Geological Magazine

*In situ* U–Th–Pb (total) dating of polychronous monazite in the Koraput anorthosite pluton, Eastern Ghats Granulite Belt (India), and implications

D. SAIKIA, P. NASIPURI & A. BHATTACHARYA

|  |
| --- |
| Supplementary Table S1 |
| Group I |
| Grain (a) | Grain (b) | Grain (c) |
|  | core | core | core | rim | rim | rim | rim | rim | rim |  | rim | rim | rim | rim |  | core | rim | rim | rim | rim | rim | rim |
| P2O5 | 28.07 | 28.20 | 28.14 | 28.06 | 27.99 | 28.09 | 29.39 | 28.00 | 28.13 | P2O5 | 21.35 | 25.26 | 29.09 | 22.07 | P2O5 | 29.03 | 24.03 | 26.99 | 25.84 | 25.93 | 27.68 | 24.83 |
| SiO2 | 1.77 | 1.71 | 1.67 | 1.79 | 1.76 | 1.75 | 0.94 | 1.68 | 1.68 | SiO2 | 5.37 | 2.92 | 1.07 | 4.95 | SiO2 | 0.70 | 4.10 | 2.38 | 2.34 | 2.20 | 2.08 | 3.21 |
| ThO2 | 10.08 | 9.80 | 10.48 | 10.01 | 10.54 | 10.42 | 10.18 | 10.01 | 9.99 | ThO2 | 29.22 | 15.48 | 6.11 | 26.99 | ThO2 | 9.56 | 21.48 | 12.83 | 12.46 | 11.86 | 12.51 | 16.83 |
| UO2 | 0.14 | 0.13 | 0.10 | 0.10 | 0.11 | 0.12 | 0.13 | 0.11 | 0.12 | UO2 | 0.12 | 0.15 | 0.08 | 0.15 | UO2 | 0.19 | 0.13 | 0.09 | 0.11 | 0.11 | 0.09 | 0.14 |
| Al2O3 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.02 | Al2O3 | 0.09 | 0.06 | 0.01 | 0.09 | Al2O3 | 0.03 | 0.07 | 0.05 | 0.05 | 0.03 | 0.05 | 0.07 |
| Y2O3 | 0.25 | 0.27 | 0.09 | 0.15 | 0.11 | 0.12 | 0.23 | 0.19 | 0.17 | Y2O3 | 0.09 | 0.21 | 0.14 | 0.08 | Y2O3 | 0.39 | 0.09 | 0.10 | 0.19 | 0.20 | 0.12 | 0.12 |
| La2O3 | 14.58 | 14.56 | 14.51 | 14.72 | 14.48 | 14.54 | 13.96 | 14.31 | 14.13 | La2O3 | 10.39 | 11.53 | 14.58 | 10.97 | La2O3 | 13.83 | 10.88 | 14.86 | 13.55 | 13.69 | 15.04 | 12.22 |
| Ce2O3 | 28.26 | 28.26 | 28.26 | 28.48 | 28.18 | 28.19 | 26.93 | 27.36 | 26.79 | Ce2O3 | 20.05 | 25.76 | 30.83 | 21.23 | Ce2O3 | 27.31 | 23.09 | 27.73 | 26.84 | 27.20 | 27.98 | 25.27 |
| Pr2O3 | 2.87 | 2.89 | 2.85 | 2.92 | 2.95 | 2.84 | 2.82 | 2.96 | 2.92 | Pr2O3 | 2.11 | 2.82 | 3.22 | 2.23 | Pr2O3 | 2.81 | 2.52 | 2.71 | 2.90 | 2.82 | 2.65 | 2.73 |
| Nd2O3 | 10.04 | 10.01 | 10.03 | 10.24 | 9.95 | 10.19 | 10.06 | 10.13 | 10.32 | Nd2O3 | 7.10 | 10.99 | 12.01 | 7.60 | Nd2O3 | 10.41 | 9.32 | 9.20 | 10.10 | 10.27 | 9.28 | 10.08 |
| Gd2O3 | 0.82 | 0.83 | 0.64 | 0.71 | 0.60 | 0.60 | 0.76 | 0.75 | 0.77 | Gd2O3 | 0.32 | 0.66 | 0.60 | 0.42 | Gd2O3 | 0.84 | 0.50 | 0.48 | 0.69 | 0.60 | 0.50 | 0.62 |
| Dy2O3 | 0.13 | 0.11 | 0.08 | 0.08 | 0.10 | 0.08 | 0.13 | 0.06 | 0.11 | Dy2O3 | 0.08 | 0.13 | 0.08 | 0.10 | Dy2O3 | 0.14 | 0.08 | 0.08 | 0.08 | 0.11 | 0.09 | 0.09 |
| Sm2O3 | 1.61 | 1.62 | 1.40 | 1.42 | 1.40 | 1.41 | 1.54 | 1.50 | 1.51 | Sm2O3 | 0.89 | 1.58 | 1.59 | 0.93 | Sm2O3 | 1.78 | 1.19 | 1.13 | 1.40 | 1.47 | 1.15 | 1.32 |
| Eu2O3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | Eu2O3 | 0.00 | 0.20 | 0.12 | 0.00 | Eu2O3 | 0.01 | 0.07 | 0.00 | 0.02 | 0.04 | 0.00 | 0.02 |
| CaO | 0.72 | 0.75 | 0.94 | 0.71 | 0.91 | 0.87 | 1.55 | 0.81 | 0.77 | CaO | 1.53 | 0.90 | 0.48 | 1.35 | CaO | 1.74 | 1.26 | 0.95 | 0.91 | 0.89 | 0.89 | 1.00 |
| PbO | 0.40 | 0.39 | 0.42 | 0.33 | 0.43 | 0.43 | 0.44 | 0.39 | 0.40 | PbO | 1.18 | 0.51 | 0.20 | 1.04 | PbO | 0.41 | 0.88 | 0.42 | 0.48 | 0.47 | 0.42 | 0.62 |
| Total | 99.70 | 99.51 | 99.57 | 99.66 | 99.49 | 99.62 | 99.02 | 98.24 | 97.75 | Total | 99.90 | 99.08 | 100.11 | 100.23 | Total | 99.08 | 99.66 | 99.94 | 97.89 | 97.81 | 100.47 | 99.11 |
| Age (Ma) | 888 | 896 | 899 | 745 | 924 | 931 | 966 | 873 | 887 | Age (Ma) | 929 | 742 | 721 | 885 | Age (Ma) | 930 | 934 | 743 | 871 | 886 | 764 | 842 |
| Age err | 35 | 36 | 35 | 33 | 35 | 35 | 36 | 35 | 36 | Age err | 18 | 24 | 50 | 18 | Age err | 37 | 21 | 27 | 30 | 31 | 28 | 24 |
| Error % | 3.941 | 4.018 | 3.893 | 4.430 | 3.788 | 3.759 | 3.727 | 4.009 | 4.059 | Error % | 1.938 | 3.235 | 6.935 | 2.034 | Error % | 3.978 | 2.248 | 3.634 | 3.444 | 3.499 | 3.665 | 2.85 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Cations |  |  |  |  |  |  |  |  |  | Cations |  |  |  |  | Cations |  |  |  |  |  |  |  |
| P | 0.948 | 0.952 | 0.950 | 0.947 | 0.947 | 0.948 | 0.983 | 0.955 | 0.960 | P | 0.771 | 0.884 | 0.972 | 0.790 | P | 0.978 | 0.843 | 0.918 | 0.907 | 0.910 | 0.933 | 0.871 |
| Si | 0.071 | 0.068 | 0.067 | 0.071 | 0.070 | 0.070 | 0.037 | 0.068 | 0.068 | Si | 0.229 | 0.121 | 0.042 | 0.209 | Si | 0.028 | 0.170 | 0.095 | 0.097 | 0.091 | 0.083 | 0.133 |
| Th | 0.091 | 0.089 | 0.095 | 0.091 | 0.096 | 0.095 | 0.092 | 0.092 | 0.092 | Th | 0.284 | 0.146 | 0.055 | 0.260 | Th | 0.087 | 0.203 | 0.117 | 0.117 | 0.112 | 0.113 | 0.159 |
| U | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | U | 0.001 | 0.001 | 0.001 | 0.001 | U | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Al | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.001 | 0.001 | 0.002 | 0.001 | Al | 0.005 | 0.003 | 0.001 | 0.004 | Al | 0.002 | 0.004 | 0.002 | 0.002 | 0.002 | 0.002 | 0.004 |
| Y | 0.005 | 0.006 | 0.002 | 0.003 | 0.002 | 0.003 | 0.005 | 0.004 | 0.004 | Y | 0.002 | 0.005 | 0.003 | 0.002 | Y | 0.008 | 0.002 | 0.002 | 0.004 | 0.004 | 0.003 | 0.003 |
| La | 0.214 | 0.214 | 0.214 | 0.216 | 0.213 | 0.214 | 0.204 | 0.213 | 0.210 | La | 0.164 | 0.176 | 0.212 | 0.171 | La | 0.203 | 0.166 | 0.220 | 0.207 | 0.209 | 0.221 | 0.187 |
| Ce | 0.413 | 0.412 | 0.413 | 0.416 | 0.412 | 0.412 | 0.390 | 0.403 | 0.395 | Ce | 0.313 | 0.39 | 0.445 | 0.329 | Ce | 0.398 | 0.350 | 0.408 | 0.407 | 0.413 | 0.408 | 0.383 |
| Pr | 0.042 | 0.042 | 0.041 | 0.042 | 0.043 | 0.041 | 0.041 | 0.043 | 0.043 | Pr | 0.033 | 0.042 | 0.046 | 0.034 | Pr | 0.041 | 0.038 | 0.040 | 0.044 | 0.043 | 0.038 | 0.041 |
| Nd | 0.143 | 0.143 | 0.143 | 0.146 | 0.142 | 0.145 | 0.142 | 0.146 | 0.149 | Nd | 0.108 | 0.162 | 0.169 | 0.115 | Nd | 0.148 | 0.138 | 0.132 | 0.149 | 0.152 | 0.132 | 0.149 |
| Gd | 0.011 | 0.011 | 0.008 | 0.009 | 0.008 | 0.008 | 0.010 | 0.010 | 0.010 | Gd | 0.004 | 0.009 | 0.008 | 0.006 | Gd | 0.011 | 0.007 | 0.006 | 0.009 | 0.008 | 0.007 | 0.009 |
| Dy | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | Dy | 0.001 | 0.002 | 0.001 | 0.001 | Dy | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Sm | 0.022 | 0.022 | 0.019 | 0.019 | 0.019 | 0.019 | 0.021 | 0.021 | 0.021 | Sm | 0.013 | 0.023 | 0.022 | 0.014 | Sm | 0.024 | 0.017 | 0.016 | 0.020 | 0.021 | 0.016 | 0.019 |
| Eu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Eu | 0 | 0.003 | 0.002 | 0 | Eu | 0 | 0.001 | 0 | 0 | 0.001 | 0 | 0 |
| Ca | 0.031 | 0.032 | 0.040 | 0.030 | 0.039 | 0.037 | 0.065 | 0.035 | 0.033 | Ca | 0.07 | 0.040 | 0.020 | 0.061 | Ca | 0.074 | 0.056 | 0.041 | 0.040 | 0.040 | 0.038 | 0.044 |
| Pb | 0.004 | 0.004 | 0.004 | 0.004 | 0.005 | 0.005 | 0.005 | 0.004 | 0.004 | Pb | 0.014 | 0.006 | 0.002 | 0.012 | Pb | 0.004 | 0.010 | 0.005 | 0.005 | 0.005 | 0.004 | 0.007 |
| Total | 2.000 | 1.999 | 2.000 | 1.999 | 2.001 | 2.000 | 1.998 | 1.997 | 1.993 | Total | 2.014 | 2.011 | 2.001 | 2.012 | Total | 2.01 | 2.008 | 2.004 | 2.013 | 2.014 | 1.999 | 2.011 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| X Hutt. | 0.068 | 0.064 | 0.062 | 0.066 | 0.064 | 0.065 | 0.033 | 0.064 | 0.066 | X Hutt. | 0.227 | 0.112 | 0.038 | 0.210 | X Hutt. | 0.018 | 0.159 | 0.083 | 0.083 | 0.078 | 0.082 | 0.122 |
| X Cher. | 0.063 | 0.066 | 0.081 | 0.062 | 0.079 | 0.075 | 0.134 | 0.072 | 0.069 | X Cher. | 0.139 | 0.079 | 0.041 | 0.122 | X Cher. | 0.148 | 0.113 | 0.083 | 0.080 | 0.079 | 0.077 | 0.088 |
| X Mon. | 0.87 | 0.871 | 0.857 | 0.872 | 0.857 | 0.860 | 0.833 | 0.864 | 0.865 | X Mon. | 0.634 | 0.808 | 0.921 | 0.668 | X Mon. | 0.834 | 0.728 | 0.835 | 0.837 | 0.844 | 0.841 | 0.790 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| Group II |
| Grain (d)  | Grain (e) |
|  | core | core | core | rim | rim | rim |  | core | core | core | rim | rim | rim | rim |
| P2O5 | 24.09 | 26.75 | 23.55 | 27.24 | 28.90 | 28.94 | P2O5 | 22.45 | 22.54 | 28.74 | 23.67 | 25.04 | 23.41 | 23.69 |
| SiO2 | 4.01 | 2.45 | 4.37 | 2.09 | 1.11 | 1.03 | SiO2 | 4.61 | 4.67 | 0.91 | 3.45 | 3.01 | 3.89 | 3.50 |
| ThO2 | 23.70 | 13.90 | 25.63 | 11.67 | 5.82 | 5.33 | ThO2 | 23.60 | 24.25 | 9.89 | 16.97 | 15.79 | 19.36 | 17.65 |
| UO2 | 0.10 | 0.13 | 0.11 | 0.10 | 0.08 | 0.08 | UO2 | 0.13 | 0.13 | 0.18 | 0.09 | 0.09 | 0.12 | 0.12 |
| Al2O3 | 0.09 | 0.06 | 0.09 | 0.03 | 0.03 | 0.01 | Al2O3 | 0.07 | 0.09 | 0.04 | 0.06 | 0.05 | 0.07 | 0.06 |
| Y2O3 | 0.12 | 0.07 | 0.11 | 0.14 | 0.14 | 0.19 | Y2O3 | 0.07 | 0.07 | 0.39 | 0.14 | 0.15 | 0.11 | 0.13 |
| La2O3 | 11.52 | 13.99 | 10.82 | 13.99 | 15.31 | 12.87 | La2O3 | 10.43 | 10.24 | 13.60 | 13.08 | 13.92 | 11.36 | 12.88 |
| Ce2O3 | 21.96 | 26.89 | 21.16 | 27.86 | 30.34 | 30.29 | Ce2O3 | 22.02 | 21.85 | 27.44 | 25.32 | 26.24 | 23.80 | 25.30 |
| Pr2O3 | 2.23 | 2.64 | 2.20 | 2.85 | 3.07 | 3.42 | Pr2O3 | 2.42 | 2.46 | 2.84 | 2.55 | 2.60 | 2.62 | 2.55 |
| Nd2O3 | 8.31 | 10.16 | 8.13 | 11.07 | 12.16 | 14.01 | Nd2O3 | 8.92 | 9.01 | 10.27 | 9.02 | 9.00 | 9.46 | 9.06 |
| Gd2O3 | 0.35 | 0.39 | 0.48 | 0.52 | 0.65 | 0.75 | Gd2O3 | 0.54 | 0.44 | 0.95 | 0.41 | 0.40 | 0.48 | 0.51 |
| Dy2O3 | 0.06 | 0.03 | 0.07 | 0.06 | 0.08 | 0.12 | Dy2O3 | 0.08 | 0.09 | 0.14 | 0.09 | 0.08 | 0.09 | 0.10 |
| Sm2O3 | 0.84 | 1.04 | 0.82 | 1.21 | 1.35 | 1.73 | Sm2O3 | 1.17 | 1.10 | 1.70 | 1.07 | 1.04 | 1.28 | 1.14 |
| Eu2O3 | 0.04 | 0.09 | 0.01 | 0.04 | 0.14 | 0.25 | Eu2O3 | 0.06 | 0.11 | 0.03 | 0.05 | 0.00 | 0.07 | 0.05 |
| CaO | 1.70 | 0.98 | 1.75 | 0.82 | 0.52 | 0.48 | CaO | 1.31 | 1.37 | 1.65 | 0.95 | 0.94 | 1.17 | 1.00 |
| PbO | 0.88 | 0.57 | 1.06 | 0.37 | 0.20 | 0.21 | PbO | 0.96 | 0.98 | 0.43 | 0.53 | 0.51 | 0.76 | 0.56 |
| Total | 99.96 | 100.07 | 100.30 | 100.00 | 99.83 | 99.62 | Total | 98.77 | 99.35 | 99.13 | 97.38 | 98.80 | 97.98 | 98.23 |
| Age (Ma) | 855.00 | 932.00 | 947.00 | 726.00 | 750.00 | 867.00 | Age (Ma) | 929 | 922 | 952 | 716 | 739 | 896 | 730 |
| 2σ err | 26.00 | 35.00 | 27.00 | 34.00 | 56.00 | 63.00 | Age err | 20 | 20 | 37 | 22 | 23 | 22 | 21 |
| Error% | 3.04 | 3.76 | 2.85 | 4.68 | 7.47 | 7.27 | Error% | 2.153 | 2.169 | 3.887 | 3.073 | 3.112 | 2.455 | 2.877 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Cations |  |  |  |  |  |  | Cations |  |  |  |  |  |  |  |
| P | 0.827 | 0.892 | 0.811 | 0.904 | 0.943 | 0.944 | P | 0.808 | 0.807 | 0.971 | 0.851 | 0.878 | 0.839 | 0.848 |
| Si | 0.162 | 0.097 | 0.178 | 0.082 | 0.043 | 0.040 | Si | 0.196 | 0.198 | 0.036 | 0.146 | 0.125 | 0.165 | 0.148 |
| Th | 0.219 | 0.125 | 0.237 | 0.104 | 0.051 | 0.047 | Th | 0.228 | 0.233 | 0.09 | 0.164 | 0.149 | 0.187 | 0.170 |
| U | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | U | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 |
| Al | 0.004 | 0.003 | 0.004 | 0.002 | 0.001 | 0.001 | Al | 0.004 | 0.004 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 |
| Y | 0.003 | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 | Y | 0.002 | 0.002 | 0.008 | 0.003 | 0.003 | 0.003 | 0.003 |
| La | 0.172 | 0.203 | 0.162 | 0.202 | 0.218 | 0.183 | La | 0.164 | 0.160 | 0.200 | 0.205 | 0.213 | 0.177 | 0.201 |
| Ce | 0.326 | 0.388 | 0.315 | 0.400 | 0.428 | 0.427 | Ce | 0.343 | 0.338 | 0.401 | 0.394 | 0.398 | 0.369 | 0.392 |
| Pr | 0.081 | 0.093 | 0.080 | 0.100 | 0.106 | 0.118 | Pr | 0.038 | 0.038 | 0.041 | 0.039 | 0.039 | 0.04 | 0.039 |
| Nd | 0.120 | 0.143 | 0.118 | 0.155 | 0.167 | 0.193 | Nd | 0.135 | 0.136 | 0.146 | 0.137 | 0.133 | 0.143 | 0.137 |
| Gd | 0.005 | 0.005 | 0.006 | 0.007 | 0.008 | 0.010 | Gd | 0.008 | 0.006 | 0.013 | 0.006 | 0.006 | 0.007 | 0.007 |
| Dy | 0.001 | 0.000 | 0.001 | 0.001 | 0.001 | 0.002 | Dy | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 |
| Sm | 0.012 | 0.014 | 0.011 | 0.016 | 0.018 | 0.023 | Sm | 0.017 | 0.016 | 0.023 | 0.016 | 0.015 | 0.019 | 0.017 |
| Eu | 0.001 | 0.001 | 0.000 | 0.001 | 0.002 | 0.003 | Eu | 0.001 | 0.002 | 0.000 | 0.001 | 0.000 | 0.001 | 0.001 |
| Ca | 0.074 | 0.041 | 0.076 | 0.034 | 0.021 | 0.020 | Ca | 0.059 | 0.062 | 0.071 | 0.043 | 0.042 | 0.053 | 0.045 |
| Pb | 0.01 | 0.006 | 0.012 | 0.004 | 0.002 | 0.002 | Pb | 0.011 | 0.011 | 0.005 | 0.006 | 0.006 | 0.009 | 0.006 |
| Total | 2.016 | 2.014 | 2.016 | 2.015 | 2.014 | 2.016 | Total | 2.015 | 2.015 | 2.010 | 2.017 | 2.010 | 2.017 | 2.018 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| X Hutt. | 0.152 | 0.089 | 0.170 | 0.073 | 0.031 | 0.029 | X Hutt. | 0.18 | 0.183 | 0.025 | 0.126 | 0.113 | 0.142 | 0.129 |
| X Cher. | 0.144 | 0.081 | 0.149 | 0.067 | 0.042 | 0.038 | X Cher. | 0.118 | 0.123 | 0.141 | 0.085 | 0.083 | 0.105 | 0.089 |
| X Mon. | 0.704 | 0.831 | 0.681 | 0.861 | 0.927 | 0.933 | X Mon. | 0.702 | 0.694 | 0.834 | 0.789 | 0.804 | 0.753 | 0.782 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| Group III |
| Grain (f)  | Grain (g) |
|  | core | core | core | rim | rim | rim | rim | rim | rim | rim | rim | rim | rim |  | core | core | rim | rim | rim | rim | rim | rim | rim |
| P2O5 | 28.82 | 29.39 | 27.10 | 28.63 | 28.61 | 27.65 | 27.97 | 29.06 | 26.81 | 29.11 | 28.54 | 28.90 | 27.45 | P2O5 | 27.59 | 28.55 | 27.09 | 27.78 | 27.29 | 28.65 | 27.62 | 27.08 | 26.89 |
| SiO2 | 1.28 | 0.98 | 1.79 | 0.87 | 0.90 | 1.79 | 1.78 | 0.95 | 2.33 | 1.11 | 1.51 | 1.17 | 1.75 | SiO2 | 1.48 | 0.89 | 1.73 | 1.67 | 2.01 | 1.20 | 1.70 | 1.99 | 1.97 |
| ThO2 | 7.53 | 9.35 | 10.30 | 4.32 | 5.47 | 9.66 | 11.29 | 9.49 | 13.39 | 9.92 | 8.69 | 7.05 | 10.87 | ThO2 | 10.91 | 9.52 | 10.22 | 9.98 | 11.64 | 10.49 | 9.71 | 12.29 | 11.05 |
| UO2 | 0.09 | 0.09 | 0.14 | 0.07 | 0.08 | 0.09 | 0.10 | 0.10 | 0.09 | 0.10 | 0.12 | 0.07 | 0.11 | UO2 | 0.12 | 0.12 | 0.12 | 0.11 | 0.13 | 0.12 | 0.12 | 0.12 | 0.10 |
| Al2O3 | 0.03 | 0.03 | 0.03 | 0.02 | 0.01 | 0.04 | 0.05 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 | 0.03 | Al2O3 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.04 |
| Y2O3 | 0.08 | 0.16 | 0.18 | 0.24 | 0.11 | 0.15 | 0.09 | 0.10 | 0.08 | 0.33 | 0.13 | 0.07 | 0.09 | Y2O3 | 0.09 | 0.22 | 0.21 | 0.19 | 0.08 | 0.30 | 0.21 | 0.06 | 0.16 |
| La2O3 | 15.29 | 13.68 | 13.80 | 13.05 | 15.30 | 14.60 | 14.20 | 13.90 | 14.18 | 14.22 | 14.60 | 14.83 | 13.90 | La2O3 | 14.29 | 14.58 | 14.50 | 14.14 | 13.83 | 14.03 | 14.36 | 13.59 | 13.58 |
| Ce2O3 | 28.82 | 27.11 | 27.25 | 30.65 | 30.99 | 28.85 | 28.08 | 28.27 | 27.35 | 26.83 | 28.77 | 28.98 | 27.36 | Ce2O3 | 27.83 | 27.96 | 28.16 | 26.98 | 26.57 | 26.01 | 26.84 | 25.63 | 26.10 |
| Pr2O3 | 2.99 | 2.99 | 2.96 | 3.63 | 3.15 | 2.94 | 2.89 | 3.01 | 2.77 | 2.94 | 3.08 | 3.23 | 2.88 | Pr2O3 | 2.90 | 2.82 | 2.91 | 2.89 | 2.89 | 2.80 | 2.88 | 2.81 | 2.90 |
| Nd2O3 | 10.36 | 10.71 | 10.32 | 13.53 | 11.06 | 10.43 | 10.07 | 10.68 | 9.35 | 10.41 | 10.72 | 10.74 | 9.93 | Nd2O3 | 10.03 | 9.89 | 10.24 | 10.07 | 9.84 | 9.87 | 10.04 | 9.58 | 9.82 |
| Gd2O3 | 0.48 | 0.67 | 0.69 | 0.95 | 0.63 | 0.72 | 0.60 | 0.67 | 0.47 | 0.75 | 0.70 | 0.58 | 0.55 | Gd2O3 | 0.72 | 0.77 | 0.69 | 0.67 | 0.57 | 0.74 | 0.80 | 0.42 | 0.62 |
| Dy2O3 | 0.08 | 0.08 | 0.07 | 0.14 | 0.03 | 0.09 | 0.04 | 0.08 | 0.12 | 0.13 | 0.13 | 0.08 | 0.08 | Dy2O3 | 0.08 | 0.12 | 0.12 | 0.11 | 0.05 | 0.12 | 0.11 | 0.08 | 0.07 |
| Sm2O3 | 1.30 | 1.47 | 1.45 | 2.06 | 1.42 | 1.44 | 1.31 | 1.48 | 1.17 | 1.52 | 1.41 | 1.42 | 1.31 | Sm2O3 | 1.32 | 1.50 | 1.49 | 1.50 | 1.31 | 1.42 | 1.46 | 1.27 | 1.34 |
| Eu2O3 | 0.00 | 0.13 | 0.04 | 0.20 | 0.03 | 0.00 | 0.03 | 0.07 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | Eu2O3 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CaO | 0.67 | 1.34 | 0.81 | 0.37 | 0.55 | 0.66 | 0.97 | 1.40 | 0.97 | 1.38 | 0.70 | 0.65 | 0.93 | CaO | 1.18 | 1.44 | 0.84 | 0.85 | 0.96 | 1.40 | 0.75 | 1.02 | 0.80 |
| PbO | 0.31 | 0.40 | 0.33 | 0.17 | 0.23 | 0.32 | 0.43 | 0.40 | 0.54 | 0.43 | 0.31 | 0.28 | 0.41 | PbO | 0.45 | 0.41 | 0.41 | 0.40 | 0.47 | 0.44 | 0.37 | 0.49 | 0.36 |
| Total | 98.07 | 98.47 | 97.18 | 98.80 | 98.49 | 99.36 | 99.83 | 99.62 | 99.63 | 99.14 | 99.37 | 98.02 | 97.59 | Total | 99.00 | 98.75 | 98.69 | 97.97 | 97.29 | 97.63 | 97.54 | 96.96 | 96.41 |
| Age(Ma) | 931 | 966 | 714 | 878 | 946 | 746 | 857 | 953 | 919 | 961 | 783 | 893 | 842 | Age (Ma) | 919 | 969 | 897 | 884 | 894 | 897 | 931 | 863 | 894 |
| Age err | 46 | 39 | 32 | 71 | 59 | 34 | 32 | 38 | 29 | 37 | 38 | 47 | 33 | Age err | 34 | 38 | 35 | 31 | 36 | 32 | 35 | 36 | 31 |
| Error% | 4.94 | 4.04 | 4.48 | 8.09 | 6.24 | 4.56 | 3.73 | 3.99 | 3.16 | 3.85 | 4.85 | 5.26 | 3.92 | Error% | 3.70 | 3.92 | 3.90 | 3.51 | 4.03 | 3.57 | 3.76 | 4.17 | 3.47 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Cations |  |  |  |  |  |  |  |  |  |  |  |  | Cations |  |  |  |  |  |  |  |  |
| P | 0.975 | 0.986 | 0.942 | 0.973 | 0.973 | 0.941 | 0.944 | 0.974 | 0.918 | 0.975 | 0.960 | 0.978 | 0.95 | P | 0.945 | 0.970 | 0.934 | 0.955 | 0.94 | 0.974 | 0.954 | 0.94 | 0.943 |
| Si | 0.051 | 0.039 | 0.073 | 0.035 | 0.036 | 0.072 | 0.071 | 0.038 | 0.094 | 0.044 | 0.060 | 0.047 | 0.07 | Si | 0.060 | 0.036 | 0.070 | 0.068 | 0.08 | 0.048 | 0.069 | 0.08 | 0.082 |
| Th | 0.068 | 0.084 | 0.096 | 0.040 | 0.050 | 0.088 | 0.102 | 0.086 | 0.123 | 0.089 | 0.080 | 0.064 | 0.10 | Th | 0.100 | 0.087 | 0.095 | 0.092 | 0.11 | 0.096 | 0.09 | 0.12 | 0.104 |
| U | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.001 | 0.00 | U | 0.001 | 0.001 | 0.001 | 0.001 | 0.00 | 0.001 | 0.001 | 0.00 | 0.001 |
| Al | 0.001 | 0.001 | 0.002 | 0.001 | 0.000 | 0.002 | 0.002 | 0.001 | 0.002 | 0.001 | 0.000 | 0.001 | 0.00 | Al | 0.001 | 0.001 | 0.002 | 0.002 | 0.00 | 0.002 | 0.002 | 0.00 | 0.002 |
| Y | 0.002 | 0.003 | 0.004 | 0.005 | 0.002 | 0.003 | 0.002 | 0.002 | 0.002 | 0.007 | 0.000 | 0.001 | 0.00 | Y | 0.002 | 0.005 | 0.005 | 0.004 | 0.00 | 0.006 | 0.005 | 0.00 | 0.004 |
| La | 0.225 | 0.200 | 0.209 | 0.193 | 0.227 | 0.216 | 0.209 | 0.203 | 0.211 | 0.208 | 0.210 | 0.219 | 0.21 | La | 0.213 | 0.216 | 0.218 | 0.212 | 0.21 | 0.208 | 0.216 | 0.21 | 0.207 |
| Ce | 0.421 | 0.393 | 0.409 | 0.451 | 0.456 | 0.425 | 0.410 | 0.410 | 0.405 | 0.389 | 0.420 | 0.424 | 0.41 | Ce | 0.412 | 0.411 | 0.420 | 0.401 | 0.40 | 0.382 | 0.401 | 0.39 | 0.396 |
| Pr | 0.044 | 0.043 | 0.044 | 0.053 | 0.046 | 0.043 | 0.042 | 0.043 | 0.041 | 0.042 | 0.050 | 0.047 | 0.04 | Pr | 0.043 | 0.041 | 0.043 | 0.043 | 0.04 | 0.041 | 0.043 | 0.04 | 0.044 |
| Nd | 0.148 | 0.152 | 0.151 | 0.194 | 0.159 | 0.150 | 0.143 | 0.151 | 0.135 | 0.147 | 0.150 | 0.153 | 0.14 | Nd | 0.145 | 0.142 | 0.149 | 0.146 | 0.14 | 0.142 | 0.146 | 0.14 | 0.145 |
| Gd | 0.006 | 0.009 | 0.009 | 0.013 | 0.008 | 0.010 | 0.008 | 0.009 | 0.006 | 0.010 | 0.010 | 0.008 | 0.01 | Gd | 0.010 | 0.010 | 0.009 | 0.009 | 0.01 | 0.010 | 0.011 | 0.01 | 0.009 |
| Dy | 0.001 | 0.001 | 0.001 | 0.002 | 0.000 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.000 | 0.001 | 0.00 | Dy | 0.001 | 0.001 | 0.002 | 0.001 | 0.00 | 0.002 | 0.001 | 0.00 | 0.001 |
| Sm | 0.018 | 0.020 | 0.020 | 0.029 | 0.020 | 0.020 | 0.018 | 0.020 | 0.016 | 0.021 | 0.020 | 0.020 | 0.02 | Sm | 0.018 | 0.021 | 0.021 | 0.021 | 0.02 | 0.020 | 0.021 | 0.02 | 0.019 |
| Eu | 0.000 | 0.002 | 0.001 | 0.003 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 | Eu | 0.001 | 0.000 | 0.000 | 0.000 | 0.00 | 0.000 | 0.000 | 0.00 | 0.000 |
| Ca | 0.029 | 0.057 | 0.036 | 0.016 | 0.023 | 0.028 | 0.042 | 0.059 | 0.042 | 0.059 | 0.030 | 0.028 | 0.04 | Ca | 0.051 | 0.062 | 0.036 | 0.037 | 0.04 | 0.06 | 0.033 | 0.05 | 0.035 |
| Pb | 0.003 | 0.004 | 0.004 | 0.002 | 0.003 | 0.003 | 0.005 | 0.004 | 0.006 | 0.005 | 0.000 | 0.003 | 0.00 | Pb | 0.005 | 0.004 | 0.004 | 0.004 | 0.01 | 0.005 | 0.004 | 0.01 | 0.004 |
| Total | 1.993 | 1.995 | 2.002 | 2.009 | 2.004 | 2.003 | 2.000 | 2.004 | 2.004 | 2.000 | 2.000 | 1.994 | 2.00 | Total | 2.008 | 2.008 | 2.009 | 1.997 | 2.00 | 1.997 | 1.996 | 2.00 | 1.995 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| X Hutt. | 0.045 | 0.034 | 0.066 | 0.026 | 0.03 | 0.065 | 0.068 | 0.032 | 0.089 | 0.037 | 0.06 | 0.041 | 0.07 | XHutt. | 0.055 | 0.030 | 0.064 | 0.062 | 0.07 | 0.043 | 0.065 | 0.08 | 0.076 |
| X Cher. | 0.06 | 0.117 | 0.073 | 0.032 | 0.047 | 0.058 | 0.085 | 0.12 | 0.085 | 0.12 | 0.06 | 0.058 | 0.08 | XCher. | 0.102 | 0.124 | 0.073 | 0.076 | 0.09 | 0.124 | 0.067 | 0.09 | 0.073 |
| X Mon. | 0.895 | 0.849 | 0.861 | 0.942 | 0.923 | 0.878 | 0.848 | 0.849 | 0.826 | 0.843 | 0.89 | 0.901 | 0.85 | XMon. | 0.843 | 0.846 | 0.864 | 0.862 | 0.84 | 0.833 | 0.868 | 0.83 | 0.851 |

X Hutt., X Cher,X Mon.: Mole fractions of Huttonite,Cheralite and Ce-La-Nd Monazite.

