Table 1 Texture and mineral composition of the studied pyroxenite xenoliths from Yangyuan

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample | Size (cm) | Lithology | Texture | Mineral modal abundance | Mg# and Cr2O3 in Cpx |
| ***Type I pyroxenite: high Mg# and Cr2O3*** |  |
| YY17-1 | 2×3 | Cpx-rich websterite | medium-grained | Cpx89Opx6Sp1Ol4 | 91.7-92.0/1.15-1.63% |
| YY17-2 | 2×3 | Cpx-rich websterite | medium-grained | Cpx85Opx13Sp2 | 90.0-90.3/1.07-1.58% |
| YY17-3 | 3×3 | Orthopyroxenite | medium-grained | Cpx<1Opx>98 +Sp<1 | 88.3-88.4/0.86-0.91% |
| ***Type II pyroxenite: medium Mg# and Cr2O3*** |
| YY17-4 | 3×5 | Cpx-rich websterite | medium-grained | Cpx90Opx10Sp<1 | 86.0-86.5/0.53-0.59% |
| YY17-5 | 3×5 | Opx-rich websterite | medium-grained | Cpx18Opx82Sp<1 | 81.0-81.3/0.55-0.60% |
| YY17-6 | 2×2 | Cpx-rich websterite | medium-grained | Cpx89Opx11Sp<1 | 86.5-86.7/0.62-0.73% |
| YY17-7 | 2×5 | Cpx-rich websterite | medium-grained | Cpx70Opx25Sp1 | 86.0/0.54-0.59% |
| ***Type III pyroxenite: low Mg# and Cr2O3*** |
| YY17-8 | 4×6 | Cpx-rich websterite | fine-granied | Cpx85Opx10Pl5+minor Ol | 73.7-76.5/0.05-0.10% |
| YY17-9 | 2×2 | Clinopyroxenite | fine-granied | Cpx90Opx10 | 68.3-72.8/0.29-0.38% |
| YY17-10 | 4×5 | Cpx-rich websterite | fine-granied | Cpx60Opx35Pl5 | 65.2-70.3/0.08-0.10% |
| YY17-10 | 2×2 | granulite | fine-granied | Pl70Cpx20Opx10 | 65.4-67.1/0.07-0.10% |

Ol=olivine, Opx=orthopyroxene, Cpx=clinopyroxene, Sp=spinel. Mg#=100∗Mg2+/(Mg2++Fe2+) (atomic number).

Table 2 Major-trace element compositions of Yangyuan pyroxenites

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | YY17-1 | YY17-2 | YY17-3 | YY17-4 | YY17-5 | YY17-6 | YY17-7 | YY17-8 | YY17-9 |
| Rock type | I | I | I | II | II | II | II | III | III |
| SiO2 | 51.9 | 50.2 | 53.8 | 51.4 | 52.4 | 51.3 | 51.3 | 49.2 | 51.6 |
| TiO2 | 0.46 | 0.25 | 0.24 | 0.5 | 0.37 | 0.41 | 0.52 | 0.73 | 0.26 |
| Al2O3 | 6.1 | 4.23 | 4.31 | 6.32 | 4.11 | 5.83 | 6.43 | 8.76 | 4.08 |
| TFe2O3 | 6.49 | 6.09 | 8.26 | 6.06 | 12.04 | 6.4 | 6.28 | 10.07 | 10.9 |
| Cr2O3 | 0.52 | 0.97 | 0.42 | 0.47 | 0.33 | 0.63 | 0.49 | 0.05 | 0.36 |
| NiO | 0.08 | 0.11 | 0.12 | 0.07 | 0.12 | 0.07 | 0.07 | 0.03 | 0.04 |
| MnO | 0.14 | 0.13 | 0.15 | 0.14 | 0.19 | 0.14 | 0.14 | 0.15 | 0.3 |
| MgO | 19.8 | 24.1 | 31.1 | 18.3 | 23.4 | 19.1 | 18.4 | 12.4 | 12.2 |
| CaO | 13.6 | 12.8 | 1.15 | 15.3 | 6.3 | 14.7 | 14.9 | 16.4 | 16.5 |
| Na2O | 0.93 | 0.93 | 0.05 | 0.99 | 0.45 | 0.86 | 1.01 | 1.5 | 2.53 |
| K2O | 0.06 | 0.12 | 0.01 | 0.01 | 0.03 | 0.02 | 0.04 | 0.12 | 0.15 |
| P2O5 | 0.03 | 0.06 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.07 | 0.07 |
| LOI | 0.07 | 0.01 | -0.01 | 0.62 | -0.02 | 0.28 | -0.14 | 0.24 | 0.76 |
| Total | 100.1 | 100 | 99.6 | 100.2 | 99.8 | 99.7 | 99.5 | 99.7 | 99.7 |
| Mg# | 87.7 | 90.2 | 89.8 | 87.6 | 81.9 | 87.4 | 87.2 | 74.1 | 72.3 |
| Li | 3.17 | 6.7 | 1.6 | 0.71 | 11.4 | 1.52 | 1.33 | 8.41 | 6.65 |
| Be | 0.12 | 0.32 | 0.22 | 0.08 | 0.49 | 0.08 | 0.03 | 0.37 | 1.04 |
| Sc | 28.5 | 38.6 | 14.9 | 32.2 | 21.4 | 32.2 | 30.9 | 39.3 | 35 |
| V | 222 | 162 | 120 | 223 | 135 | 206 | 250 | 309 | 132 |
| Cr | 3370 | 1446 | 2968 | 2796 | 2322 | 3924 | 3267 | 342 | 2356 |
| Co | 42.4 | 51.6 | 64.6 | 38.8 | 70.5 | 39.9 | 42 | 50.1 | 27.8 |
| Ni | 508 | 753 | 778 | 430 | 796 | 451 | 491 | 179 | 244 |
| Rb | 1.28 | 0.59 | 0.6 | 1.63 | 0.66 | 0.18 | 0.39 | 1.32 | 3.4 |
| Sr | 68.1 | 36.9 | 7.1 | 57.1 | 42.2 | 51.3 | 53.3 | 198.1 | 342.1 |
| Y | 7.08 | 5.81 | 1.28 | 7.09 | 6.54 | 6.46 | 7.78 | 10.69 | 30.91 |
| Zr | 25.4 | 24.5 | 6.7 | 21.9 | 28 | 17.8 | 18.1 | 56.2 | 242.3 |
| Nb | 3.34 | 5.7 | 2.59 | 2.67 | 3.09 | 1.77 | 0.51 | 6.59 | 11.2 |
| Cs | 0.01 | 0.03 | 0.01 | 0.01 | 0.04 | 0.01 | 0.01 | 0.01 | 0.31 |
| Ba | 24.35 | 7.68 | 3.07 | 6.9 | 5.65 | 3.65 | 3.29 | 38.17 | 48.26 |
| La | 2.65 | 6.55 | 0.44 | 1.35 | 2.5 | 1.5 | 1.28 | 6.78 | 13 |
| Ce | 6.57 | 4.07 | 1.08 | 4.12 | 10.46 | 4.98 | 4.38 | 17.75 | 39.51 |
| Pr | 1.01 | 2.02 | 0.13 | 0.8 | 2.1 | 0.79 | 0.8 | 3.16 | 6.51 |
| Nd | 5.23 | 9.14 | 0.6 | 4.61 | 11.11 | 4.44 | 4.78 | 16.99 | 32.57 |
| Sm | 1.53 | 1.89 | 0.15 | 1.52 | 2.58 | 1.29 | 1.53 | 4.17 | 8.62 |
| Eu | 0.51 | 0.56 | 0.05 | 0.5 | 0.64 | 0.43 | 0.53 | 1.27 | 2.92 |
| Gd | 1.62 | 1.65 | 0.18 | 1.75 | 2.07 | 1.45 | 1.81 | 3.7 | 8.37 |
| Tb | 0.28 | 0.23 | 0.03 | 0.3 | 0.28 | 0.24 | 0.3 | 0.52 | 1.32 |
| Dy | 1.67 | 1.23 | 0.23 | 1.8 | 1.55 | 1.5 | 1.84 | 2.72 | 7.09 |
| Ho | 0.33 | 0.24 | 0.05 | 0.34 | 0.29 | 0.3 | 0.36 | 0.5 | 1.33 |
| Er | 0.81 | 0.6 | 0.16 | 0.88 | 0.75 | 0.75 | 0.87 | 1.12 | 3.1 |
| Tm | 0.1 | 0.08 | 0.02 | 0.11 | 0.1 | 0.1 | 0.11 | 0.14 | 0.43 |
| Yb | 0.59 | 0.53 | 0.18 | 0.68 | 0.6 | 0.57 | 0.64 | 0.77 | 2.57 |
| Lu | 0.09 | 0.08 | 0.03 | 0.09 | 0.1 | 0.09 | 0.09 | 0.11 | 0.36 |
| Hf | 0.82 | 0.58 | 0.19 | 0.8 | 1.02 | 0.65 | 0.78 | 1.58 | 3.63 |
| Ta | 0.2 | 0.33 | 0.39 | 0.05 | 0.32 | 0.09 | 0.05 | 0.39 | 0.63 |
| Pb | 0.53 | 1.13 | 0.18 | 1.65 | 0.38 | 0.28 | 0.48 | 0.59 | 1.16 |
| Th | 0.41 | 0.73 | 0.06 | 0.07 | 0.44 | 0.17 | 0.07 | 0.68 | 1.1 |
| U | 0.07 | 0.17 | 0.04 | 0.03 | 0.23 | 0.04 | 0.02 | 0.19 | 0.22 |
| (La/Yb)N | 3.22 | 8.86 | 1.75 | 1.42 | 2.99 | 1.89 | 1.43 | 6.32 | 3.63 |
| (La/Sm)N | 1.12 | 2.24 | 1.89 | 0.57 | 0.63 | 0.75 | 0.54 | 1.05 | 0.97 |

Table 3 Whole rock Sr-Nd-Pb-Mg isotopic compositions and equilibrium temperatures (°C) of Yangyuan pyroxenites

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | YY17-1 | YY17-2 | YY17-3 | YY17-4 | YY17-5 | YY17-6 | YY17-7 | YY17-8 | YY17-9 |
| Rock type | I | I | I | II | II | II | II | III | III |
| Rb (ppm) | 0.55  | 1.75  | 0.20  | 0.18  | 0.59  | 0.17  | 0.15  | 1.14  | 2.12  |
| Sr (ppm) | 53.58  | 120.79  | 6.35  | 56.96  | 41.02  | 54.57  | 52.05  | 207.07  | 371.22  |
| 87Rb/86Sr | 0.0296  | 0.0419  | 0.0918  | 0.0091  | 0.0418  | 0.0090  | 0.0083  | 0.0160  | 0.0165  |
| 87Sr/86Sr | 0.703650  | 0.703953  | 0.704420  | 0.703530  | 0.706922  | 0.704203  | 0.703319  | 0.705881  | 0.704158  |
| 2σ | 0.000008  | 0.000007  | 0.000008  | 0.000007  | 0.000007  | 0.000008  | 0.000008  | 0.000014  | 0.000008  |
| (87Sr/86Sr)i(30Ma) | 0.703637  | 0.703935  | 0.704381  | 0.703526  | 0.706904  | 0.704199  | 0.703315  | 0.705874  | 0.704151  |
| Sm (ppm) | 1.11  | 1.88  | 0.12  | 1.45  | 2.35  | 1.24  | 1.37  | 3.80  | 9.03  |
| Nd (ppm) | 3.54  | 8.58  | 0.46  | 4.21  | 9.59  | 3.94  | 3.98  | 14.3  | 32.6  |
| 147Sm/144Nd | 0.1897  | 0.1321  | 0.1578  | 0.2086  | 0.1483  | 0.1895  | 0.2073  | 0.1606  | 0.1672  |
| 143Nd/144Nd | 0.512901  | 0.512874  | 0.512638  | 0.512902  | 0.511818  | 0.512868  | 0.512961  | 0.512343  | 0.512857  |
| 2σ | 0.000014  | 0.000008  | 0.000007  | 0.000008  | 0.000013  | 0.000013  | 0.000011  | 0.000013  | 0.000006  |
| (143Nd/144Nd)i(30Ma) | 0.512864  | 0.512848  | 0.512607  | 0.512861  | 0.511789  | 0.512831  | 0.512920  | 0.512311  | 0.512824  |
| εNd((30Ma)) | 5.16  | 4.85  | 0.15  | 5.10  | -15.81 | 4.51  | 6.26  | -5.62 | 4.38  |
| 206Pb/204Pb | 17.987  | 18.343  | 17.822  | 17.704  | 17.282  | 17.976  | 17.834  | 17.962  | 18.100  |
| 2SE | 0.003  | 0.002  | 0.005  | 0.004  | 0.003  | 0.003  | 0.002  | 0.002  | 0.002  |
| 207Pb/204Pb | 15.541  | 15.540  | 15.525  | 15.476  | 15.413  | 15.522  | 15.538  | 15.501  | 15.504  |
| 2SE | 0.002  | 0.002  | 0.005  | 0.004  | 0.003  | 0.003  | 0.002  | 0.002  | 0.002  |
| 208Pb/204Pb | 38.096  | 38.425  | 37.912  | 37.659  | 37.675  | 38.006  | 37.942  | 38.250  | 38.143  |
| 2SE | 0.006  | 0.005  | 0.012  | 0.009  | 0.009  | 0.006  | 0.006  | 0.005  | 0.004  |
| δ26Mg | -0.44 | -0.39 | -0.46 | -0.43 | -0.35 | - | -0.29 | -0.23 | -0.35 |
| 2SD (std) | 0.06 | 0.07 | 0.07 | 0.06 | 0.06 | - | 0.07 | 0.06 | 0.05 |
| δ25Mg | -0.20 | -0.21 | -0.25 | -0.24 | -0.20 | - | -0.16 | -0.13 | -0.16 |
| 2SD (std) | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | - | 0.05 | 0.04 | 0.04 |
| T (BK)Cpx-Opx @15kbar | 954  | 951  | 945  | 965  | 887  | 968  | 975  | 874  | - |
| T (W)Cpx-Opx  | 937 | 937 | 917 | 940 | 885 | 948 | 949 | 885 | - |

T (W): Cpx–Opx thermometer of Wells (1977).

T (BK): Cpx–Opx thermometer of Brey and Kohler (1990).