|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Miocene alkali olivine basalts | | | | | | | | | | | |
| Sample | P9Lt19 | P9Lt40 | P6Tc14-1 | P5LH5-1 | P4Tc70 | PdLtla | p22tcl5 | p22tc40 | JB-24 | JB-25 | JB-26 | JB-27 |
| Source | Li (2013) | | | | | | | | Yan & Zhao (2008) | | | |
| SiO2 (wt%) | 50.9 | 47.6 | 45.9 | 46.0 | 46.3 | 45.4 | 48.9 | 47.8 | 48.4 | 46.6 | 47.3 | 47.3 |
| TiO2 | 1.28 | 1.98 | 2.06 | 2.17 | 2.46 | 1.86 | 1.67 | 2.16 | 1.70 | 2.22 | 1.99 | 1.97 |
| Al2O3 | 16.6 | 14.3 | 13.4 | 13.8 | 15.6 | 13.1 | 16.8 | 15.1 | 15.4 | 15.5 | 15.7 | 15.8 |
| Fe2O3T | 10.9 | 12.9 | 12.1 | 11.9 | 12.8 | 14.4 | 11.4 | 11.3 | 10.9 | 11.5 | 10.9 | 10.9 |
| MnO | 0.17 | 0.15 | 0.17 | 0.17 | 0.20 | 0.31 | 0.20 | 0.12 | 0.16 | 0.15 | 0.15 | 0.15 |
| MgO | 5.79 | 7.11 | 10.4 | 9.29 | 6.54 | 8.96 | 6.24 | 5.36 | 8.00 | 9.08 | 8.73 | 8.76 |
| CaO | 6.97 | 8.12 | 8.04 | 8.18 | 9.12 | 8.56 | 6.83 | 8.32 | 8.78 | 9.05 | 8.76 | 8.81 |
| Na2O | 3.86 | 2.34 | 2.82 | 3.45 | 2.34 | 2.87 | 3.54 | 1.82 | 4.12 | 2.44 | 2.48 | 2.51 |
| K2O | 2.03 | 2.02 | 1.91 | 1.37 | 1.19 | 1.68 | 1.72 | 1.28 | 2.27 | 1.63 | 2.07 | 2.06 |
| P2O5 | 0.42 | 0.72 | 0.65 | 0.73 | 0.80 | 0.72 | 0.38 | 0.56 | 0.64 | 0.41 | 0.41 | 0.40 |
| Total | 99.0 | 97.2 | 97.5 | 97.1 | 97.3 | 97.8 | 97.6 | 93.8 | 100.3 | 98.5 | 98.4 | 98.7 |
| CaO/Al2O3 | 0.42 | 0.57 | 0.60 | 0.59 | 0.58 | 0.66 | 0.41 | 0.55 | 0.57 | 0.59 | 0.56 | 0.56 |
| Mg# | 0.51 | 0.52 | 0.63 | 0.61 | 0.51 | 0.55 | 0.52 | 0.49 | 0.60 | 0.61 | 0.61 | 0.62 |
| Cs (ppm) | 0.78 | 0.37 | 0.35 | 0.62 | 1.71 | 0.47 | 2.90 | 1.00 | 0.67 | 0.35 | 0.54 | 0.47 |
| Ba | 250 | 310 | 354 | 448 | 444 | 407 | 320 | 468 | 648 | 247 | 257 | 254 |
| Rb | 42 | 34 | 43 | 49 | 138 | 40 | 45 | 19 | 43 | 14.9 | 24 | 24 |
| U | 1.19 | 1.11 | 1.22 | 1.06 | 1.05 | 1.48 | 1.20 | 0.70 | 1.44 | 0.77 | 0.68 | 0.68 |
| Th | 5.10 | 3.62 | 3.81 | 4.71 | 5.21 | 6.02 | 3.60 | 3.10 | 7.24 | 2.33 | 2.36 | 2.29 |
| Nb | 45 | 51 | 52 | 55 | 60 | 60 | 27 | 53 | 66 | 31 | 30 | 29 |
| Ta | 2.51 | 3.29 | 3.18 | 3.21 | 3.47 | 3.26 | 1.40 | 2.20 | 3.89 | 2.19 | 2.03 | 2.34 |
| Sr | 607 | 837 | 769 | 888 | 1431 | 876 | 582 | 724 | 718 | 611 | 540 | 521 |
| Zr | 193 | 178 | 184 | 190 | 201 | 204 | 189 | 193 | 211 | 189 | 191 | 189 |
| Hf | 5.87 | 4.49 | 4.56 | 6.07 | 6.18 | 5.72 | 5.30 | 4.90 | 4.24 | 4.03 | 4.08 | 4.01 |
| Y | 17 | 20 | 19 | 16 | 21 | 19 | 18 | 29 | 24 | 19 | 21 | 21 |
| La | 29 | 41 | 42 | 45 | 52 | 47 | 25 | 35 | 43 | 19 | 19 | 19 |
| Ce | 51 | 74 | 83 | 85 | 89 | 85 | 48 | 54 | 76 | 40 | 41 | 40 |
| Pr | 4.36 | 6.52 | 6.86 | 7.25 | 9.13 | 7.88 | 5.88 | 7.86 | 8.61 | 5.14 | 5.26 | 5.13 |
| Nd | 21 | 31 | 33 | 32 | 38 | 37 | 25 | 32 | 33 | 22 | 22 | 22 |
| Sm | 4.39 | 6.64 | 6.56 | 6.22 | 7.67 | 7.14 | 5.75 | 7.49 | 6.59 | 5.26 | 5.40 | 5.35 |
| Eu | 1.50 | 2.21 | 2.23 | 1.96 | 2.55 | 2.38 | 1.83 | 2.54 | 2.10 | 1.77 | 1.83 | 1.80 |
| Gd | 4.78 | 6.65 | 6.82 | 6.00 | 7.17 | 6.72 | 5.07 | 7.65 | 5.81 | 4.97 | 5.22 | 5.11 |
| Tb | 0.72 | 1.07 | 0.91 | 0.88 | 1.14 | 1.04 | 0.51 | 0.87 | 0.86 | 0.74 | 0.78 | 0.77 |
| Dy | 3.97 | 4.81 | 4.30 | 4.16 | 5.07 | 4.81 | 4.09 | 5.68 | 4.50 | 3.81 | 4.13 | 4.08 |
| Ho | 0.70 | 0.81 | 0.80 | 0.69 | 0.88 | 0.81 | 0.68 | 1.05 | 0.85 | 0.69 | 0.76 | 0.75 |
| Er | 1.81 | 2.16 | 2.26 | 1.79 | 2.04 | 1.94 | 2.00 | 2.73 | 2.17 | 1.69 | 1.90 | 1.88 |
| Tm | 0.25 | 0.28 | 0.29 | 0.21 | 0.25 | 0.25 | 0.25 | 0.27 |  |  |  |  |
| Yb | 1.50 | 1.44 | 1.51 | 1.19 | 1.45 | 1.43 | 1.70 | 1.97 | 1.66 | 1.20 | 1.47 | 1.43 |
| Lu | 0.21 | 0.23 | 0.24 | 0.17 | 0.24 | 0.24 | 0.24 | 0.29 | 0.24 | 0.16 | 0.20 | 0.20 |
| TREE | 125 | 179 | 191 | 192 | 217 | 203 | 126 | 160 | 185 | 107 | 109 | 107 |
| (La/Yb)N | 13.02 | 19.06 | 18.78 | 25.48 | 24.38 | 22.22 | 9.78 | 11.97 | 17.35 | 10.60 | 8.75 | 8.83 |
| EuN/EuN\* | 1.00 | 1.01 | 1.01 | 0.97 | 1.04 | 1.03 | 1.01 | 1.02 | 1.02 | 1.04 | 1.04 | 1.04 |
| Sm/Yb | 2.93 | 4.61 | 4.34 | 5.23 | 5.29 | 4.99 | 3.38 | 3.80 | 3.97 | 4.38 | 3.67 | 3.74 |
| (Dy/Er)N | 1.43 | 1.46 | 1.24 | 1.52 | 1.62 | 1.62 | 1.34 | 1.36 | 1.36 | 1.47 | 1.42 | 1.42 |
| (La/Sm)N | 4.14 | 3.85 | 4.03 | 4.54 | 4.29 | 4.15 | 2.69 | 2.93 | 4.07 | 2.25 | 2.22 | 2.20 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Pleistocene alkali olivine basalts | | | | | | | | | | | | |
| Sample | 0228c | 0237p | P2Lt66b | P3Lt3-1f | P3Lt3-1e | P3Lt88h | P2Lt8-1d | P3Lt3-1b | P3Lt88e | P2Lt8-1b | P3Lt88b | JB-1 | JB-2 |
| Source | Li (2013) | | | | | | | | | | | Yan & Zhao (2008) | |
| SiO2 (wt%) | 48.9 | 46.9 | 47.3 | 46.6 | 46.0 | 47.3 | 48.0 | 46.3 | 47.5 | 48.2 | 48.2 | 47.8 | 50.0 |
| TiO2 | 1.61 | 1.89 | 1.80 | 1.78 | 1.76 | 1.70 | 1.79 | 1.85 | 1.74 | 1.78 | 1.72 | 1.74 | 1.70 |
| Al2O3 | 14.9 | 15.3 | 14.6 | 15.2 | 15.8 | 15.1 | 15.0 | 15.1 | 15.2 | 14.9 | 15.4 | 15.7 | 15.9 |
| Fe2O3T | 11.5 | 11.7 | 11.1 | 11.5 | 11.8 | 11.2 | 11.0 | 11.5 | 11.0 | 10.9 | 10.9 | 11.1 | 10.9 |
| MnO | 0.19 | 0.20 | 0.18 | 0.18 | 0.20 | 0.18 | 0.17 | 0.17 | 0.18 | 0.17 | 0.18 | 0.16 | 0.15 |
| MgO | 7.71 | 8.65 | 8.75 | 9.30 | 6.51 | 8.94 | 8.40 | 8.53 | 8.19 | 8.22 | 7.79 | 9.11 | 8.24 |
| CaO | 8.36 | 8.59 | 8.19 | 8.61 | 8.95 | 8.33 | 8.15 | 8.59 | 8.23 | 8.20 | 8.37 | 9.11 | 8.60 |
| Na2O | 4.06 | 2.55 | 3.73 | 3.90 | 4.61 | 4.08 | 4.14 | 4.27 | 3.87 | 3.93 | 4.00 | 3.10 | 3.14 |
| K2O | 2.02 | 2.06 | 2.51 | 2.59 | 1.00 | 2.47 | 2.70 | 2.80 | 2.81 | 2.93 | 2.69 | 1.89 | 1.44 |
| P2O5 | 0.62 | 0.57 | 0.52 | 0.59 | 0.57 | 0.58 | 0.54 | 0.58 | 0.57 | 0.52 | 0.57 | 0.49 | 0.38 |
| Total | 99.8 | 98.3 | 98.8 | 100.2 | 97.2 | 99.9 | 99.8 | 99.6 | 99.3 | 99.7 | 99.9 | 100.2 | 100.4 |
| CaO/Al2O3 | 0.56 | 0.56 | 0.56 | 0.57 | 0.57 | 0.55 | 0.55 | 0.57 | 0.54 | 0.55 | 0.54 | 0.58 | 0.54 |
| Mg# | 0.57 | 0.60 | 0.61 | 0.62 | 0.52 | 0.61 | 0.61 | 0.60 | 0.60 | 0.60 | 0.59 | 0.62 | 0.60 |
| Cs (ppm) | 0.72 | 1.12 | 0.83 | 0.44 | 1.33 | 0.48 | 0.56 | 0.72 | 0.90 | 0.73 | 0.82 | 0.26 | 0.25 |
| Ba | 580 | 1705 | 577 | 535 | 499 | 526 | 580 | 578 | 574 | 562 | 578 | 442 | 346 |
| Rb | 53 | 61 | 63 | 43 | 82 | 44 | 44 | 57 | 58 | 50 | 53 | 30 | 22 |
| U | 1.28 | 1.36 | 1.24 | 1.27 | 1.09 | 1.33 | 1.35 | 1.29 | 1.36 | 1.28 | 1.36 | 0.90 | 0.51 |
| Th | 6.41 | 5.34 | 4.99 | 5.58 | 5.80 | 5.49 | 5.63 | 5.39 | 6.35 | 5.59 | 5.52 | 4.19 | 2.91 |
| Nb | 59 | 55 | 53 | 56 | 58 | 54 | 56 | 56 | 59 | 54 | 57 | 43 | 29 |
| Ta | 3.06 | 4.19 | 3.16 | 3.70 | 3.42 | 3.45 | 3.37 | 3.50 | 3.73 | 3.29 | 3.61 | 2.90 | 2.25 |
| Sr | 603 | 737 | 568 | 581 | 612 | 575 | 583 | 611 | 646 | 590 | 649 | 656 | 653 |
| Zr | 158 | 212 | 168 | 162 | 178 | 168 | 173 | 175 | 188 | 176 | 181 | 158 | 129 |
| Hf | 4.29 | 5.63 | 5.76 | 5.22 | 5.25 | 5.25 | 5.58 | 5.25 | 5.89 | 5.75 | 5.40 | 3.34 | 2.86 |
| Y | 20 | 18 | 18 | 19 | 20 | 21 | 19 | 18 | 19 | 18 | 18 | 23 | 21 |
| La | 42 | 39 | 36 | 42 | 44 | 46 | 40 | 41 | 43 | 38 | 39 | 29 | 21 |
| Ce | 73 | 68 | 63 | 74 | 77 | 81 | 73 | 75 | 77 | 68 | 71 | 55 | 40 |
| Pr | 6.46 | 6.16 | 5.96 | 6.55 | 6.95 | 7.56 | 6.76 | 6.66 | 7.08 | 6.12 | 6.38 | 6.49 | 4.88 |
| Nd | 29 | 28 | 26 | 29 | 31 | 32 | 29 | 28 | 30 | 27 | 27 | 26 | 20 |
| Sm | 6.01 | 5.81 | 5.43 | 5.89 | 6.16 | 6.54 | 6.09 | 6.01 | 6.10 | 5.81 | 5.90 | 5.51 | 4.82 |
| Eu | 2.09 | 1.98 | 1.78 | 1.99 | 2.09 | 2.15 | 1.96 | 2.04 | 2.03 | 1.93 | 1.97 | 1.83 | 1.65 |
| Gd | 5.78 | 5.83 | 5.50 | 6.13 | 5.83 | 6.18 | 5.65 | 5.40 | 6.10 | 5.63 | 5.88 | 5.24 | 4.69 |
| Tb | 0.85 | 0.89 | 0.85 | 0.91 | 0.92 | 0.92 | 0.91 | 0.79 | 0.80 | 0.77 | 0.80 | 0.79 | 0.71 |
| Dy | 4.32 | 4.01 | 4.23 | 4.45 | 4.32 | 4.63 | 4.42 | 4.32 | 4.21 | 3.95 | 4.23 | 4.29 | 3.86 |
| Ho | 0.90 | 0.84 | 0.85 | 0.88 | 0.85 | 0.89 | 0.90 | 0.83 | 0.84 | 0.76 | 0.79 | 0.82 | 0.74 |
| Er | 2.12 | 1.85 | 1.81 | 1.90 | 2.12 | 2.31 | 1.88 | 1.93 | 2.04 | 1.90 | 1.89 | 2.11 | 1.89 |
| Tm | 0.28 | 0.25 | 0.23 | 0.24 | 0.28 | 0.32 | 0.25 | 0.25 | 0.29 | 0.24 | 0.25 |  |  |
| Yb | 1.69 | 1.45 | 1.45 | 1.54 | 1.67 | 1.77 | 1.53 | 1.40 | 1.62 | 1.47 | 1.53 | 1.63 | 1.50 |
| Lu | 0.28 | 0.23 | 0.24 | 0.24 | 0.27 | 0.31 | 0.26 | 0.23 | 0.27 | 0.26 | 0.24 | 0.24 | 0.22 |
| TREE | 175 | 164 | 153 | 175 | 183 | 193 | 173 | 174 | 180 | 162 | 168 | 139 | 106 |
| (La/Yb)N | 16.78 | 17.96 | 16.60 | 18.35 | 17.96 | 17.58 | 17.73 | 19.80 | 17.82 | 17.34 | 17.32 | 12.07 | 9.41 |
| EuN/EuN\* | 1.07 | 1.03 | 0.99 | 1.00 | 1.05 | 1.02 | 1.01 | 1.07 | 1.01 | 1.02 | 1.01 | 1.03 | 1.05 |
| Sm/Yb | 3.56 | 4.01 | 3.74 | 3.82 | 3.69 | 3.69 | 3.98 | 4.29 | 3.77 | 3.95 | 3.86 | 3.38 | 3.21 |
| (Dy/Er)N | 1.33 | 1.42 | 1.53 | 1.53 | 1.33 | 1.31 | 1.54 | 1.46 | 1.35 | 1.36 | 1.46 | 1.33 | 1.33 |
| (La/Sm)N | 4.40 | 4.18 | 4.13 | 4.47 | 4.53 | 4.43 | 4.15 | 4.30 | 4.41 | 4.09 | 4.18 | 3.33 | 2.73 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Holocene alkali olivine basalts | | | | | | | | | | | | |
| Sample | JP-2 | JP-3 | RY-1 | DX-10 | DX1-26 | DX-2 | DX-13 | DX1-4 | DX1-16 | DX4-8 | DX4-28 | DG-7 | WD2-5 |
| Source | Zhang et al. (2000b) | | | | | | | | | | | | |
| SiO2 (wt%) | 47.1 | 47.3 | 47.5 | 47.5 | 45.8 | 46.4 | 46.9 | 47.4 | 46.9 | 43.5 | 44.0 | 44.2 | 45.2 |
| TiO2 | 1.70 | 1.68 | 1.67 | 1.67 | 1.79 | 1.76 | 1.75 | 1.68 | 1.75 | 1.87 | 1.84 | 1.83 | 1.87 |
| Al2O3 | 15.0 | 14.9 | 15.0 | 15.2 | 14.9 | 15.1 | 15.3 | 15.1 | 15.3 | 14.3 | 14.6 | 14.6 | 15.3 |
| Fe2O3T | 11.8 | 11.7 | 11.7 | 11.6 | 11.8 | 11.8 | 11.0 | 11.5 | 11.0 | 11.4 | 11.5 | 11.4 | 11.0 |
| MnO | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.19 | 0.19 | 0.18 |
| MgO | 8.48 | 8.59 | 8.21 | 7.91 | 8.71 | 8.26 | 8.06 | 8.04 | 8.06 | 9.20 | 8.83 | 8.81 | 8.48 |
| CaO | 8.56 | 8.49 | 8.39 | 8.56 | 8.62 | 8.46 | 7.93 | 8.51 | 7.93 | 8.49 | 8.68 | 8.34 | 7.87 |
| Na2O | 4.24 | 4.21 | 4.23 | 4.51 | 4.88 | 4.68 | 5.03 | 4.59 | 5.03 | 5.29 | 4.91 | 5.23 | 5.05 |
| K2O | 2.23 | 2.17 | 2.16 | 2.35 | 2.30 | 2.35 | 3.24 | 2.35 | 3.24 | 3.57 | 3.09 | 3.45 | 3.44 |
| P2O5 | 0.67 | 0.62 | 0.59 | 0.67 | 0.89 | 0.76 | 0.86 | 0.65 | 0.86 | 0.99 | 1.07 | 0.96 | 0.90 |
| Total | 99.9 | 99.9 | 99.7 | 100.1 | 99.9 | 99.7 | 100.3 | 100.1 | 100.3 | 98.8 | 98.6 | 99.1 | 99.3 |
| CaO/Al2O3 | 0.57 | 0.57 | 0.56 | 0.56 | 0.58 | 0.56 | 0.52 | 0.56 | 0.52 | 0.59 | 0.60 | 0.57 | 0.52 |
| Mg# | 0.59 | 0.59 | 0.58 | 0.58 | 0.60 | 0.58 | 0.59 | 0.58 | 0.59 | 0.62 | 0.61 | 0.61 | 0.61 |
| Cs (ppm) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ba | 588 | 586 | 543 | 561 | 520 | 481 | 577 | 573 | 578 | 611 | 610 | 616 | 628 |
| Rb | 37 | 39 | 41 | 43 | 41 | 41 | 40 | 44 | 59 | 54 | 53 | 53 | 62 |
| U | 1.80 | 1.90 | 1.70 | 1.80 | 1.70 | 1.80 | 2.00 | 1.80 | 2.30 | 2.70 | 2.40 | 2.50 | 2.40 |
| Th | 8.10 | 8.20 | 7.50 | 8.00 | 6.90 | 6.90 | 8.30 | 8.10 | 9.00 | 9.40 | 9.00 | 9.50 | 9.30 |
| Nb | 59 | 59 | 54 | 62 | 11 | 43 | 41 | 56 | 35 | 81 | 14 | 83 | 71 |
| Ta | 4.00 | 3.70 | 3.50 | 3.00 | 0.50 | 1.50 | 2.40 | 3.40 | 1.60 | 4.00 | 0.50 | 4.30 | 4.00 |
| Sr | 679 | 662 | 625 | 649 | 786 | 706 | 674 | 668 | 850 | 960 | 980 | 939 | 823 |
| Zr | 189 | 188 | 180 | 184 | 184 | 179 | 188 | 190 | 230 | 243 | 230 | 252 | 239 |
| Hf | 4.00 | 4.30 | 4.20 | 4.10 | 3.50 | 3.90 | 4.10 | 4.00 | 4.70 | 5.50 | 4.50 | 5.50 | 5.50 |
| Y | 18 | 17 | 18 | 19 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 19 | 20 |
| La | 36 | 43 | 42 | 48 | 49 | 50 | 49 | 48 | 59 | 65 | 64 | 69 | 65 |
| Ce | 54 | 66 | 66 | 73 | 79 | 79 | 76 | 73 | 91 | 100 | 97 | 105 | 101 |
| Pr | 5.87 | 7.11 | 6.93 | 7.87 | 8.42 | 8.73 | 7.13 | 7.82 | 9.86 | 10.7 | 10.4 | 11.4 | 10.8 |
| Nd | 22 | 27 | 27 | 30 | 31 | 32 | 30 | 30 | 37 | 41 | 39 | 42 | 39 |
| Sm | 4.84 | 6.01 | 6.27 | 6.66 | 7.19 | 7.33 | 6.74 | 6.59 | 7.92 | 8.41 | 8.48 | 9.13 | 8.41 |
| Eu | 1.48 | 1.86 | 1.93 | 2.01 | 2.11 | 2.16 | 2.00 | 1.96 | 2.31 | 2.49 | 2.49 | 2.63 | 2.41 |
| Gd | 4.07 | 5.07 | 5.34 | 5.63 | 6.12 | 6.05 | 6.19 | 5.55 | 6.59 | 6.59 | 6.28 | 6.41 | 5.93 |
| Tb | 0.53 | 0.69 | 0.69 | 0.78 | 0.77 | 0.83 | 0.78 | 0.79 | 0.95 | 0.93 | 0.87 | 0.94 | 0.86 |
| Dy | 2.56 | 3.61 | 3.85 | 3.86 | 3.95 | 4.09 | 3.92 | 3.84 | 4.32 | 4.40 | 4.43 | 4.46 | 4.34 |
| Ho | 0.46 | 0.68 | 0.65 | 0.68 | 0.72 | 0.70 | 0.70 | 0.69 | 0.75 | 0.74 | 0.73 | 0.76 | 0.80 |
| Er | 0.85 | 1.38 | 1.65 | 1.40 | 1.48 | 1.57 | 1.52 | 1.43 | 1.66 | 1.50 | 1.53 | 1.50 | 1.61 |
| Tm | 0.12 | 0.20 | 0.22 | 0.20 | 0.21 | 0.20 | 0.22 | 0.19 | 0.22 | 0.20 | 0.21 | 0.19 | 0.21 |
| Yb | 0.78 | 1.27 | 1.37 | 1.34 | 1.26 | 1.31 | 1.37 | 1.34 | 1.33 | 1.23 | 1.30 | 1.16 | 1.25 |
| Lu | 0.12 | 0.18 | 0.16 | 0.19 | 0.17 | 0.18 | 0.19 | 0.20 | 0.20 | 0.18 | 0.19 | 0.16 | 0.20 |
| TREE | 133 | 164 | 164 | 182 | 192 | 194 | 186 | 181 | 223 | 242 | 237 | 255 | 243 |
| (La/Yb)N | 31.07 | 22.77 | 20.86 | 24.27 | 26.53 | 25.81 | 24.39 | 24.19 | 29.96 | 35.61 | 33.08 | 39.95 | 35.38 |
| EuN/EuN\* | 0.99 | 1.00 | 0.99 | 0.98 | 0.95 | 0.96 | 0.93 | 0.97 | 0.95 | 0.99 | 1.00 | 1.00 | 0.99 |
| Sm/Yb | 6.21 | 4.73 | 4.58 | 4.97 | 5.71 | 5.60 | 4.92 | 4.92 | 5.95 | 6.84 | 6.52 | 7.87 | 6.73 |
| (Dy/Er)N | 1.97 | 1.71 | 1.52 | 1.80 | 1.74 | 1.70 | 1.69 | 1.75 | 1.70 | 1.92 | 1.89 | 1.94 | 1.76 |
| (La/Sm)N | 4.66 | 4.48 | 4.25 | 4.55 | 4.33 | 4.30 | 4.62 | 4.58 | 4.69 | 4.85 | 4.72 | 4.73 | 4.90 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Holocene alkali olivine basalts | | | | | | | | | | | | |
| Sample | J99821-1 | J99821-5 | J99821-6 | J99824-1 | 0228a | P1Lt60 | p301t15b | mj4532c | JBH-BH-1a | JBH-BH-1g | JBH-BH-1u | JBH-BH-1af | JBH-3c |
| Source | Zou et al. (2008) | | | | Li (2013) | | | | Chen et al. (2007) | | | | |
| SiO2 (wt%) | 47.4 | 47.8 | 45.0 | 46.4 | 48.6 | 48.2 | 49.2 | 47.0 | 44.2 | 44.2 | 44.3 | 44.5 | 44.1 |
| TiO2 | 1.69 | 1.71 | 1.83 | 1.77 | 1.65 | 1.60 | 1.50 | 1.77 | 1.80 | 1.79 | 1.79 | 1.77 | 1.79 |
| Al2O3 | 15.1 | 15.1 | 15.0 | 14.9 | 14.9 | 14.7 | 15.4 | 14.8 | 14.4 | 14.4 | 14.4 | 14.4 | 14.4 |
| Fe2O3T | 11.8 | 10.5 | 11.6 | 10.4 | 11.6 | 11.4 | 11.0 | 11.8 | 11.0 | 11.0 | 11.1 | 11.1 | 10.9 |
| MnO | 0.17 | 0.17 | 0.17 | 0.17 | 0.18 | 0.17 | 0.18 | 0.18 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| MgO | 8.04 | 8.13 | 8.50 | 9.03 | 7.92 | 7.93 | 7.62 | 8.89 | 9.18 | 9.08 | 9.14 | 9.34 | 9.15 |
| CaO | 8.46 | 7.96 | 8.41 | 8.30 | 8.44 | 8.49 | 7.48 | 8.32 | 8.36 | 8.33 | 8.38 | 8.29 | 8.32 |
| Na2O | 4.47 | 4.92 | 4.96 | 4.77 | 3.73 | 4.20 | 3.68 | 4.32 | 4.72 | 4.82 | 4.87 | 4.65 | 4.70 |
| K2O | 2.32 | 2.88 | 3.27 | 3.00 | 1.99 | 2.24 | 2.00 | 2.36 | 2.81 | 2.99 | 2.73 | 3.20 | 2.98 |
| P2O5 | 0.72 | 0.91 | 0.96 | 0.99 | 0.56 | 0.72 | 0.53 | 0.70 | 1.05 | 1.06 | 1.06 | 1.04 | 1.06 |
| Total | 100.2 | 100.1 | 99.6 | 99.7 | 99.5 | 99.6 | 98.6 | 100.1 | 97.8 | 97.8 | 97.9 | 98.4 | 97.6 |
| CaO/Al2O3 | 0.56 | 0.53 | 0.56 | 0.56 | 0.57 | 0.58 | 0.49 | 0.56 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Mg# | 0.58 | 0.61 | 0.60 | 0.63 | 0.58 | 0.58 | 0.58 | 0.60 | 0.63 | 0.62 | 0.62 | 0.63 | 0.63 |
| Cs (ppm) | 0.79 | 0.97 | 0.69 | 0.87 | 0.48 | 0.37 | 1.40 | 0.90 |  |  |  |  |  |
| Ba | 652 | 636 | 668 | 680 | 527 | 568 | 573 | 557 | 584 | 646 | 620 | 580 | 632 |
| Rb | 51 | 58 | 43 | 57 | 42 | 30 | 44 | 46 |  |  |  |  |  |
| U | 1.98 | 2.15 | 1.64 | 2.18 | 1.33 | 1.45 | 1.40 | 1.40 |  |  |  |  |  |
| Th | 8.13 | 8.59 | 7.84 | 8.47 | 6.17 | 6.86 | 5.80 | 5.10 | 8.49 | 9.35 | 9.39 | 8.74 | 9.46 |
| Nb | 73 | 69 | 63 | 77 | 59 | 65 | 55 | 66 | 89 | 87 | 87 | 89 | 87 |
| Ta | 4.21 | 4.00 | 3.57 | 4.43 | 3.27 | 3.90 | 2.80 | 2.80 | 4.97 | 4.50 | 4.69 | 5.05 | 4.47 |
| Sr | 1011 | 960 | 759 | 1066 | 591 | 648 | 561 | 763 | 978 | 1024 | 1002 | 1000 | 1012 |
| Zr | 246 | 239 | 199 | 254 | 161 | 176 | 190 | 201 | 282 | 280 | 278 | 280 | 274 |
| Hf | 5.55 | 5.52 | 4.63 | 5.57 | 4.33 | 6.04 | 5.00 | 5.00 | 5.71 | 5.69 | 5.89 | 5.74 | 5.60 |
| Y | 25 | 25 | 23 | 26 | 18 | 19 | 20 | 16 | 26 | 25 | 26 | 26 | 25 |
| La | 59 | 57 | 47 | 63 | 41 | 46 | 41 | 43 | 63 | 68 | 66 | 62 | 66 |
| Ce | 106 | 102 | 84 | 112 | 71 | 79 | 74 | 75 | 118 | 118 | 112 | 113 | 112 |
| Pr | 11.9 | 11.4 | 9.30 | 12.5 | 6.15 | 6.87 | 7.81 | 8.33 | 12.5 | 13.7 | 13.2 | 12.0 | 13.1 |
| Nd | 45 | 43 | 35 | 48 | 28 | 30 | 31 | 32 | 49 | 52 | 51 | 48 | 50 |
| Sm | 8.92 | 8.46 | 7.18 | 9.38 | 5.80 | 5.93 | 6.79 | 6.86 | 8.73 | 8.65 | 8.78 | 8.43 | 8.45 |
| Eu | 2.87 | 2.69 | 2.43 | 2.99 | 1.95 | 2.05 | 2.09 | 2.22 | 2.83 | 2.82 | 2.73 | 2.68 | 2.70 |
| Gd | 7.58 | 7.44 | 6.47 | 8.35 | 5.34 | 6.03 | 5.80 | 5.70 | 7.53 | 8.70 | 8.72 | 7.54 | 8.25 |
| Tb | 1.11 | 1.06 | 0.94 | 1.14 | 0.85 | 0.91 | 1.10 | 0.80 | 1.00 | 1.04 | 1.04 | 1.05 | 1.04 |
| Dy | 5.75 | 5.64 | 5.13 | 6.06 | 4.14 | 4.22 | 4.61 | 4.09 | 4.97 | 5.10 | 5.27 | 5.05 | 5.02 |
| Ho | 1.01 | 1.00 | 0.92 | 1.03 | 0.80 | 0.82 | 0.80 | 0.68 | 0.87 | 0.84 | 0.86 | 0.88 | 0.84 |
| Er | 2.36 | 2.38 | 2.21 | 2.37 | 1.90 | 2.03 | 2.12 | 1.74 | 2.03 | 2.02 | 2.04 | 2.10 | 2.08 |
| Tm |  |  |  |  | 0.25 | 0.28 | 0.25 | 0.22 |  |  |  |  |  |
| Yb | 1.64 | 1.68 | 1.60 | 1.56 | 1.43 | 1.58 | 1.73 | 1.22 |  |  |  |  |  |
| Lu | 0.23 | 0.25 | 0.24 | 0.23 | 0.24 | 0.27 | 0.24 | 0.17 |  |  |  |  |  |
| TREE | 254 | 244 | 203 | 268 | 169 | 186 | 179 | 182 | 270 | 281 | 271 | 263 | 269 |
| (La/Yb)N | 24.39 | 22.73 | 19.89 | 27.07 | 19.39 | 19.82 | 16.09 | 23.71 |  |  |  |  |  |
| EuN/EuN\* | 1.04 | 1.01 | 1.07 | 1.01 | 1.05 | 1.04 | 0.99 | 1.06 | 1.04 | 0.98 | 0.94 | 1.01 | 0.98 |
| Sm/Yb | 5.44 | 5.04 | 4.49 | 6.01 | 4.06 | 3.75 | 3.92 | 5.62 |  |  |  |  |  |
| (Dy/Er)N | 1.59 | 1.55 | 1.52 | 1.67 | 1.42 | 1.36 | 1.42 | 1.54 | 1.60 | 1.65 | 1.69 | 1.57 | 1.58 |
| (La/Sm)N | 4.18 | 4.20 | 4.13 | 4.19 | 4.45 | 4.92 | 3.82 | 3.93 | 4.53 | 4.95 | 4.72 | 4.64 | 4.89 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Holocene alkali olivine basalts | | | | | | | | | | | | |
| Sample | JBH-3d | JBH-1a | JBH-2a | JBH-3a | JBH-4a | JBH-5a | JBH-6a | JBH-7a | JBH-8a | JBH-10a | JB-5 | JB-7 | JB-8 |
| Source | Chen et al. (2007) | | | | | | | | | | Yan & Zhao (2008) | | |
| SiO2 (wt%) | 44.1 | 47.0 | 47.7 | 47.6 | 47.6 | 45.2 | 44.4 | 46.2 | 47.3 | 44.1 | 47.8 | 48.3 | 45.8 |
| TiO2 | 1.79 | 1.53 | 1.66 | 1.58 | 1.61 | 1.80 | 1.78 | 2.77 | 1.62 | 1.79 | 1.76 | 1.70 | 1.83 |
| Al2O3 | 14.5 | 14.4 | 14.9 | 14.5 | 14.7 | 14.8 | 14.5 | 14.5 | 14.6 | 14.5 | 15.5 | 15.5 | 14.9 |
| Fe2O3T | 11.0 | 11.6 | 11.5 | 11.5 | 11.5 | 11.3 | 11.1 | 12.4 | 11.7 | 11.3 | 10.3 | 10.9 | 10.8 |
| MnO | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.18 | 0.16 | 0.16 | 0.17 |
| MgO | 9.13 | 9.18 | 8.07 | 9.43 | 8.52 | 8.86 | 8.89 | 7.89 | 8.65 | 10.2 | 8.04 | 8.08 | 9.53 |
| CaO | 8.29 | 8.63 | 8.50 | 8.40 | 8.36 | 8.43 | 8.30 | 8.56 | 8.32 | 9.32 | 8.09 | 8.80 | 8.56 |
| Na2O | 4.76 | 3.75 | 4.07 | 3.92 | 3.86 | 4.38 | 4.81 | 3.04 | 3.85 | 3.35 | 4.54 | 4.01 | 4.63 |
| K2O | 2.87 | 2.00 | 2.22 | 1.96 | 2.04 | 3.14 | 3.31 | 2.01 | 2.07 | 2.61 | 3.19 | 2.31 | 3.32 |
| P2O5 | 1.06 | 0.57 | 0.64 | 0.56 | 0.58 | 0.97 | 0.98 | 0.75 | 0.57 | 0.65 | 0.87 | 0.68 | 1.01 |
| Total | 97.7 | 98.7 | 99.4 | 99.5 | 98.9 | 99.1 | 98.2 | 98.4 | 98.8 | 98.0 | 100.2 | 100.5 | 100.6 |
| CaO/Al2O3 | 0.57 | 0.60 | 0.57 | 0.58 | 0.57 | 0.57 | 0.57 | 0.59 | 0.57 | 0.64 | 0.52 | 0.57 | 0.57 |
| Mg# | 0.62 | 0.61 | 0.58 | 0.62 | 0.60 | 0.61 | 0.62 | 0.56 | 0.60 | 0.64 | 0.61 | 0.60 | 0.64 |
| Cs (ppm) |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.86 | 0.93 |
| Ba | 582 | 572 | 628 | 554 | 576 | 638 | 671 | 433 | 562 | 587 | 638 | 651 | 679 |
| Rb |  |  |  |  |  |  |  |  |  |  | 57 | 52 | 58 |
| U |  |  |  |  |  |  |  |  |  |  | 1.80 | 1.90 | 1.97 |
| Th | 8.77 | 6.84 | 7.41 | 6.16 | 6.63 | 8.39 | 8.47 | 3.32 | 6.60 | 6.02 | 7.95 | 8.00 | 8.42 |
| Nb | 89 | 55 | 59 | 53 | 54 | 74 | 78 | 38 | 54 | 57 | 76 | 81 | 88 |
| Ta | 5.02 | 2.99 | 3.23 | 3.08 | 2.94 | 4.03 | 4.41 | 2.28 | 3.01 | 3.25 | 5.21 | 5.23 | 5.50 |
| Sr | 996 | 671 | 644 | 647 | 609 | 920 | 960 | 952 | 614 | 678 | 937 | 971 | 1058 |
| Zr | 282 | 183 | 197 | 174 | 187 | 252 | 264 | 254 | 184 | 187 | 259 | 266 | 279 |
| Hf | 5.71 | 4.20 | 4.55 | 4.02 | 4.32 | 5.53 | 5.91 | 6.03 | 4.37 | 4.41 | 5.09 | 5.19 | 5.46 |
| Y | 27 | 21 | 23 | 22 | 22 | 26 | 26 | 26 | 22 | 24 | 26 | 26 | 27 |
| La | 64 | 39 | 42 | 37 | 38 | 57 | 60 | 31 | 37 | 39 | 54 | 57 | 64 |
| Ce | 119 | 68 | 72 | 63 | 66 | 95 | 104 | 65 | 63 | 68 | 97 | 103 | 115 |
| Pr | 12.7 | 8.02 | 8.40 | 6.70 | 7.78 | 11.3 | 12.2 | 8.85 | 7.60 | 8.23 | 11.1 | 11.7 | 13.0 |
| Nd | 50 | 31 | 33 | 27 | 30 | 44 | 47 | 39 | 30 | 32 | 42 | 44 | 49 |
| Sm | 8.79 | 6.08 | 6.47 | 6.15 | 6.03 | 8.12 | 8.70 | 8.25 | 6.01 | 6.46 | 8.01 | 8.37 | 9.15 |
| Eu | 2.80 | 2.02 | 2.16 | 2.09 | 2.04 | 2.57 | 2.74 | 2.57 | 2.00 | 2.10 | 2.42 | 2.61 | 2.82 |
| Gd | 7.94 | 6.07 | 6.44 | 5.69 | 6.05 | 8.04 | 8.47 | 7.51 | 6.05 | 6.38 | 6.85 | 7.18 | 7.64 |
| Tb | 1.05 | 0.84 | 0.91 | 0.84 | 0.85 | 1.09 | 1.14 | 1.04 | 0.85 | 0.92 | 0.98 | 1.02 | 1.07 |
| Dy | 5.06 | 4.17 | 4.56 | 4.59 | 4.39 | 5.31 | 5.26 | 5.41 | 4.50 | 4.86 | 4.99 | 5.11 | 5.33 |
| Ho | 0.89 | 0.76 | 0.83 | 0.83 | 0.79 | 0.92 | 0.92 | 0.95 | 0.80 | 0.89 | 0.89 | 0.92 | 0.94 |
| Er | 2.16 | 1.96 | 2.13 | 2.01 | 2.02 | 2.32 | 2.24 | 2.38 | 2.09 | 2.35 | 2.27 | 2.31 | 2.29 |
| Tm |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Yb |  |  |  |  |  |  |  |  |  |  | 1.62 | 1.64 | 1.55 |
| Lu |  |  |  |  |  |  |  |  |  |  | 0.23 | 0.23 | 0.21 |
| TREE | 274 | 168 | 178 | 156 | 164 | 235 | 252 | 171 | 160 | 171 | 232 | 245 | 272 |
| (La/Yb)N |  |  |  |  |  |  |  |  |  |  | 22.32 | 23.54 | 27.81 |
| EuN/EuN\* | 1.01 | 1.01 | 1.01 | 1.06 | 1.02 | 0.96 | 0.96 | 0.98 | 1.00 | 0.99 | 0.97 | 1.01 | 1.00 |
| Sm/Yb |  |  |  |  |  |  |  |  |  |  | 4.94 | 5.10 | 5.90 |
| (Dy/Er)N | 1.53 | 1.39 | 1.40 | 1.49 | 1.42 | 1.50 | 1.53 | 1.49 | 1.41 | 1.35 | 1.44 | 1.45 | 1.52 |
| (La/Sm)N | 4.57 | 4.05 | 4.08 | 3.81 | 3.98 | 4.39 | 4.34 | 2.40 | 3.85 | 3.75 | 4.20 | 4.30 | 4.39 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Holocene alkali olivine basalts | | | | | | | | | | | | |
| Sample | JB-9 | JB-11 | JB-12 | JB-14 | JB-15 | JB-16A | JB-16B | JB-17 | JB-18 | JB-19 | JB-20 | JB-21 | JB-22 |
| Source | Yan & Zhao (2008) | | | | | | | | | | | | |
| SiO2 (wt%) | 45.4 | 48.7 | 48.6 | 47.8 | 48.2 | 45.4 | 47.9 | 47.8 | 48.4 | 47.8 | 47.8 | 48.3 | 48.1 |
| TiO2 | 1.86 | 1.68 | 1.70 | 2.56 | 1.70 | 1.83 | 1.69 | 1.67 | 1.67 | 1.68 | 1.69 | 1.67 | 1.67 |
| Al2O3 | 15.0 | 15.6 | 15.5 | 16.3 | 15.3 | 14.9 | 15.1 | 15.1 | 15.3 | 15.1 | 15.1 | 15.4 | 15.2 |
| Fe2O3T | 10.7 | 10.8 | 10.4 | 12.2 | 10.8 | 11.0 | 10.9 | 10.9 | 10.8 | 11.2 | 11.0 | 11.1 | 11.1 |
| MnO | 0.16 | 0.15 | 0.15 | 0.17 | 0.16 | 0.17 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 | 0.16 | 0.16 |
| MgO | 9.11 | 8.28 | 7.96 | 6.20 | 7.97 | 9.15 | 8.18 | 8.48 | 8.37 | 9.05 | 8.59 | 8.34 | 8.62 |
| CaO | 8.62 | 8.75 | 8.94 | 7.73 | 8.85 | 8.46 | 8.70 | 8.78 | 8.91 | 8.90 | 8.59 | 8.91 | 8.75 |
| Na2O | 4.75 | 3.63 | 3.83 | 3.64 | 4.05 | 4.39 | 4.22 | 3.88 | 3.98 | 3.53 | 4.03 | 3.72 | 3.64 |
| K2O | 3.31 | 2.18 | 2.20 | 2.52 | 2.35 | 3.19 | 2.37 | 2.27 | 2.16 | 1.93 | 2.30 | 1.99 | 2.13 |
| P2O5 | 1.00 | 0.57 | 0.62 | 0.55 | 0.68 | 0.94 | 0.67 | 0.66 | 0.59 | 0.59 | 0.66 | 0.53 | 0.60 |
| Total | 99.9 | 100.4 | 99.8 | 99.7 | 100.0 | 99.4 | 99.8 | 99.7 | 100.3 | 100.0 | 100.0 | 100.1 | 99.9 |
| CaO/Al2O3 | 0.58 | 0.56 | 0.58 | 0.47 | 0.58 | 0.57 | 0.58 | 0.58 | 0.58 | 0.59 | 0.57 | 0.58 | 0.58 |
| Mg# | 0.63 | 0.60 | 0.60 | 0.50 | 0.60 | 0.63 | 0.60 | 0.61 | 0.61 | 0.62 | 0.61 | 0.60 | 0.61 |
| Cs (ppm) | 0.92 | 0.58 | 0.55 | 0.70 | 0.70 | 0.70 | 0.71 | 0.70 | 0.37 | 0.59 | 0.69 | 0.37 | 0.40 |
| Ba | 679 | 598 | 619 | 643 | 660 | 650 | 646 | 640 | 602 | 621 | 647 | 569 | 619 |
| Rb | 56 | 40 | 39 | 43 | 43 | 43 | 43 | 41 | 39 | 35 | 42 | 36 | 39 |
| U | 2.00 | 1.17 | 1.32 | 1.51 | 1.50 | 1.51 | 1.52 | 1.48 | 1.21 | 1.30 | 1.50 | 1.25 | 1.24 |
| Th | 8.47 | 6.39 | 6.72 | 7.58 | 7.60 | 7.57 | 7.56 | 7.47 | 6.46 | 6.51 | 7.53 | 6.19 | 6.64 |
| Nb | 89 | 60 | 61 | 68 | 69 | 68 | 68 | 67 | 59 | 60 | 68 | 56 | 61 |
| Ta | 5.88 | 3.74 | 4.16 | 4.12 | 4.30 | 4.32 | 4.84 | 4.44 | 4.55 | 4.11 | 4.19 | 3.44 | 3.79 |
| Sr | 1044 | 679 | 695 | 738 | 746 | 752 | 738 | 742 | 688 | 738 | 722 | 674 | 689 |
| Zr | 284 | 198 | 200 | 215 | 217 | 217 | 216 | 211 | 195 | 197 | 215 | 190 | 200 |
| Hf | 5.54 | 4.07 | 4.12 | 4.36 | 4.41 | 4.35 | 4.37 | 4.29 | 4.07 | 4.06 | 4.34 | 3.98 | 4.10 |
| Y | 27 | 23 | 23 | 24 | 24 | 24 | 24 | 23 | 23 | 23 | 24 | 23 | 23 |
| La | 63 | 39 | 40 | 44 | 45 | 45 | 45 | 44 | 39 | 39 | 44 | 37 | 40 |
| Ce | 113 | 70 | 71 | 79 | 80 | 80 | 80 | 78 | 70 | 70 | 79 | 66 | 71 |
| Pr | 12.7 | 7.84 | 8.06 | 8.85 | 8.96 | 8.93 | 8.93 | 8.75 | 7.89 | 7.93 | 8.83 | 7.52 | 8.03 |
| Nd | 48 | 30 | 31 | 34 | 34 | 34 | 34 | 33 | 30 | 30 | 33 | 29 | 31 |
| Sm | 9.09 | 6.16 | 6.27 | 6.62 | 6.71 | 6.66 | 6.70 | 6.52 | 6.13 | 6.21 | 6.63 | 6.02 | 6.27 |
| Eu | 2.79 | 1.99 | 2.05 | 2.14 | 2.16 | 2.17 | 2.15 | 2.11 | 2.01 | 2.02 | 2.12 | 1.99 | 2.03 |
| Gd | 7.58 | 5.57 | 5.64 | 5.89 | 5.99 | 5.96 | 5.92 | 5.89 | 5.62 | 5.59 | 5.92 | 5.50 | 5.62 |
| Tb | 1.07 | 0.83 | 0.83 | 0.87 | 0.88 | 0.88 | 0.87 | 0.86 | 0.83 | 0.82 | 0.87 | 0.81 | 0.83 |
| Dy | 5.29 | 4.33 | 4.41 | 4.52 | 4.60 | 4.56 | 4.53 | 4.46 | 4.35 | 4.31 | 4.53 | 4.28 | 4.32 |
| Ho | 0.93 | 0.81 | 0.82 | 0.83 | 0.84 | 0.83 | 0.83 | 0.83 | 0.81 | 0.81 | 0.84 | 0.81 | 0.82 |
| Er | 2.30 | 2.08 | 2.12 | 2.15 | 2.17 | 2.17 | 2.14 | 2.12 | 2.07 | 2.07 | 2.15 | 2.07 | 2.10 |
| Tm |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Yb | 1.55 | 1.58 | 1.60 | 1.61 | 1.61 | 1.63 | 1.62 | 1.60 | 1.57 | 1.59 | 1.62 | 1.58 | 1.61 |
| Lu | 0.21 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| TREE | 267 | 170 | 174 | 191 | 193 | 192 | 192 | 189 | 170 | 171 | 190 | 163 | 173 |
| (La/Yb)N | 27.25 | 16.49 | 16.75 | 18.61 | 18.77 | 18.49 | 18.60 | 18.53 | 16.60 | 16.54 | 18.42 | 15.66 | 16.60 |
| EuN/EuN\* | 1.00 | 1.02 | 1.03 | 1.03 | 1.02 | 1.03 | 1.02 | 1.02 | 1.03 | 1.03 | 1.01 | 1.04 | 1.03 |
| Sm/Yb | 5.86 | 3.90 | 3.92 | 4.11 | 4.17 | 4.09 | 4.14 | 4.08 | 3.90 | 3.91 | 4.09 | 3.81 | 3.89 |
| (Dy/Er)N | 1.50 | 1.36 | 1.36 | 1.37 | 1.39 | 1.37 | 1.38 | 1.37 | 1.37 | 1.36 | 1.38 | 1.35 | 1.34 |
| (La/Sm)N | 4.33 | 3.94 | 3.98 | 4.22 | 4.19 | 4.22 | 4.19 | 4.24 | 3.96 | 3.94 | 4.19 | 3.83 | 3.97 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Holocene alkali olivine basalts | Holocene Leucite tephrites | | | | | | | |
| Sample | JB-23 | HM-5 | HM-3 | HM-11 | J99822-1 | JB11-11 | JBH-HMT-1a | JBH-HMT-2a | JBH-HMT-3a |
| Source | Yan & Zhao (2008) | Zhang et al. (2000b) | | | Zou et al. (2008) | | Chen et al. (2007) | | |
| SiO2 (wt%) | 48.0 | 47.1 | 47.5 | 47.6 | 50.1 | 46.8 | 46.6 | 47.5 | 46.8 |
| TiO2 | 1.65 | 1.93 | 1.89 | 1.84 | 1.79 | 1.92 | 1.93 | 1.87 | 1.89 |
| Al2O3 | 15.1 | 17.0 | 17.1 | 16.9 | 16.9 | 17.1 | 17.1 | 16.9 | 16.9 |
| Fe2O3T | 10.9 | 11.1 | 11.0 | 10.9 | 10.0 | 11.4 | 11.2 | 10.8 | 10.9 |
| MnO | 0.16 | 0.16 | 0.16 | 0.17 | 0.14 | 0.15 | 0.15 | 0.15 | 0.15 |
| MgO | 8.63 | 4.56 | 4.48 | 4.17 | 4.39 | 4.67 | 4.32 | 4.42 | 4.13 |
| CaO | 8.73 | 5.81 | 5.81 | 5.62 | 5.64 | 5.77 | 5.68 | 5.69 | 5.57 |
| Na2O | 4.06 | 6.22 | 6.18 | 6.32 | 6.09 | 6.20 | 6.23 | 5.96 | 6.07 |
| K2O | 2.20 | 4.71 | 4.76 | 4.89 | 4.07 | 4.59 | 4.54 | 4.66 | 4.74 |
| P2O5 | 0.61 | 1.01 | 1.05 | 1.03 | 1.03 | 1.06 | 1.10 | 1.07 | 1.09 |
| Total | 100.1 | 99.5 | 99.9 | 99.4 | 100.1 | 99.6 | 98.8 | 99.0 | 98.2 |
| CaO/Al2O3 | 0.58 | 0.34 | 0.34 | 0.33 | 0.33 | 0.34 | 0.33 | 0.34 | 0.33 |
| Mg# | 0.61 | 0.45 | 0.45 | 0.43 | 0.47 | 0.45 | 0.44 | 0.45 | 0.43 |
| Cs (ppm) | 0.66 |  |  |  | 1.25 | 1.22 |  |  |  |
| Ba | 623 | 635 | 605 | 612 | 697 | 689 | 630 | 641 | 649 |
| Rb | 41 | 74 | 78 | 83 | 86 | 82 |  |  |  |
| U | 1.37 | 3.10 | 3.20 | 3.20 | 2.85 | 2.71 |  |  |  |
| Th | 6.94 | 12.0 | 12.0 | 12.2 | 11.4 | 11.2 | 11.6 | 11.8 | 11.9 |
| Nb | 63 | 95 | 89 | 99 | 89 | 94 | 104 | 99 | 102 |
| Ta | 3.63 | 4.30 | 3.20 | 5.10 | 5.66 | 5.75 | 6.42 | 6.15 | 6.41 |
| Sr | 706 | 957 | 966 | 951 | 1047 | 1136 | 1008 | 972 | 1021 |
| Zr | 204 | 349 | 348 | 345 | 355 | 385 | 395 | 384 | 394 |
| Hf | 4.16 | 7.80 | 7.40 | 7.30 | 8.04 | 8.46 | 8.88 | 8.87 | 9.31 |
| Y | 23 | 17 | 17 | 14.9 | 21 | 20 | 21 | 21 | 21 |
| La | 41 | 67 | 66 | 65 | 65 | 67 | 61 | 61 | 63 |
| Ce | 74 | 106 | 105 | 103 | 119 | 123 | 108 | 106 | 111 |
| Pr | 8.28 | 11.4 | 11.4 | 11.3 | 13.3 | 13.8 | 13.0 | 12.9 | 13.4 |
| Nd | 31 | 43 | 42 | 41 | 50 | 53 | 50 | 50 | 51 |
| Sm | 6.38 | 9.20 | 8.80 | 8.79 | 9.61 | 10.1 | 9.23 | 9.02 | 9.38 |
| Eu | 2.04 | 2.56 | 2.52 | 2.44 | 2.98 | 3.24 | 2.87 | 2.80 | 2.89 |
| Gd | 5.60 | 6.20 | 6.28 | 5.81 | 7.76 | 8.09 | 8.60 | 8.61 | 8.80 |
| Tb | 0.83 | 0.79 | 0.85 | 0.82 | 1.03 | 1.07 | 1.13 | 1.11 | 1.14 |
| Dy | 4.38 | 4.05 | 3.95 | 3.77 | 5.19 | 5.21 | 4.82 | 4.85 | 5.11 |
| Ho | 0.82 | 0.65 | 0.60 | 0.69 | 0.82 | 0.81 | 0.75 | 0.76 | 0.81 |
| Er | 2.10 | 1.17 | 1.11 | 1.10 | 1.72 | 1.66 | 1.65 | 1.75 | 1.77 |
| Tm |  | 0.17 | 0.17 | 0.13 |  |  |  |  |  |
| Yb | 1.59 | 0.88 | 0.84 | 0.77 | 1.07 | 0.87 |  |  |  |
| Lu | 0.23 | 0.13 | 0.12 |  | 0.15 | 0.11 |  |  |  |
| TREE | 178 | 253 | 249 | 245 | 278 | 288 | 261 | 258 | 268 |
| (La/Yb)N | 17.41 | 51.53 | 53.18 | 57.40 | 41.18 | 52.27 |  |  |  |
| EuN/EuN\* | 1.02 | 0.98 | 0.99 | 0.98 | 1.02 | 1.06 | 0.97 | 0.96 | 0.96 |
| Sm/Yb | 4.01 | 10.45 | 10.48 | 11.42 | 8.98 | 11.62 |  |  |  |
| (Dy/Er)N | 1.36 | 2.26 | 2.33 | 2.24 | 1.97 | 2.05 | 1.91 | 1.81 | 1.89 |
| (La/Sm)N | 4.04 | 4.59 | 4.73 | 4.68 | 4.27 | 4.19 | 4.17 | 4.24 | 4.23 |

Note: LOI, loss in ignition; Mg# = Mg/(Mg+Fetotal) in atomic ratio; TREE, total rare earth elements; EuN/EuN\* = EuN/SQRT (SmN×GdN); Subscript N, chondrite normalized value; The concentrations of the major oxides analyzed in wt. % and trace elements in ppm