11.54 | 11.70 | 14.31 | 12.97 | 11.16 | 10.85 | 12.18 | 13.20 | 14.97 | 12.83 | 12.53 | 15.52 | 13.95 | 14.44 | 13.60 | 13.95 |
| **MnO** | 0.18 | 0.17 | 0.25 | 0.17 | 0.18 | 0.16 | 0.19 | 0.19 | 0.23 | 0.20 | 0.19 | 0.24 | 0.22 | 0.25 | 0.20 | 0.22 |
| **MgO** | 44.75 | 45.08 | 46.27 | 45.18 | 44.58 | 41.74 | 40.88 | 45.62 | 44.34 | 46.86 | 43.82 | 40.33 | 45.60 | 46.65 | 46.71 | 45.60 |
| **CaO** | 0.16 | 0.33 | 0.28 | 0.20 | 2.45 | 0.76 | 0.30 | 0.23 | 0.26 | 0.27 | 2.98 | 0.37 | 0.25 | 0.25 | 0.23 | 0.25 |
| **Na2O** | 0.06 | 0.05 | 0.06 | 0.04 | 0.07 | 0.53 | 0.06 | 0.04 | 0.03 | 0.32 | 0.13 | 0.34 | 0.05 | 0.02 | 0.03 | 0.05 |
| **K2O** | 0.06 | 0.02 | 0.04 | 0.01 | 0.02 | 0.46 | 0.03 | 0.02 | 0.02 | 0.25 | 0.02 | 0.28 | 0.01 | 0.02 | 0.02 | 0.01 |
| **P2O5** | 0.02 | 0.02 | 0.13 | 0.05 | 0.04 | 0.21 | 0.06 | 0.03 | 0.05 | 0.10 | 0.06 | 0.07 | 0.06 | 0.05 | 0.05 | 0.06 |
| **Total** | 96.53 | 94.56 | 100.77 | 97.59 | 100.16 | 96.92 | 89.71 | 98.66 | 98.68 | 101.58 | 98.07 | 94.67 | 99.29 | 101.60 | 100.32 | 99.29 |
| **Mg#** | 88.48 | 88.42 | 86.50 | 87.35 | 88.78 | 88.41 | 86.93 | 87.26 | 85.44 | 87.86 | 87.39 | 83.74 | 86.63 | 86.80 | 86.50 | 85.80 |
| **Si** | 1.02 | 0.98 | 0.98 | 0.99 | 1.04 | 1.04 | 0.97 | 0.99 | 0.98 | 0.98 | 1.00 | 0.97 | 0.98 | 0.99 | 0.98 | 0.98 |
| **Ti** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Al** | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.05 | 0.05 | 0.01 | 0.01 | 0.03 | 0.01 | 0.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fe(ii)** | 0.25 | 0.26 | 0.30 | 0.28 | 0.23 | 0.23 | 0.28 | 0.28 | 0.32 | 0.26 | 0.27 | 0.35 | 0.30 | 0.30 | 0.28 | 0.30 |
| **Mn** | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| **Mg** | 1.71 | 1.77 | 1.72 | 1.72 | 1.67 | 1.60 | 1.70 | 1.72 | 1.69 | 1.73 | 1.71 | 1.63 | 1.72 | 1.72 | 1.74 | 1.72 |
| **Ni** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ca** | 0.00 | 0.01 | 0.01 | 0.01 | 0.07 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.08 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | 2.99 | 3.03 | 3.02 | 3.01 | 3.02 | 2.95 | 3.02 | 3.01 | 3.02 | 3.01 | 3.08 | 3.01 | 3.02 | 3.02 | 3.02 | 3.02 |
| **Fo** | 87.19 | 87.12 | 84.99 | 85.97 | 87.51 | 87.12 | 85.49 | 85.87 | 83.87 | 86.50 | 86.00 | 82.03 | 85.16 | 84.99 | 85.78 | 85.16 |
| **Fa** | 12.62 | 12.69 | 14.74 | 13.84 | 12.29 | 12.70 | 14.28 | 13.93 | 15.88 | 13.28 | 13.79 | 17.70 | 14.61 | 14.75 | 14.01 | 14.61 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 2**: continued

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ghale-Parian mountain** | | | | **Ghare-Toreh** | | | | | | | | | | |
|  | **O33** | **O34** | **O35** | **O36** | **O37** | **O38** | **O39** | **O40** | **O41** | **O42** | **O43** | **O44** | **O45** | **O46** | **O47** |
| **SiO2** | 38.69 | 37.22 | 39.35 | 39.98 | 38.23 | 37.54 | 38.35 | 38.28 | 38.19 | 36.54 | 37.76 | 37.98 | 37.73 | 36.75 | 37.99 |
| **TiO2** | 0.02 | 0.02 | 0.04 | 0.02 | 0.04 | 0.04 | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.04 | 0.03 |
| **Al2O3** | 0.26 | 0.55 | 0.24 | 0.05 | 0.05 | 0.04 | 0.35 | 0.65 | 0.06 | 0.03 | 0.04 | 0.04 | 0.03 | 0.08 | 0.05 |
| **FeO** | 13.15 | 13.44 | 13.79 | 14.54 | 13.58 | 13.83 | 13.62 | 14.21 | 13.94 | 14.23 | 14.30 | 14.10 | 13.96 | 13.87 | 13.82 |
| **MnO** | 0.21 | 0.21 | 0.20 | 0.25 | 0.21 | 0.21 | 0.22 | 0.30 | 0.26 | 0.27 | 0.26 | 0.25 | 0.22 | 0.23 | 0.22 |
| **MgO** | 45.29 | 44.27 | 42.68 | 45.84 | 48.28 | 47.44 | 46.12 | 44.82 | 46.68 | 46.08 | 45.78 | 46.29 | 44.66 | 46.69 | 45.66 |
| **CaO** | 0.28 | 0.25 | 0.23 | 0.23 | 0.25 | 0.26 | 0.29 | 0.30 | 0.28 | 0.31 | 0.32 | 0.27 | 0.24 | 0.29 | 0.24 |
| **Na2O** | 0.03 | 0.06 | 0.03 | 0.02 | 0.04 | 0.03 | 0.16 | 0.33 | 0.04 | 0.04 | 0.09 | 0.04 | 0.05 | 0.07 | 0.05 |
| **K2O** | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.08 | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.05 |
| **P2O5** | 0.06 | 0.05 | 0.04 | 0.06 | 0.16 | 0.10 | 0.14 | 0.07 | 0.08 | 0.12 | 0.08 | 0.09 | 0.14 | 0.14 | 0.09 |
| **Total** | 98.00 | 96.09 | 96.62 | 101.00 | 98.43 | 99.48 | 99.38 | 99.13 | 99.58 | 97.65 | 98.67 | 99.10 | 97.09 | 98.17 | 98.21 |
| **Mg#** | 87.22 | 86.72 | 85.98 | 86.20 | 87.57 | 87.18 | 87.03 | 86.21 | 86.91 | 86.52 | 86.38 | 86.67 | 86.38 | 86.96 | 86.75 |
| **Si** | 0.99 | 0.97 | 1.02 | 0.99 | 0.95 | 0.95 | 0.97 | 0.98 | 0.97 | 0.95 | 0.97 | 0.97 | 0.98 | 0.95 | 0.97 |
| **Ti** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Al** | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fe(ii)** | 0.28 | 0.29 | 0.30 | 0.30 | 0.28 | 0.29 | 0.29 | 0.30 | 0.30 | 0.31 | 0.31 | 0.30 | 0.30 | 0.30 | 0.30 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| **Mg** | 1.72 | 1.73 | 1.65 | 1.70 | 1.80 | 1.79 | 1.74 | 1.71 | 1.76 | 1.78 | 1.75 | 1.76 | 1.73 | 1.80 | 1.75 |
| **Ni** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ca** | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | 3.01 | 3.02 | 2.98 | 3.01 | 3.05 | 3.05 | 3.03 | 3.02 | 3.04 | 3.06 | 3.04 | 3.04 | 3.03 | 3.06 | 3.03 |
| **Fo** | 85.80 | 85.26 | 84.47 | 84.67 | 86.19 | 85.76 | 85.58 | 84.63 | 85.43 | 85.00 | 84.85 | 85.18 | 84.88 | 85.52 | 85.29 |
| **Fa** | 13.97 | 14.51 | 15.31 | 15.07 | 13.60 | 14.02 | 14.18 | 15.05 | 14.30 | 14.72 | 14.87 | 14.56 | 14.88 | 14.24 | 14.48 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 2:** continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ghare-Toreh** | | | | | | | |
|  | **O48** | **O49** | **O50** | **O51** | **O52** | **O53** | **O54** | **O55** |
| **SiO2** | 38.53 | 37.75 | 37.32 | 36.77 | 37.58 | 37.75 | 37.62 | 35.59 |
| **TiO2** | 0.04 | 0.02 | 0.03 | 0.03 | 0.01 | 0.03 | 0.04 | 0.06 |
| **Al2O3** | 0.05 | 0.07 | 0.52 | 0.21 | 0.15 | 0.09 | 0.06 | 0.22 |
| **FeO** | 13.81 | 13.95 | 14.39 | 14.70 | 14.08 | 13.68 | 13.87 | 13.10 |
| **MnO** | 0.21 | 0.23 | 0.22 | 0.19 | 0.21 | 0.19 | 0.23 | 0.19 |
| **MgO** | 45.95 | 46.75 | 45.57 | 45.24 | 46.72 | 46.80 | 46.64 | 44.44 |
| **CaO** | 0.23 | 0.23 | 0.21 | 0.23 | 0.22 | 0.22 | 0.25 | 0.23 |
| **Na2O** | 0.04 | 0.03 | 0.08 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 |
| **K2O** | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 |
| **P2O5** | 0.13 | 0.10 | 0.08 | 0.07 | 0.08 | 0.08 | 0.10 | 0.14 |
| **Total** | 99.00 | 99.16 | 98.44 | 97.48 | 99.10 | 98.89 | 98.85 | 94.03 |
| **Mg#** | 86.83 | 86.91 | 86.25 | 85.91 | 86.80 | 87.14 | 86.95 | 87.05 |
| **Si** | 0.98 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| **Ti** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Al** | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| **Cr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fe(ii)** | 0.29 | 0.30 | 0.31 | 0.32 | 0.30 | 0.29 | 0.30 | 0.29 |
| **Mn** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| **Mg** | 1.74 | 1.77 | 1.74 | 1.75 | 1.77 | 1.78 | 1.77 | 1.78 |
| **Ni** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Ca** | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | 3.03 | 3.04 | 3.04 | 3.05 | 3.05 | 3.04 | 3.04 | 3.05 |
| **Fo** | 85.38 | 85.46 | 84.76 | 84.41 | 85.36 | 85.74 | 85.50 | 85.64 |
| **Fa** | 14.39 | 14.31 | 15.01 | 15.38 | 14.43 | 14.06 | 14.26 | 14.15 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 3** . Whole-rock major and trace element compositions of the Qorveh-Bijar basaltic rocks (major elements in wt. %, trace elements in ppm).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **A1** | **A2** | **Il1** | **IL2** | **G1** | **G2** | **GH1** | **GH2** | **TE1** | **TE2** |
| **SiO2** | 47.87 | 48.05 | 46.25 | 46.15 | 45.91 | 45.53 | 46.25 | 45.30 | 46.42 | 46.67 |
| **TiO2** | 1.88 | 1.78 | 1.88 | 1.85 | 2.55 | 2.53 | 1.74 | 2.36 | 2.01 | 1.93 |
| **Al2O3** | 13.79 | 13.44 | 13.75 | 13.69 | 15.04 | 15.12 | 10.09 | 15.43 | 15.32 | 14.62 |
| **FeO** | 7.24 | 7.03 | 7.99 | 8.20 | 8.70 | 8.68 | 6.33 | 9.05 | 9.15 | 9.35 |
| **MnO** | 0.14 | 0.12 | 0.15 | 0.15 | 0.17 | 0.18 | 0.12 | 0.13 | 0.17 | 0.14 |
| **MgO** | 8.52 | 8.74 | 10.27 | 10.24 | 8.06 | 8.25 | 12.73 | 9.31 | 9.23 | 9.97 |
| **CaO** | 10.32 | 11.17 | 10.76 | 10.97 | 9.64 | 9.47 | 15.25 | 10.13 | 10.05 | 9.83 |
| **Na2O** | 5.09 | 4.86 | 4.51 | 4.17 | 5.75 | 5.96 | 2.61 | 4.58 | 4.82 | 3.74 |
| **K2O** | 3.43 | 3.16 | 2.96 | 3.15 | 2.49 | 2.59 | 3.00 | 2.93 | 1.63 | 2.71 |
| **P2O5** | 1.83 | 1.78 | 1.53 | 1.48 | 1.69 | 1.69 | 1.73 | 0.93 | 1.18 | 1.03 |
| **Total** | 100.12 | 100.12 | 100.06 | 100.06 | 100.00 | 100.00 | 99.86 | 100.14 | 100.00 | 100.00 |
| **Mg#** | 67.70 | 68.90 | 69.60 | 69.00 | 62.30 | 62.90 | 78.20 | 64.70 | 64.20 | 65.50 |
| **Sc** | 14.38 | 15.50 | 16.94 | 17.73 | 13.78 | 13.59 | 27.95 | 19.74 | 17.65 | 17.80 |
| **V** | 145.68 | 142.59 | 167.83 | 169.66 | 164.40 | 162.25 | 143.65 | 210.26 | 175.53 | 172.65 |
| **Cr** | 234.88 | 356.37 | 333.93 | 404.44 | 167.54 | 149.50 | 430.04 | 225.06 | 336.65 | 295.35 |
| **Co** | 37.31 | 36.13 | 42.95 | 47.72 | 40.33 | 39.43 | 43.04 | 50.55 | 47.86 | 49.76 |
| **Ni** | 179.55 | 165.29 | 232.10 | 274.94 | 137.94 | 129.97 | 253.48 | 176.69 | 204.15 | 246.51 |
| **Rb** | 72.66 | 68.39 | 44.15 | 50.02 | 59.67 | 83.33 | 65.51 | 56.07 | 41.28 | 50.38 |
| **Sr** | 1866.04 | 1779.16 | 3080.00 | 2502.94 | 1585.54 | 1624.25 | 1177.33 | 1400.04 | 1662.38 | 1638.65 |
| **Y** | 22.71 | 22.02 | 20.67 | 20.85 | 27.50 | 27.23 | 15.70 | 20.54 | 22.50 | 22.28 |
| **Zr** | 356.07 | 317.13 | 246.12 | 249.01 | 295.56 | 294.13 | 157.43 | 246.46 | 222.79 | 219.01 |
| **Nb** | 51.75 | 46.32 | 38.33 | 38.61 | 83.91 | 84.50 | 22.06 | 49.36 | 45.64 | 43.78 |
| **Cs** | 1.80 | 1.79 | 1.39 | 1.33 | 3.08 | 3.61 | 1.11 | 1.13 | 1.88 | 1.33 |
| **Ba** | 2058.22 | 1914.77 | 1565.18 | 1557.05 | 1318.18 | 1386.50 | 1989.24 | 854.58 | 957.58 | 944.96 |
| **La** | 161.70 | 151.47 | 132.91 | 132.75 | 101.41 | 99.84 | 83.12 | 73.43 | 89.66 | 90.46 |
| **Ce** | 309.82 | 289.67 | 269.65 | 272.69 | 195.51 | 191.96 | 171.50 | 137.08 | 175.50 | 177.15 |
| **Pr** | 33.20 | 31.04 | 30.63 | 31.03 | 21.45 | 20.97 | 19.98 | 15.04 | 19.50 | 19.63 |
| **Nd** | 118.40 | 110.49 | 115.84 | 115.41 | 80.29 | 78.63 | 76.91 | 56.08 | 72.36 | 73.33 |
| **Sm** | 16.73 | 15.56 | 15.94 | 16.10 | 13.52 | 13.29 | 11.84 | 9.26 | 11.29 | 11.38 |
| **Eu** | 4.12 | 3.86 | 3.98 | 4.00 | 3.56 | 3.52 | 3.00 | 2.63 | 3.03 | 3.07 |
| **Gd** | 10.00 | 9.34 | 9.11 | 9.06 | 10.01 | 9.70 | 7.46 | 6.78 | 7.57 | 7.65 |
| **Tb** | 1.14 | 1.04 | 1.01 | 1.00 | 1.27 | 1.23 | 0.82 | 0.87 | 0.93 | 0.94 |
| **Dy** | 5.43 | 4.99 | 4.72 | 4.78 | 6.38 | 6.24 | 3.87 | 4.51 | 4.77 | 4.87 |
| **Ho** | 0.90 | 0.82 | 0.79 | 0.78 | 1.06 | 1.04 | 0.62 | 0.79 | 0.81 | 0.83 |
| **Er** | 2.11 | 1.96 | 1.83 | 1.84 | 2.45 | 2.42 | 1.44 | 1.90 | 1.99 | 2.04 |
| **Tm** | 0.27 | 0.24 | 0.22 | 0.23 | 0.29 | 0.28 | 0.17 | 0.24 | 0.24 | 0.25 |
| **Yb** | 1.62 | 1.53 | 1.39 | 1.39 | 1.74 | 1.70 | 1.00 | 1.46 | 1.53 | 1.54 |
| **Lu** | 0.22 | 0.21 | 0.19 | 0.19 | 0.22 | 0.21 | 0.14 | 0.20 | 0.21 | 0.22 |
| **Hf** | 8.11 | 6.99 | 5.62 | 5.67 | 6.58 | 6.45 | 4.10 | 5.31 | 4.73 | 4.82 |
| **Ta** | 2.65 | 2.28 | 1.95 | 1.97 | 4.51 | 4.50 | 1.12 | 2.68 | 2.33 | 2.33 |
| **Pb** | 27.17 | 28.10 | 23.23 | 22.19 | 11.97 | 11.24 | 11.94 | 11.69 | 13.02 | 14.56 |
| **Th** | 27.91 | 24.72 | 14.16 | 14.22 | 13.51 | 13.46 | 11.12 | 9.07 | 8.82 | 9.31 |
| **U** | 5.32 | 4.62 | 3.09 | 3.11 | 3.19 | 3.18 | 2.18 | 2.37 | 2.09 | 2.27 |
| **Li** | 18.64 | 18.32 | 10.34 | 10.72 | 14.56 | 14.14 | 8.53 | 10.92 | 12.53 | 13.37 |

(Mg# expressed as molar Mg/(Mg + Fe+2)

**Supplementary table 4** Rb-Sr and Sm-Nd isotopic data for the Qorveh-Bijar basaltic rocks

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ɛNd** | **(143Nd/144Nd)i** | **143Nd/144Nd** | **±2s** | **147Sm/144Nd** | **(87Sr/86Sr)i** | **87Sr/86Sr** | **±2s** | **87Rb/86Sr** | **Samples\*** |
| 0.43 | 0.5126553 | 0.512660 | 9 | 0.086494 | 0.7052650 | 0.705279 | 12 | 0.1112 | **A2** |
| 0.18 | 0.5126425 | 0.512647 | 12 | 0.085094 | 0.7053481 | 0.705360 | 10 | 0.0928 | **A3** |
| 1.37 | 0.5127023 | 0.512708 | 17 | 0.101794 | 0.7046851 | 0.704699 | 11 | 0.1088 | **IL1** |
| 1.11 | 0.5126888 | 0.512695 | 13 | 0.106505 | 0.7046465 | 0.704662 | 13 | 0.1272 | **IL3** |
| 0.23 | 0.5126455 | 0.512650 | 12 | 0.083180 | 0.7048874 | 0.704893 | 12 | 0.0415 | **G1** |
| 0.37 | 0.5126520 | 0.512657 | 9 | 0.086771 | 0.7048469 | 0.704852 | 11 | 0.0411 | **G3** |
| 0.68 | 0.5126673 | 0.512673 | 13 | 0.093038 | 0.7051539 | 0.705174 | 11 | 0.1609 | **GH1** |
| 1.76 | 0.5127220 | 0.512728 | 13 | 0.099813 | 0.7045312 | 0.704545 | 17 | 0.1158 | **GH2** |
| 1.03 | 0.5126858 | 0.512691 | 13 | 0.093685 | 0.7046393 | 0.704646 | 10 | 0.0540 | **TE3** |
| 1.07 | 0.5126873 | 0.512693 | 13 | 0.094225 | 0.7046793 | 0.704686 | 10 | 0.0525 | **TE4** |

\*The age correction is based on the ages calculated by Bocaletti et al. (1976)

**Supplementary table 5** Results from clinopyroxene-based thermobarometery, olivine-based thermometry for QBB rocks.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Clinopyroxene** | | | **Olivine** | |
|  | **Putrika et al. (2003)** | **Putrika (2008)** | |  | **Putrika (2008)** |
| **Sample** | **T (oC)** | **P (kbar)** | **T (oC)** | **Fo content** | **T (oC)** |
| **Ghare-Toreh** | 1179 | 4.00 | 1182 | 87.5 | 1211 |
| **Illanlu** | 1236 | 5.00 | 1119 | 87.3 | 1264 |
| **Ahmad-Abad** | 1224 | 6.00 | 1213 | 85.5 | 1202 |
| **Tahmoures** | 1211 | 6.00 | 1186 | 85.2 | 1209 |
| **Ghale-Parian** | 1231 | 4.00 | 1213 | 84.9 | 1256 |