附表1 流纹岩锆石Lu-Hf同位素组成

Table 1 Zircon Lu-Hf isotopic data of rhyolite

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 测点号 | *t*(Ma) | 176Yb/177Hf | 176Lu/177Hf | 176Hf/177Hf | ±2*σ* | (176Hf/177Hf)i | (176Hf/177Hf)DM,t | *f*Lu/Hf | *ε*Hf(0) | *ε*Hf(*t*) | *t*DM1 | *t*DMC | *t*DM2 |
| （Ma） | （Ma） | （Ma） |
| 1 | 476 | 0.048 451 | 0.001 238 | 0.282 370 | 0.000 0132 | 0.282 359 | 0.282 909 | -0.96 | -14.14 | -4.14 | 1 255 | 1 721 | 1 707 |
| 3 | 477 | 0.044 191 | 0.001 22 | 0.282 889 | 0.000 0141 | 0.282 878 | 0.282 908 | -0.96 | 4.20 | 14.24 | 519 | 546 | 543 |
| 4 | 476 | 0.055 700 | 0.001 523 | 0.282 823 | 0.000 0118 | 0.282 810 | 0.282 909 | -0.95 | 1.88 | 11.8 | 617 | 702 | 698 |
| 10 | 476 | 0.118 348 | 0.003 017 | 0.282 870 | 0.000 0165 | 0.282 843 | 0.282 909 | -0.91 | 3.54 | 12.99 | 573 | 626 | 622 |
| 13 | 475 | 0.109 534 | 0.003 535 | 0.282 872 | 0.000 0232 | 0.282 841 | 0.282 909 | -0.9 | 3.61 | 12.89 | 578 | 632 | 628 |
| 16 | 472 | 0.020 348 | 0.000 605 | 0.282 793 | 0.000 0124 | 0.282 788 | 0.282 911 | -0.98 | 0.81 | 10.94 | 645 | 755 | 750 |
| 17 | 468 | 0.018 927 | 0.000 576 | 0.282 773 | 0.000 011 | 0.282 768 | 0.282 914 | -0.98 | 0.12 | 10.18 | 671 | 802 | 795 |
| 18 | 474 | 0.030 250 | 0.000 877 | 0.282 789 | 0.000 0118 | 0.282 782 | 0.282 910 | -0.97 | 0.69 | 10.77 | 654 | 767 | 762 |
| 19 | 468 | 0.075 334 | 0.002 086 | 0.282 884 | 0.000 0164 | 0.282 865 | 0.282 914 | -0.94 | 4.02 | 13.62 | 538 | 580 | 576 |
| 20 | 473 | 0.064 703 | 0.001 883 | 0.282 912 | 0.000 0142 | 0.282 895 | 0.282 911 | -0.94 | 5.03 | 14.78 | 494 | 508 | 505 |
| 23 | 472 | 0.087 026 | 0.002 372 | 0.282 883 | 0.000 0155 | 0.282 862 | 0.282 911 | -0.93 | 4.01 | 13.6 | 543 | 584 | 580 |
| 24 | 472 | 0.101 690 | 0.002 9 | 0.282 503 | 0.000 0265 | 0.282 477 | 0.282 911 | -0.91 | -9.46 | -0.05 | 1 117 | 1 459 | 1 447 |
| 26 | 474 | 0.092 702 | 0.002 495 | 0.282 894 | 0.000 0163 | 0.282 872 | 0.282 910 | -0.92 | 4.40 | 13.99 | 528 | 560 | 557 |
| 28 | 474 | 0.073 839 | 0.001 958 | 0.282 874 | 0.000 0137 | 0.282 857 | 0.282 910 | -0.94 | 3.69 | 13.45 | 550 | 595 | 591 |
| 30 | 474 | 0.126 326 | 0.003 381 | 0.282 860 | 0.000 0152 | 0.282 830 | 0.282 910 | -0.9 | 3.18 | 12.48 | 594 | 657 | 653 |

注: 锆石Hf同位素的*ε*Hf值以及亏损地幔模式年龄计算公式如下(吴福元等, 2007）:*ε*Hf(0)=[(176Hf/177Hf)S/(176Hf/177Hf)CHUR.O-1]×10 000,*ε*Hf(*t*)={[(176Hf/177Hf)S-(176Lu/177Hf)S×(eλ*t*-1)]/[(176Hf/177Hf)CHUR.O-(176Lu/177Hf)CHUR×(eλ*t*-1)]-1}×10 000, *t*DM1=1/λ×ln{1+[(176Hf/177Hf)S-(176Hf/177Hf)DM]/[(176Lu/177Hf)S-(176Lu/177Hf)DM],*t*DMC=1/λ×ln{1+[(176Hf/177Hf)s,t-(176Hf/177Hf)DM,t]/[(176Lu/177Hf)c-(176Lu/177Hf)DM]+*t*, *t*DM2=*t*DM1-(*t*DM1-*t*)×[(*f*cc-*f*s)/(*f*cc-*f*DM)], *f*Lu/Hf=(176Lu/177Hf)S/(176Lu/177Hf)CHUR-1；其中, (176Lu/177Hf)S和(176Hf/177Hf)S为样品测定值, (176Lu/177Hf)CHUR=0.033 2, (176Hf/177Hf)CHUR.O=0.282 772 (Bouvier *et al.*, 2008); (176Hf/177Hf)DM=0.283 25和(176Lu/177Hf)DM=0.038 4(Griffin *et al.*, 2000),(176Lu/177Hf)c=0.015, *f*cc、*f*s、*f*DM分别为大陆平均地壳、测试样品和亏损地幔的*f*Lu/Hf, *f*cc=-0.55, *f*DM=0.16, *t*为锆石表面206Pb/238U年龄, λ=1.867×10-11 a-1.

附表2 白银岩群流纹岩与玄武岩的主量元素(%)、微量和稀土元素(10-6)

Table2 Geochemical compositions of major (%), trace elements and rare earth elements (10-6) for rhyolite and basalt from Baiyin Group

| 样品号 | 20EDW01-流纹岩 | | | | | | | |  | 20EDW04-玄武岩 | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 岩性 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |  | 1 | 2 | 3 | 4 | 5 | 6 |
| SiO2 | 77.68 | 80.91 | 79.59 | 80.56 | 78.91 | 77.82 | 78.89 | 80.15 |  | 51.04 | 51.63 | 51.27 | 51.24 | 51.58 | 51.68 |
| Al2O3 | 11.15 | 9.49 | 10.26 | 9.92 | 10.92 | 11.10 | 10.39 | 10.09 |  | 18.15 | 18.59 | 17.97 | 18.87 | 18.52 | 18.27 |
| Fe2O3 | 0.68 | 0.61 | 0.58 | 0.53 | 0.56 | 0.74 | 0.89 | 0.81 |  | 4.13 | 3.88 | 4.20 | 4.18 | 4.30 | 4.02 |
| FeO | 0.80 | 0.78 | 0.65 | 0.82 | 0.80 | 0.62 | 0.78 | 0.55 |  | 5.00 | 5.05 | 4.65 | 4.45 | 4.79 | 4.82 |
| CaO | 1.90 | 1.63 | 1.66 | 1.36 | 1.31 | 2.06 | 1.92 | 1.56 |  | 8.47 | 8.30 | 8.80 | 9.16 | 9.58 | 8.84 |
| MgO | 0.52 | 0.49 | 0.48 | 0.53 | 0.53 | 0.46 | 0.63 | 0.50 |  | 4.39 | 4.43 | 4.26 | 3.90 | 3.86 | 4.09 |
| K2O | 0.18 | 0.09 | 0.16 | 0.07 | 0.13 | 0.19 | 0.27 | 0.18 |  | 0.44 | 0.18 | 0.76 | 0.14 | 0.14 | 0.32 |
| Na2O | 5.26 | 4.52 | 4.99 | 4.88 | 5.44 | 5.22 | 4.35 | 4.70 |  | 2.98 | 3.44 | 2.77 | 3.69 | 2.88 | 3.14 |
| TiO2 | 0.22 | 0.18 | 0.19 | 0.20 | 0.19 | 0.20 | 0.20 | 0.20 |  | 1.12 | 1.13 | 1.12 | 1.12 | 1.20 | 1.11 |
| P2O5 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |  | 0.16 | 0.22 | 0.20 | 0.19 | 0.22 | 0.16 |
| MnO | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | 0.05 |  | 0.14 | 0.14 | 0.16 | 0.13 | 0.14 | 0.14 |
| LOI | 1.38 | 1.03 | 1.23 | 0.88 | 0.99 | 1.34 | 1.39 | 1.00 |  | 3.86 | 2.91 | 3.73 | 2.85 | 2.71 | 3.32 |
| Na2O/K2O | 29.22 | 50.22 | 31.19 | 69.71 | 41.85 | 27.47 | 16.11 | 26.11 |  | 6.77 | 19.11 | 3.64 | 26.36 | 20.57 | 9.81 |
| FeOT | 1.41 | 1.33 | 1.17 | 1.30 | 1.30 | 1.29 | 1.58 | 1.28 |  | 8.72 | 8.54 | 8.43 | 8.21 | 8.66 | 8.44 |
| Mg＃ | 39.87 | 39.89 | 42.44 | 42.38 | 42.25 | 39.17 | 41.77 | 41.31 |  | 47.55 | 48.28 | 47.64 | 46.09 | 44.52 | 46.60 |
| AR | 2.43 | 2.42 | 2.52 | 2.56 | 2.67 | 2.40 | 2.20 | 2.44 |  | 1.29 | 1.31 | 1.30 | 1.32 | 1.24 | 1.29 |
| SI | 6.99 | 7.55 | 7.00 | 7.76 | 7.10 | 6.36 | 9.10 | 7.42 |  | 25.91 | 26.09 | 25.60 | 23.84 | 24.17 | 24.95 |
| A/CNK | 0.91 | 0.90 | 0.90 | 0.94 | 0.95 | 0.89 | 0.95 | 0.94 |  | 0.87 | 0.89 | 0.84 | 0.82 | 0.83 | 0.85 |
| A/NK | 1.26 | 1.26 | 1.22 | 1.22 | 1.20 | 1.26 | 1.39 | 1.27 |  | 3.37 | 3.18 | 3.34 | 3.03 | 3.79 | 3.31 |
| Cu | 25.60 | 38.10 | 20.90 | 29.00 | 27.80 | 20.50 | 38.40 | 65.90 |  | 44.00 | 47.60 | 30.00 | 42.80 | 48.20 | 35.50 |
| Pb | 7.23 | 6.51 | 6.42 | 6.77 | 7.50 | 6.98 | 7.76 | 7.39 |  | 20.40 | 19.10 | 15.80 | 28.10 | 21.60 | 24.70 |
| Zn | 43.50 | 37.50 | 39.20 | 43.20 | 46.10 | 39.10 | 46.30 | 42.00 |  | 70.30 | 73.50 | 76.40 | 71.50 | 83.00 | 74.30 |
| Cr | 24.10 | 6.86 | 5.47 | 7.80 | 14.30 | 6.71 | 9.30 | 6.45 |  | 16.80 | 16.30 | 14.50 | 18.80 | 18.90 | 16.50 |
| Ni | 11.80 | 5.15 | 4.68 | 7.04 | 8.26 | 4.90 | 6.29 | 5.77 |  | 9.09 | 8.95 | 8.03 | 8.86 | 8.57 | 8.41 |
| Co | 4.22 | 1.89 | 1.67 | 1.87 | 2.34 | 1.68 | 2.48 | 2.07 |  | 22.30 | 22.40 | 20.50 | 20.20 | 23.20 | 21.70 |
| Li | 5.54 | 3.21 | 4.14 | 3.92 | 3.96 | 3.50 | 4.72 | 3.73 |  | 15.40 | 13.00 | 13.70 | 11.90 | 12.40 | 13.50 |
| Rb | 5.26 | 2.02 | 3.64 | 1.92 | 3.01 | 4.36 | 6.62 | 5.52 |  | 14.50 | 5.33 | 17.30 | 3.74 | 3.39 | 7.11 |
| Cs | 0.30 | 0.12 | 0.19 | 0.11 | 0.17 | 0.25 | 0.31 | 0.23 |  | 0.89 | 0.43 | 0.91 | 0.95 | 0.76 | 0.64 |
| Sr | 173 | 139 | 132 | 137 | 142 | 163 | 202 | 162 |  | 430 | 388 | 423 | 474 | 449 | 433 |
| Ba | 31 | 34 | 24 | 130 | 30 | 26 | 38 | 30 |  | 169 | 98 | 315 | 117 | 72 | 186 |
| V | 31.7 | 15.6 | 14.7 | 14.8 | 16.5 | 18.1 | 21.8 | 15.4 |  | 274.0 | 285.0 | 269.0 | 284.0 | 302.0 | 291.0 |
| Sc | 10.10 | 5.74 | 6.06 | 6.77 | 5.39 | 5.85 | 5.64 | 5.44 |  | 29.60 | 29.60 | 28.30 | 29.60 | 31.50 | 30.70 |
| Nb | 3.63 | 2.60 | 2.85 | 2.78 | 3.17 | 3.13 | 3.26 | 3.14 |  | 6.15 | 5.85 | 5.82 | 6.03 | 5.98 | 6.26 |
| Ta | 0.32 | 0.20 | 0.23 | 0.20 | 0.23 | 0.24 | 0.24 | 0.23 |  | 0.56 | 0.49 | 0.49 | 0.50 | 0.51 | 0.53 |
| Zr | 109 | 70 | 82 | 77 | 94 | 90 | 88 | 80 |  | 99 | 94 | 92 | 94 | 95 | 98 |
| Hf | 3.14 | 1.97 | 2.30 | 2.02 | 2.45 | 2.39 | 2.33 | 2.22 |  | 3.14 | 2.84 | 2.83 | 2.95 | 2.92 | 3.12 |
| Be | 0.58 | 0.40 | 0.48 | 0.40 | 0.45 | 0.46 | 0.55 | 0.54 |  | 1.28 | 1.09 | 1.21 | 1.25 | 1.18 | 1.18 |
| Ga | 11.00 | 7.75 | 8.78 | 8.56 | 9.56 | 10.30 | 11.20 | 9.38 |  | 17.30 | 18.00 | 17.50 | 18.80 | 19.40 | 18.50 |
| U | 1.66 | 1.27 | 1.22 | 1.40 | 1.46 | 1.38 | 1.35 | 1.37 |  | 2.75 | 1.93 | 2.07 | 2.04 | 2.32 | 2.38 |
| Th | 4.41 | 3.33 | 3.69 | 3.34 | 3.78 | 3.73 | 3.95 | 4.01 |  | 5.28 | 4.55 | 4.38 | 4.92 | 4.78 | 4.99 |
| La | 6.14 | 5.99 | 5.58 | 6.61 | 6.44 | 6.31 | 6.95 | 7.46 |  | 12.60 | 12.00 | 11.80 | 12.40 | 12.70 | 12.40 |
| Ce | 12.84 | 12.44 | 11.92 | 13.64 | 13.73 | 13.26 | 14.13 | 17.10 |  | 28.20 | 28.00 | 27.30 | 27.60 | 28.60 | 28.50 |
| Pr | 1.64 | 1.62 | 1.36 | 1.62 | 1.67 | 1.63 | 1.86 | 2.18 |  | 3.64 | 3.56 | 3.36 | 3.52 | 3.67 | 3.66 |
| Nd | 5.91 | 6.40 | 5.32 | 6.32 | 6.00 | 6.00 | 6.92 | 8.10 |  | 14.70 | 15.00 | 14.40 | 15.50 | 16.00 | 15.10 |
| Sm | 1.35 | 1.30 | 1.22 | 1.43 | 1.34 | 1.38 | 1.41 | 1.58 |  | 3.76 | 3.94 | 3.76 | 3.85 | 4.12 | 3.87 |
| Eu | 0.42 | 0.38 | 0.33 | 0.41 | 0.37 | 0.38 | 0.39 | 0.40 |  | 1.09 | 1.17 | 1.19 | 1.17 | 1.23 | 1.17 |
| Gd | 1.40 | 1.46 | 1.22 | 1.47 | 1.36 | 1.45 | 1.45 | 1.58 |  | 4.09 | 4.18 | 4.37 | 4.29 | 4.64 | 4.21 |
| Tb | 0.26 | 0.25 | 0.24 | 0.25 | 0.26 | 0.26 | 0.28 | 0.30 |  | 0.71 | 0.68 | 0.72 | 0.72 | 0.78 | 0.72 |
| Dy | 2.00 | 1.69 | 1.60 | 1.71 | 1.75 | 1.71 | 1.94 | 1.96 |  | 4.33 | 4.34 | 4.42 | 4.63 | 4.92 | 4.66 |
| Ho | 0.47 | 0.38 | 0.37 | 0.36 | 0.40 | 0.39 | 0.44 | 0.42 |  | 0.91 | 0.92 | 1.00 | 1.00 | 1.02 | 0.96 |
| Er | 1.46 | 1.09 | 1.12 | 1.03 | 1.25 | 1.29 | 1.38 | 1.33 |  | 2.64 | 2.60 | 2.96 | 2.80 | 2.92 | 2.83 |
| Tm | 0.27 | 0.17 | 0.20 | 0.16 | 0.21 | 0.21 | 0.23 | 0.22 |  | 0.43 | 0.41 | 0.43 | 0.43 | 0.46 | 0.44 |
| Yb | 1.95 | 1.11 | 1.39 | 1.05 | 1.46 | 1.53 | 1.59 | 1.43 |  | 2.94 | 2.68 | 2.85 | 2.90 | 2.96 | 2.96 |
| Lu | 0.33 | 0.19 | 0.24 | 0.16 | 0.25 | 0.25 | 0.24 | 0.22 |  | 0.42 | 0.42 | 0.41 | 0.43 | 0.44 | 0.43 |
| Y | 14.58 | 11.01 | 11.21 | 11.62 | 12.90 | 12.77 | 13.96 | 13.47 |  | 23.00 | 24.80 | 25.30 | 24.00 | 26.00 | 24.50 |
| ΣREE | 36.4 | 34.5 | 32.1 | 36.2 | 36.5 | 36.0 | 39.2 | 44.3 |  | 80.5 | 79.9 | 79.0 | 81.2 | 84.5 | 81.9 |
| LREE/HREE | 3.48 | 4.44 | 4.04 | 4.86 | 4.26 | 4.08 | 4.19 | 4.94 |  | 3.89 | 3.92 | 3.60 | 3.72 | 3.66 | 3.76 |
| LaN/YbN | 2.26 | 3.86 | 2.89 | 4.53 | 3.16 | 2.96 | 3.13 | 3.76 |  | 3.07 | 3.21 | 2.97 | 3.07 | 3.08 | 3.00 |
| *δ*Eu | 0.93 | 0.84 | 0.82 | 0.87 | 0.83 | 0.82 | 0.83 | 0.77 |  | 0.85 | 0.88 | 0.90 | 0.88 | 0.86 | 0.89 |
| *δ*Ce | 0.99 | 0.98 | 1.06 | 1.02 | 1.03 | 1.01 | 0.96 | 1.04 |  | 1.02 | 1.05 | 1.06 | 1.02 | 1.03 | 1.04 |

注:FeOT=FeO+0.899 8×Fe2O3; Mg#(摩尔比)=100×(MgO)/(MgO+FeOT); AR=(Al2O3+CaO+Na2O+K2O)/(Al2O3+CaO-(Na2O+K2O)); SI=100×MgO/(MgO+FeO+Fe2O3+Na2O+K2O); A/CNK(摩尔比)=Al2O3/(CaO+Na2O+K2O); A/NK(摩尔比)=Al2O3/(Na2O+K2O); ΣREE=LREE+HREE+Y; *δ*Eu=EuN/[(SmN×GdN)1/2]; *δ*Ce=CeN/[(LaN×PrN)1/2]; LaN/YbN: N表示标准化,标准化数据参考Sun and McDonough (1989).